# A RESIDENTIAL CONSTRUCTION MANAGEMENT COGNITIVE APPRENTICESHIP PROGRAM

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**Title**

## A Residential Construction Management Cognitive Apprenticeship Program

**By**

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The Supervisory Committee certifies that this ***disquisition*** complies with North Dakota State University's regulations and meets the accepted standards for the degree of

**MASTER OF SCIENCE**

## ABSTRACT

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**Background**

The U.S. Bureau of Labor's *Occupational Outlook Handbook* states that faster-than-average employment growth is expected in construction management with job openings projected to exceed qualified applicants (2008). Increasing complexity of projects, including sophistication of technology and new laws for building standards, will boost the demand for specialized management personnel (U. S. Bureau of Labor 2008).

**Purpose**

Obvious locales for the recruitment and training of construction managers are construction management baccalaureate degree programs. Because these programs educate for an occupation, it is essential for them to be aware of what the industry requires of its workers. The purpose of this study was to enhance the current curriculum of B.S. programs by redesigning the internship, creating a cognitive apprenticeship in the form of a prospectus having the capacity to be implemented by the construction industry and educators.

**Scope/Method**

This residential construction management apprenticeship model employs a cognitive apprenticeship learning structure designed by Allan Collins, John Seely Brown, and Susan E. Newman and seeks to educate students in residential construction management methodology (1989). Jack H. Willenbrock's (1994) *Management Guidelines for Growth Oriented Homebuilding Firms* is used as the theoretical framework taught to students from which they can gain analytical proficiency of management methods.

**Conclusions**

A practical, three-phase progressive model for a Residential Construction Management Cognitive Apprenticeship Program (RCMCAP) has been developed. This model can be used by institutions of higher learning for a likely increase of the number and quality of graduates entering residential construction at managerial levels.

## ACKNOWLEDGEMENTS

I would like to thank the National Housing Endowment for its funding of this research by way of awarding North Dakota State University the Homebuilding Education Leadership Program (HELP) grant.

## TABLE OF CONTENTS

## LIST OF FIGURES

# CHAPTER I. INTRODUCTION

## 1. Background

The United States Bureau of Labor contends that faster-than-average employment growth is expected in the field of construction management with job openings projected to exceed qualified applicants (U. S. Bureau of Labor 2008). Baccalaureate programs in construction management supply needed management personnel to the construction workforce and, thus, require a curriculum highly sensitive to the required skill set of the occupation. In keeping with a program-design sensitive to workforce necessities, North Dakota State University's (NDSU) Construction Management and Engineering (CM&E) Department applied for and was awarded a National Housing Endowment Homebuilding Education Leadership Program (HELP) grant in order to develop a cognitive apprenticeship—a model of learning using "methods not involving didactic [intentional] teaching but observation, coaching, and successive approximation" (Collins, Brown, and Newman 1989, p. 453).

Because funding for this project came from the National Housing Endowment, this thesis incorporates the idea of designing and implementing a cognitive apprenticeship program focused on residential construction for CM&E undergraduates. Currently, NDSU's Construction Management Program does not require internships. With HELP funds, a two-year project period to develop a formal cognitive apprenticeship program for training mangers and leaders in residential construction management began in the spring of 2009. The goals of developing this cognitive apprenticeship program include enhanced education of students, expanding the scope of the residential option within the Construction

Management and Engineering (CM&E) Department at NDSU, and establishing stronger ties with the residential construction industry.

## 2. Research Question and Methodology

Considering the projected need for construction managers, a mandate exists for construction management baccalaureate programs to produce students who have both the academic training and actual field experience to deal with the complex issues facing the construction industry including the homebuilding sector. Therefore, the overarching issue is as follows: "How can construction management programs at the baccalaureate level be improved to better prepare students entering the residential construction field including instilling in students the abilities and skills to adapt to changes in future building technologies and regulations?" Within the context of the above query, this thesis deals with the specific question, "Can the internship program currently used by construction management baccalaureate programs be advanced to increase the preparedness of future construction managers by instituting a cognitive apprenticeship feature?"

In attempting to answer the above questions, this research employed a type of qualitative methodology within ethnography called historical inquiry. C.H. Edson writes in the article, "Our Past and Present: Historical Inquiry in Education" about the value of historical inquiry:

> History may inform our understanding of research by counteracting the empiricism and quantification that dominates educational research today. By ignoring the concerns of qualitative research, non-qualitative approaches often limit our ability to ask questions, fail to unmask common assumptions, deny the complexity of experience, and restrict our frames of reference. (1990, p. 49)

In education, historical inquiry can help researchers understand ideas such as: many institutions besides schools have curricula educating young people, that what is intended by

the curricula is not necessarily what is internalized by students, and that students constantly make connections between the content in formal and informal education (Edson 1990).

Utilizing an historical investigation into apprenticeship in construction, this research seeks to examine current apprenticeships in a larger context, examine what has been and can still be improved upon in trades and construction apprenticeships, and to better understand what is worth using and keeping in construction management baccalaureate internships/apprenticeships. As the educator C. H. Edson wrote: People often "—view the past as an obstacle to progress, fail to see the continuity between the past and the present, and are unable to understand themselves as a part of the whole they seek to examine and understand" (Edson 1990, p. 56). By examining historical sources discussing the history of apprenticeship in the U.S.; trades' apprenticeships; baccalaureate programs curriculum; and the origins of cognitive apprenticeships in education and psychology, it is hoped the structure of qualitative inquiry, manifested in particular historical works, will broaden understanding of this curriculum design (Edson 1990).

Using an historical inquiry methodology, the methods for this thesis included 1.) documenting the historical development of the apprenticeship concept, 2.) documenting the use of the apprenticeship model in the construction trades, 3.) documenting the mechanics of existing residential construction internship programs at the baccalaureate level, 4.) reviewing previous "cognitive apprenticeship" applications and how they can be adapted to residential construction management, 5.) integrating the apprenticeship with the management theoretical framework provided in *Management Guidelines for Growth Oriented Homebuilding Firms* (Willenbrock 1994), 6.) using all of the above information to create a Residential Construction Management Cognitive Apprenticeship Program

(RCMCAP), and 7.) surveying select residential construction industry professionals and NDSU construction management students to solicit feedback for improving the RCMCAP. These steps are reflected in Figure 1.

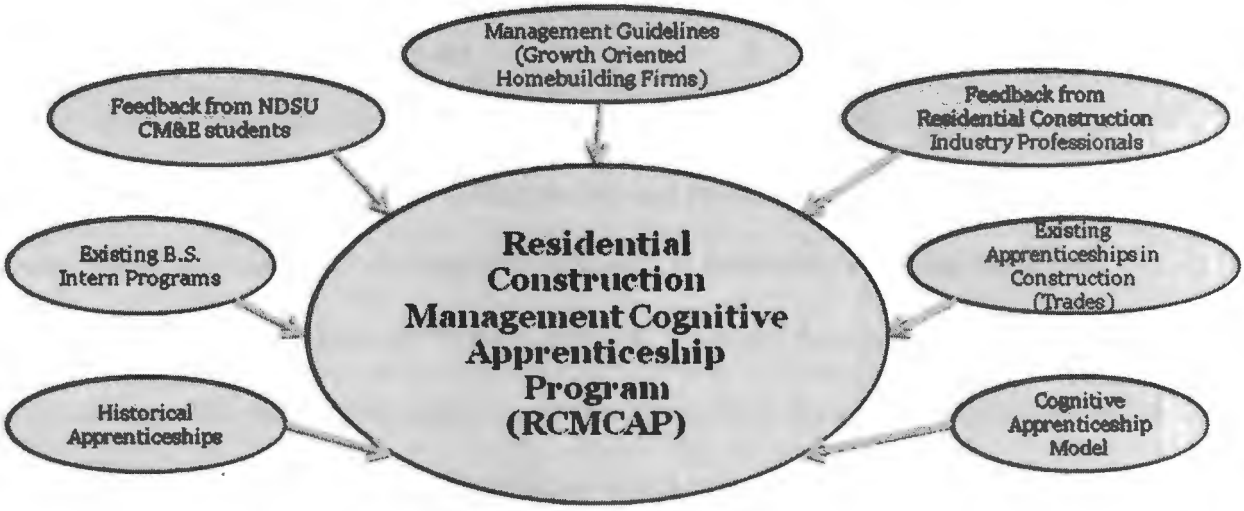


Figure 1. Development of the RCMCAP Program.

### 3. Research Objectives

Critical analysis of internships or apprenticeships within construction management is sparse. The common use of traditional-type internships within this field, while useful, leaves room for improvement because managing construction projects is a complex, ever-changing job that requires critical thinking and clear communication skills (U.S. Bureau of Labor 2008-09). The application of cognitive apprenticeships to construction management students' education creates a new direction for developing future leaders in the construction industry. It attempts to make overt the learning process of managing in a field where tangible results need to be visible but where there is a world of intangible actions for which managers are accountable in a well-run construction project. Thus, the design and development of cognitive apprenticeships incorporate two aspects of construction

management. First, the design focuses specifically on residential construction, and employs the concept of cognitive learning —i.e. the mental process by which knowledge is acquired—to the apprenticeship experience.

### 4. Research Contributions

A model for a Residential Construction Management Cognitive Apprenticeship Program has been developed. The model can be used by institutions of higher learning to assist in training students in residential construction at the managerial level. Successful implementation of the model will require dedicated resources from both the academic institutions and the residential construction industry (in the form of mentors), as well as the student apprentices. The RCMCAP is a rigorous and very structured program, but has the potential to help foster the development of future leaders for the residential construction industry.

### 5. Overview of the Thesis

This thesis documents background information through an extensive literature review exploring the History of Apprenticeships and Modern Apprenticeships in the United States as well as a brief overview of construction management education. A Formal Definition of the Problem and Specific Research Objectives are followed by the Research Methodology, Data Collection, and data analysis; these sections all contribute to developing the Residential Construction Management Cognitive Apprenticeship Program. The Conclusions and Discussion follow and include a summary of this research, research significance, and future areas of research. The appendices contain the supplemental documentation to support this research effort.

## CHAPTER II. BACKGROUND INFORMATION AND LITERATURE REVIEW

According to the educator C. H. Edson, "As a mode of qualitative inquiry, history serves as an important corrective for researchers by counseling that our understanding...is limited" (Edson 1990, p. 56). In the past, the apprenticeship model was often designed by tradition and regulations and those historical features of apprenticeship and training used in construction were worth examining in crafting the RCMCAP; therefore, the following chapter uses historical narrative to describe: the history of apprenticeships, how apprenticeships are currently utilized in the United States, the structure of internship programs in construction management departments, and the development of cognitive apprenticeships.

### 1. History of Apprenticeships

Apprenticeship, in its most basic definition, is learning by doing. This thesis focuses on modern-day apprenticeship in the United States, specifically the on-the-job learning used by college and university programs of construction management. However, while the above type of baccalaureate degrees are a fairly new development, apprenticeships are ages old and, at certain points and places in history, were the main form for educating and training young people (De Munck, Kaplan, and Soly 2007). For this review, the two defining books on the history of apprenticeships in the trades are the following: Learning on the Shop Floor: Historical Perspectives on Apprenticeship (De Munck, Kaplan, and Soly 2007) which is an anthology containing papers on the apprenticeship systems in Europe, and The Craft Apprentice: From Franklin to the

Machine Age in America (Rorabaugh 1986), a book focused on the early United States apprentice system.

### 1.1 The Apprentice of Early Modern Europe

The United States apprenticeship history was largely influenced by Europe's system. More specifically, England's system was the law of the American colonies until they declared independence in 1776. Jonathan Reinarz states in his article, "Learning by Brewing: Apprenticeship and the English Brewing Industry in the Late Victorian and Early Edwardian Period," that, although apprenticeship "was not the only means of acquiring skill in past centuries, it was, arguably, the single most important" (Reinarz 2007, p.112). The reason for acquiring an apprenticeship, of course, is to become a master and to have an occupation where one can make a living. Historically, ways of becoming a master existed without apprenticing: one could buy an expensive "member of mastership" or marry a master's widow, but the vast majority of masters were apprentices at one time (De Munck et al. 2007). For example, by the end of the 17$^{th}$ century, 70 to 80% of Dutch males were included within the guild system (De Munck et al. 2007).

Apprenticeships existed as a transmitter of knowledge, skills, and socialization of young people into the corporate order (De Munck et al. 2007). In training and education, the desired result was to produce new, expert practitioners, but beyond that, an apprenticeship was a principle means to discipline labor and maintain a distinction between ranks in society, thus upholding order and hierarchy (De Munck et al. 2007). Historically, apprenticeships involved the drafting of a contract, or indenture, binding a young servant to a master in exchange for a fee and a designated term of service, generally lasting between four and seven years (Reinarz 2007). A master agreed to teach an apprentice the secrets of

a trade as well as to assume responsibility for the pupil's moral welfare, board, and lodging (De Munck et al. 2007). The average age for apprentices was 15 or 16, but poorer children could be apprenticed as early as 12 (De Munck et al. 2007).

Apprentices had a contract, but, for example, 16th century European dropout rates ranged anywhere from 20% to 60% (De Munck et al. 2007). Apprentices left because of ill treatment, including physical abuse, inadequate nutrition, and because they were only assigned menial tasks (De Munck et al. 2007). Also, masters could and did terminate apprenticeships because the apprentices had a physical ailment, were chronically ill, or were unsuitable for the job (De Munck et al. 2007).

The problem of apprenticeships was whether each party (master/apprentice) would honor the agreement (De Munck et al. 2007). Therefore, some researchers argue that more important than the information passed-on during an apprenticeship was the information withheld (Rorabaugh 1986). As training approached its conclusion, apprentices became an increasingly valuable asset to a master's workshop as well as a potential competing shop owner (De Munck et al. 2007). Often, neither masters nor journeymen were inclined to make an effort to train apprentices. Those individuals knowledgeable in the trade regularly preferred to use apprentices as general helpers, leading apprentices with a strong desire to learn to "steal with their eyes" because they were not actually taught the high-level skills needed to become an expert (De Munck et al. 2007, p. 14). Nonetheless, apprentices more often than not finished their training having acquired useful skills; professional contacts; and the potential to, one day, become a master (De Munck et al. 2007).

### 1.2 Guilds

In Europe, powerful guilds most often controlled apprenticeships. A guild was a corporate body regulating a specific trade, such as cabinet making or tailoring. The guild system of apprenticeship became a way of preserving political power, social prestige, and economic capital (De Munck et al. 2007). Guilds established regulations regarding apprenticeships, often including who and how many people could be apprenticed, and maintained a supervisory role in the training offered by the masters (De Munck et al. 2007). Thus, organizing apprenticeships within guilds restricted qualified workers to a limited number of employers and gave individual masters a greater incentive to invest in an apprentice's training (De Munck et al. 2007).

Generally stipulated in a guild's bylaws were the following: the registration of apprentices, amount of apprenticeship fees, duration of an apprenticeship, and the number of apprentices per master (De Munck et al. 2007). Some guilds also had "creation of masterpiece" as a requirement at the completion of an apprentice's training (De Munck et al. 2007, p.68). Under the guild system, apprentices were legally the sole workers eligible for employment in corporate workshops (De Munck et al. 2007).

Beyond the above regulations, guilds seldom defined a master's qualifications or the content of an apprentice's training (De Munck et al. 2007). Occurrences like sickness and/or death of a master or apprentice were most often addressed on an individual basis (De Munck et al. 2007). Furthermore, as powerful as many guilds were, historical records show that a guild's set guidelines were often blatantly disregarded by people in the trades (De Munck et al. 2007). Guilds' control and design varied widely, and many apprenticeships existed without these governing bodies (De Munck et al. 2007).

### 1.3 British Influence on Apprenticeships in the United States

Two laws specifically defined English apprenticeships. The first one was the Statue of Artificers of 1563 which required parents to bind their sons to a trade or agriculture unless they had other means of support (Rorabaugh 1986). The second law was England's Poor Law of 1601, requiring local authorities to bind children whose parents were unwilling or unable to do so; however, pauper apprentices were not guaranteed a written indenture until 1691 (Rorabaugh 1986; Reinarz 2007).

For the next century in England, this statutory apprenticeship system appears to have guaranteed employment and limited competition and, in this manner, maintained workers' earning while also ensuring a certain level or standard of workmanship (Reinarz 2007). By the late 18th century, this system had broken down in many industries, including textiles, as economic and social change weakened the authority and organization of guilds (Reinarz 2007). The English apprenticeship system was further weakened as a result of children, often very young, being sent to work in newly formed factories instead of apprenticing (Reinarz 2007).

In more modern times, apprenticeship, often seen as a penance for poor children, was brought into disrepute and was said to have been formally buried with the repeal of the Elizabethan Statue of Artificers in 1814 (Reinarz 2007). With the absence of any legislated safeguards, exploitative forms of industrial training for young people increased, flourishing in the 19th century (Reinarz 2007).

Reflecting changed perceptions of childhood, organizations such as churches began investing in children's formal education by sending them to schools, rather than to manufacturing sites such as textile mills (Reinarz 2007). Educators and the general

population, for a long time, viewed apprenticeships as the goal for poor children, but as the 19th century ended, education reformers viewed apprenticeships as too expensive, difficult to obtain, and a thing which led to an uncertain future for the poor (De Munck et al. 2007). Considering the above reasons, these reformers preferred a classroom type of general education for all children (De Munck et al. 2007). All of these laws plus industrialization influenced apprenticeships in the United States.

### 1.4 Apprenticeships in the United States

Although the apprenticeship system most influential to the United States was that of England, guilds failed to develop, a likely consequence of less available labor and a much less-structured and less-traditional society (Hamilton 2000; Rorabaugh 1986). Because the United States was a British colony, both the Poor Law and the Statue of Artificers applied stateside, but were much less stringently enforced (Rorabaugh 1986). In the United States, the practice of importing indentured servants weakened apprenticeships, and in the southern colonies, slavery led to a different type of craft system (Rorabaugh 1986).

The revolutionary war caused a frail U.S. apprenticeship system to become even weaker because, after the war, masters had little legal and actual control over apprentices (Rorabaugh 1986). At the same time, apprenticeships were still fairly common in many areas as evidenced by mayoral records in Philadelphia showing that approximately half the young male population of that city signed apprenticeship indentures between 1771 and 1773, and those records excluded father-son pairings (Hamilton 2000).

During the 1800s, more laws were enacted, attempting to strengthen government across the United States, including laws created to control apprenticeships, such as legal redress for dealing with runaway apprentices (Rorabaugh 1986). However, through

advances in technology in the 1800s, local production for local use gave way to concentrated production for nationwide use, meaning large factories were replacing smaller workshops (Rorabaugh 1986). Gillian Hamilton suggested one theory for the decline in apprenticeships during the 19th century in her article "The Decline of Apprenticeship in North America: Evidence from Montreal":

> A widespread drop in masters' propensity to sign contracts characterized the initial downturn—a grassroots rejection that spanned trades and occurred in what were likely small artisan shops. Changes in compensation and the nature of the contracts indicate that masters initially responded to a greater difficulty in enforcing the traditional long-term arrangement (a consequence...of rapid postwar population growth). The lure of high-paying jobs in larger, factory-like, firms also had an adverse affect on the apprentice market, but direct signs of this effect do not appear until the late-1820s and 1830s. (2000, p. 629).

As Hamilton suggested, the 1800s brought the most drastic changes to the apprenticeship system. Previously, few other options for young people to earn a living existed, but with the development of factories, youth could earn immediate wages (Rorabaugh 1986). In the new, large-scale factory system, immediate cash wages were paid. As cash wages developed, it affected the apprenticeship model of room and board in exchange for learning a craft (Rorabaugh 1986). Textile mills, for example, were the first to offer apprentices' wages for their work (Rorabaugh 1986). Paying apprentices shifted the definition of apprenticeship itself (De Munck et al. 2007). In the new cash-wage society, masters tended to ignore runaway apprentices and just hired new ones, but penalties remained for a master hiring a runaway apprentice (Rorabaugh 1986).

By the 1820s, craft organizations had withered (Rorabaugh 1986). In the 1830s, better economic conditions led to shortages of workers in many trades, and the remaining workers gained higher wages and shorter hours (Rorabaugh 1986). Journeyworkers successfully fought to get a 10-hour workday (Rorabaugh 1986). Until that time, if

journeyworkers went on strike, masters often hired apprentices as their replacements, and this undercutting action became less common with the withering apprenticeship system (Rorabaugh 1986). Also, the early 1800s brought the creation of the U.S. public school system. Mandatory schooling combined with technological advances caused people such as shoemakers, weavers, silversmiths, potters, and cabinet makers, among others, to face extinction as those masters, habitually unable to find amenable trainees, were replaced by unskilled machine tenders (Rorabaugh 1986). Finally, immigrants were entering the labor market and taking over many crafts and factory jobs (Rorabaugh 1986). By the 1850s, immigrants constituted a majority of skilled craftworkers in most large cities (Rorabaugh 1986).

When the Civil War began, apprentices rushed to join the army (Rorabaugh 1986). In the decade after the Civil War, with apprenticeships disappearing, boys were, instead, hired as unskilled labor, a designation which alarmed labor leaders (Rorabaugh 1986). In the rural United States, apprenticeships held on longer, and in southern states, the apprenticeship was intertwined with slavery: a slave with artisan skills was worth three times as much as a field hand (Rorabaugh 1986). Slaves were often craftspeople on plantations because it was more economical to have a slave trained as a blacksmith, for one example, than to hire a white craftsperson (Rorabaugh 1986). The few white artisans in the south rarely took on apprentices (Rorabaugh 1986).

Manual labor was not considered proper work for whites; the U.S. elite had always held craftspeople in low regard, so it was not disconcerting for whites in power to have blacks become craftspeople (Rorabaugh 1986). Many black people had been trained in a variety of crafts; however, when free black people worked alongside whites, during

economic downturns, white workers consistently demanded something be done to get rid of black workers (Rorabaugh 1986).

As trade unions developed into their modern-day forms in the United States, discrimination against people of color within the trades remained. In an article from 1967 titled "Discrimination and the Apprentice Regulation in the Building Trades," Richard Rowan discussed the impact of Title VII of the Civil Rights Act of 1964 against discrimination in employment in trade unions. In fact, the first injunction requested by the U.S. Department of Justice pursuant to Title VII was aimed at three building-trade unions: the International Brotherhood of Electrical Workers, the United Association of Plumbers and Steamfitters, and the Sheet Metal Workers International Association (Rowan 1967). The Department of Justice sought a court order to permit black tradesmen, a people who, as a group, had not previously been allowed into these unions, to work (Rowan 1967). Rowan wrote:

> The closed-shop principle, which requires union membership as a condition of employment, has given unions in the building trades control over hiring. This has resulted in a high percentage of white members in the craft unions. Indeed, it would be unusual to find more than a few Negroes represented in an apprentice training program in any state at any time. (1967, p. 436)

Race discrimination was rampant in trade unions across the country, and in 1963 and 1964, demonstrations were organized at construction sites in several major cities, protesting the overt racist practices (Rowan 1967). While improvements were made, most trade unions in the United States are still dominated by white males.

### 1.5 Women and Apprenticeships

Craftwork offered fewer opportunities for women. Paradoxically, women fared better in Europe's apprentice system in the late middle-ages than in the early modern

period (De Munck et al. 2007). It appears that, as guilds developed into more organized units, increased barriers were erected against the entrance of women, and in many guilds, women were only allowed to run a shop when they were widows of a master who owned a shop (De Munck et al. 2007). However, women could be found in a few crafts, such as the garment trades, food processing, and some textile or retail, but in all cases, they were paid abysmally (De Munck et al. 2007).

In her article "'To Learn Me the Whole of the Trade': Conflict Between a Female Apprentice and a Merchant Tailor in Ante-Bellum New England," Jo Anne Preston discussed the experiences of a young woman from a farm in New Hampshire who apprenticed with a tailor. Often, young women who grew up on farms were exploited as cheap labor and never taught the requisite skills of the trade in which they were apprenticed. Without certain critical skills, women apprenticed as tailors, for example, were forced to remain shop girls, often continuing to work for the tailor with wages comparable to and sometimes lower than those paid to female textile-factory workers. Rather than becoming masters of the trade, most women of this time period remained shop girls, working 14-16 hour days while barely able to pay board with their low wages, and they did not fare better in other crafts (Preston 1983).

In the early 19$^{th}$ century United States, tailored clothes were in demand, and farmwives frequently did not have skills beyond the making of simple garments; therefore, women who could learn "tailoring" were assured a good wage (Preston 1983). The cutting of the garment was the skill most coveted and most hidden by masters (Preston 1983). The woman Preston observed in her article finally did learn how to "cut," but Preston noted from the letters written to family members, it was unclear how she acquired the knowledge,

and it looked possible that she was not directly taught the coveted skill by the master (Preston 1983).

## 2. Modern Apprenticeships in the United States

Links remain among vocational training, trade unions (guilds), and schools/popular education (De Munck et al. 2007). Apprenticeships continue to play a role in modern society even though they are no longer the main form of education for young people (De Munck et al. 2007). At present, apprenticeships are usually a formalized system combining supervised, on-the-job training with related classroom instruction. Although guilds and laws like the Statue of Artificers are long gone, the U.S. federal government does define apprenticeship programs.

Unregulated until 1911, modern apprenticeships in the United States began in Wisconsin (Winters 2005). Shortly thereafter, the federal government established guidelines for officially sponsored apprenticeships (Winters 2005). Currently, from retail, to hospitality, to construction, programs are operated by both the public and private sectors in an array of fields (Career Voyages n.d.).

Apprenticeship sponsors, i.e., employers, employer associations, and labor-management organizations, register programs with federal and state government agencies (Career Voyages n.d.). Oversight of registered programs is provided directly by the U.S. Department of Labor for 25 states and through state-approved agencies in the other 25 (CPI 2009). The legislative regulation of apprenticeship programs creates a unique immersion training system and sets them apart from other training such as paid internships (CPI 2009). As was done historically, the apprentice and the program sponsor sign an agreement containing the terms and conditions of employment as well as the training of the apprentice

(CPI 2009). Included in the agreement is the graduated wage scale to be paid to the apprentice, the required hours and skills learned in on-the-job training, and related technical instruction and performance standards (CPI 2009). A registered apprenticeship program must meet government-mandated standards for the quality and quantity of instruction, and the sponsor must provide adequate and safe equipment and facilities; safety training; and, usually, between 2,000 and 8,000 hours of on-the-job training (CPI 2009).

### 2.1 Construction Apprenticeships

Essentially, two types of jobs exist in the construction industry. One type includes livable wages, healthcare and pension benefits, safe working conditions, career stability, and opportunity for advancement (CPI 2009). The other consists of low pay, no benefits, stagnation of tasks and job level, dangerous conditions, and frequent periods of unemployment (CPI 2009). In 2007, the construction industry accounted for 20% of workplace deaths and 10% of all workplace injuries (CPI 2009).

### 2.2 Union Apprenticeships

Often, apprenticeship programs in construction help people avoid more hazardous aspects of the occupation by providing career paths with better training; wages; and, often, health insurance and other benefits (Winters 2005). The construction employers said that, in general and depending upon the trade and individual, apprentices can become profitable in about six months: that is to say that the apprentice has sufficient skills that he/she can be substituted for many journeyworker tasks on a crew, lowering composite crew costs (Winters 2005).

In the organized sector, contractor participation in training is mandatory. Collective-bargaining agreements historically include provisions for apprenticeship training that specify the obligations of both the union and signatory employers, including cents per labor-hour training charges that contractors are required to pay to the training trust fund (Bilginsoy 2007). Thus, with union employment, employers do not provide training to a specific worker but participate in the training of a pool of workers (Bilginsoy 2007). Union apprenticeship programs are sponsored by a local joint apprenticeship training committee composed of representatives from the union and contractors (Bilginsoy 2007). The union has a dual role in acting both as an agent of the apprentice, ensuring the pupil receives the promised skills and is not taken advantage of as cheap labor, and also acts as a gatekeeper of skilled labor, screening new entrants into the craft workforce for the requisite qualifications (Bilginsoy 2007). Hence, unions like the International Brotherhood of Electrical Workers (IBEW), with its National Joint Apprenticeship and Training Committee; the United Brotherhood of Carpenters; the International Union of Bricklayers and Allied Craftworkers; and Ironworkers Local all have apprentice programs lasting around 3-5 years.

For example, the National Joint Apprenticeship and Training Committee (NJATC) for the electrical union was created in the first half of the 20$^{th}$ century and has developed into what is, perhaps, the largest apprenticeship and training program of its kind (NJATC 2009). Local programs affiliated with the NJATC have trained over 350,000 apprentices to journeyworker status (NJATC 2009). This joint program between the National Electrical Contractors Association (NECA) and the International Brotherhood of Electrical Workers (IBEW) demonstrates a cost-effective way to train qualified craftworkers in residential,

linemen, tree trimmers, and inside wireman telecommunication voice-data-video installer-technicians (NJATC 2009).

Those individuals in NJATC training programs earn wages while learning (NJATC 2009). With this program, apprentices work 40-hour-weeks and then spend at least 4 hours a week in classroom settings (Wolfe 2009). In aggregate, the apprenticeship requires 8,000 hours of on-the-job training and 900 hours of classroom instruction, including the requirement of passing 12 exams a year as well as a midterm and final; lastly, the program requires passing the state licensing exam in order to advance to a journey electrician (Wolfe 2009).

Beyond—or before—apprenticeship training, many construction companies and unions are now using pre-apprentice training programs that are often implemented by community or technical colleges, or non-profit organizations. These programs, usually lasting about 13 weeks, often yield an early indication of whether the apprentice candidate has the basic skills and work ethic demanded in the construction trades (Winters 2005). Apprentice candidates completing the pre-apprentice training and deciding to enter a formal apprentice program begin with a basic skill set that is immediately useful to the employer, particularly in the knowledge of safety, terminology, and tools (Winters 2005). Employers often offer apprentices who go through pre-apprentice programs higher-than-required percentages for journeyworker base-pay rates (Winters 2005).

### 2.3 A Wisconsin Case Study of Apprenticeships

Southeastern Wisconsin construction journeyworkers' average annual earnings are $42,582, which is $7,712, or 22%, more than the average Wisconsin workers' earnings (Winters 2005). Also, construction journeyworker benefits contribute a sizable portion of

total compensation and include healthcare insurance, pension, savings, union dues, and other support programs (Winters 2005).

An interesting comparison of a journeyworker's cost for training is to that of a Wisconsin university student. State funds to the University of Wisconsin (UW) System in fiscal year 2003-04 were $1.0 billion dollars (Winters 2005). With 120,037 full-time undergraduate students in the UW System in 2003-04, the state average funding per pupil was $8,354 per year at approximately 4 years of education (Winters 2005). UW System students earn about $7,080, on average, per year in jobs during the academic year and through the summer (Winters 2005).

Conversely, apprentices in construction enter a contract with an employer for schooling in a trade and on-the-job training (Winters 2005). The apprenticeship generally lasts three to five years, depending upon the trade; e.g., bricklayer, ironworker, and operating-engineer apprenticeships last three years while the electrician, plumber, and sheet metal-worker programs are five years (Winters 2005).Upon completion of an apprentice program, a new southeastern Wisconsin construction journeyworker can expect to make about $23.76 per hour, or $49,428 per year (Winters 2005). This wage compares with the national average for a college graduate's annual income of roughly $51,000 (Winters 2005). However, the amount is average earnings of all college graduates in the workforce, not just recent graduates (Winters 2005). Furthermore, the earnings may, over the long-term, be comparable, but expenses are not (Winters 2005). UW System graduates spend about $56,000 to obtain their degree (Winters 2005). University graduates begin their careers with about $16,500 of debt (Winters 2005). Journeyworkers begin their careers with very little debt and have drawn wages and paid taxes throughout the apprenticeship

training period (Winters 2005). The net difference in employment training is estimated at nearly $160,000 per person (Winters 2005). As Robert Wolfe, the training director for the Dakotas and Western Minnesota area-wide NJATC suggested, "Apprenticeship is one of the best kept secrets in America" (Wolfe 2009).

### 2.4 Apprenticeship Drawbacks

Apprenticeship programs in the construction industry, while often cost-effective training models, are, of course, not perfect. The quality and extent of training are sometimes contested issues (Bilginsoy 2007). While all registered programs are required to abide by the basic federal or state apprenticeship standards, individual sponsors make decisions regarding organization, admission, and curriculum (Bilginsoy 2007). The highly scattered and decentralized structure of the system potentially produces substantial variability in terms of operations and practices within each type of program (Bilginsoy 2007).

The organized sector (unions), which historically carried out the task of training new workers through formal apprenticeship programs, often accuses the open-shop contractors of not providing bona fide training and poaching on union-trained workers (Bilginsoy 2007). The union sector of the construction industry is in decline and, hence, so are its training programs. In 1966, 41.3% of construction workers were union members; in 2001, the rate of membership was 18.4%; either unions need to rejuvenate their workforce, or substantial training needs to come from other places (Worthen and Haynes 2003). Today, the pressure on union contractors to compete with their open-shop counterparts, along with the pressure on the union itself to organize better, is forcing a new look at the role of apprenticeships in training a productive workforce (Byrd 1999).

In the 1970s, according to instructors and JATC members, the majority of carpenters' apprentices were the young sons, nephews, and other close relations of carpenters and other craftspeople (Byrd 1999). That situation does not seem to be the case in 1997 (Byrd 1999). Not only is the average age of apprentices higher, but fewer apprentices have close relatives in the trade (Byrd 1999). Thus, where in the past, recruitment to the program was often a simple matter of steering a son or nephew toward the appropriate union hall and a willing contractor, this informal system seems no longer applicable to the majority of new applicants (Byrd 1999).

If one looks at the carpentry trade, the work performed on commercial projects has become more specialized (Byrd 1999). Ostensibly, apprentices are required to work and receive training in a wide variety of tasks, but their on-the-job experience is sometimes limited to just one area like framing, form work, or finishing (Byrd 1999). Furthermore, among working carpenters, attitudes toward the apprenticeship are not always positive (Byrd 1999). While entry to some trades requires stringent written and/or performance tests, or intensive interviews, entry to the carpentry apprenticeship program requires simply a minimum age of 18 with a high school diploma or GED as well as the ability to find work (Byrd 1999). Although classroom training in the carpentry apprenticeship program is often technical and requires skills in trigonometry and geometry, surveying, blueprint reading, and traditional tools and work process knowledge, apprentices are not required to pass exams in order to advance (Byrd 1999). Among many working carpenters, classroom training is not held in high regard, and carpenters frequently claim that they "learned everything on the job" (Byrd 1999, p15).

### 2.5 Case Study: The Building Bridges Project

Getting into a union building-trade apprenticeship program is a slightly different process than typically used when applying for a job. The boundaries of apprenticeship programs can seem complicated because they are shaped by history, Department of Labor regulations, and the labor market (Worthen and Haynes 2003). In reality, the system is implicitly geared to work best for certain types of individuals.

Because union membership is on the decline, unions are looking at increasing hiring among women of all races and men of color: people who have historically been excluded from membership (Worthen and Haynes 2003). One example of this effort to diversify the union workforce is The Building Bridges Project in Chicago. Minorities in Chicago are often weary of unions they see as bringing in all white men from the suburbs to do work in their neighborhoods (Worthen and Haynes 2003). This project allowed unions to work on their image as well as to draw minorities into membership.

The Building Bridges Project is a pre-apprentice training program for people of color who are considering work in the building trades and was sponsored by a half dozen trade unions, churches in minority communities, and The Chicago Interfaith Committee. The program was an 11-week class with no hands-on skill components (Worthen and Haynes 2003). The course was designed to help people apply for apprenticeships and to learn what to expect with the apprenticeship process (Worthen and Haynes 2003). The instruction included education about required paperwork, prep classes for taking the pre-apprenticeship tests, and knowledge about the work via visits from minority journeypersons who spoke about personal experiences in the union (Worthen and Haynes 2003).

In the results reported from the pilot of the Building Bridges Project, of the 81 people who graduated, only 15 people were either working union jobs or "making normal progress" toward acquiring apprenticeships (Worthen and Haynes 2003). Interviews were completed with the graduates, showing that, even with this classroom instruction, barriers remained for people wanting apprenticeships (Worthen and Haynes 2003). For example, many apprenticeship programs require a person to have reliable transportation, most often in the form of a personal car, but that transportation is something people below a certain income level and people living within large cities often do not own (Worthen and Haynes 2003). Also, union halls are usually located outside city bus routes, and if participants had vehicles, they were unfamiliar with places where required tests were given (Worthen and Haynes 2003). Furthermore, upfront costs for joining a union can run into the hundreds of dollars (Worthen and Haynes 2003). From the union perspective, these costs are an investment into a future where one can make $60,000 a year, but for people in generational poverty, those hundreds of dollars can be hard to acquire (Worthen and Haynes 2003). Another barrier can be language. In Chicago, with a large Latino population, teaching should be bilingual, yet most unions do not provide any instruction in Spanish and are often hostile to doing so (Worthen and Haynes 2003). Finally, the windows for accepting new apprentices can be few and far between, particularly in down economies, and waits to get called-up can sometimes be more than a year, causing people not used to the process to become frustrated and lose their focus on joining (Worthen and Haynes 2003).

### 2.6 The Gender Gap

Since the late 1970s, with the growing awareness of the feminization of poverty and the persistent wage gap between men and women, considerable attention has been paid to

the skilled construction trades as a non-traditional source of high-paying jobs for women (Byrd 1999). There have, however, been only slight gains in the proportion of women in construction occupations even after a series of initiatives intended to promote progress in this area, such as the passage of Title VII of the Civil Rights Act, the issuance of Executive Order 11246 in 1978, the filing of lawsuits, the organization of tradeswomen's advocacy groups, and the allocation of millions of dollars in grant funding for ameliorative programs (Byrd 1999).

There is no construction craft category that, at present, consistently has more than 9% female representation (Byrd 1999). Interviews with women who work in the trades tell a now-familiar story of harassment, discrimination, and isolation from other women on the job (Byrd 1999). Below is a summary of a 1999 study executed by Barbara Byrd who examined the results of women looking to acquire union apprenticeships in commercial carpentry.

In 1996, the carpentry apprenticeship program had been in existence for almost 90 years, admitting its first woman apprentice in 1973 (Byrd 1999). Women's low representation in the carpentry union (below 5%) was assessed by Byrd to often be the fact that contractors would not hire women. Generally, there are two major pathways into the carpenters' apprenticeship program (Byrd 1999). The formal procedure is to go through a union hall and get sent to a contractor who has put in a request to the union for an apprentice (Byrd 1999). This process was followed by most women applicants (Byrd 1999). However, especially during the rapid growth in the construction workforce of the 1990s, the informal and more common method of becoming an apprentice was to first be offered work by a union contractor, and then be sent to apply to the apprenticeship program

with the union (Byrd 1999). The particular selection procedure the carpenters were using is sometimes referred to as a "hunting license" approach because the applicant must hunt for and secure a job prior to being admitted (Byrd 1999). The apprenticeship program has now adopted an alternative selection procedure using an objective rating scale; nonetheless, it remains the case that most carpenter apprentices and most journeyworkers continue to seek work without using the dispatch system (Byrd 1999). As long as contractors have this option, their desire for certain workers—i.e., males—functions as an institutionalized part of the system and continues to make it difficult for women to find work and join the union (Byrd 1999).

Over half of the women whom Byrd interviewed tried to find work in the trade but were unsuccessful even when they had prior construction experience (Byrd 1999). The women described many of the same problems male applicants cited, including unfamiliarity with hiring procedures in commercial construction and transportation difficulties, but also provided examples of what they considered to be discrimination against them because they were women (Byrd 1999). One woman quoted a foreman as telling her she ought to apply for the electrical apprenticeship program because, as he explained, it was a better trade for a woman (Byrd 1999). Some apprentices speculated that employers seemed to hire women on the basis of their appearance (Byrd 1999). Women do not often look like they can handle the job because the employers have a bias about what a good worker looks like, namely, a big, hefty man (Byrd 1999). One current apprentice described the experience of going to dozens of sites looking for work (Byrd 1999). She went back to one site five times because they were importing people from a distant state to

work, and after the fifth visit, the company finally hired her (Byrd 1999). Others confirmed that only through dogged persistence did they land their first position (Byrd 1999).

Little of what those individuals hired or the unsuccessful applicants encountered was overt, illegal discrimination (Byrd 1999). The danger of lawsuits is well known, and one rarely hears the kind of blatantly sexist language documented by past studies (Byrd 1999). However, comments about women's inability to perform hard physical labor are common on job sites, as is speculation that women are only working until they find a husband, or that a woman's presence on the job is disruptive (Byrd 1999). Unfortunately, for the long haul, working in such conditions is often debilitating (Byrd 1999). The extent to which journey-level women leave the carpentry trade is a reflection of the enormous energy it takes for a tradeswoman to work in such an environment for any length of time (Byrd 1999). Once a woman is able to leap the giant hurdle of getting hired, remaining is still another battle for her in apprenticeship programs.

### 2.7 Apprentices in the Non-Union Sector

In the open-shop sector, there are no institutions requiring companies to invest in training (Bilginsoy 2007). Since the 1970s, however, contractor associations have attempted to promote cooperation and coordination across individual companies and have organized multiple employer programs to facilitate training (Bilginsoy 2007). The most prominent among the providers is the Associated Building Contractors (ABC; Bilginsoy 2007). With ABC, training committees of the local chapters carry out the daily tasks of the program, including arrangement of in-class training (Bilginsoy 2007). Most workers have an employer at the time they apply to these apprenticeship programs, and the employer pays for the tuition and other expenses of the training (Bilginsoy 2007). It is not clear to

what extent sponsoring employers coordinate job rotation across contractors and projects (Bilginsoy 2007).

For the most part, the open-shop sector may have chosen a low-skill, low-wage path that relies on a narrowly skilled workforce where each worker can perform the rudimentary repetitive tasks in several trades (Bilginsoy 2007). Such a training route has been argued to be beneficial for both workers who would accumulate skills flexibly at relatively low cost and avoid learning little-used skills as well as contractors who would save on costs by not paying journey-level wages for work that not requiring a fully skilled craft worker (Bilginsoy 2007).

According to the article "Delivering Skills: Apprenticeship Program Sponsorship and Transition from Training" by Cihan Bilginsoy, in the case of open shops without apprenticeship programs, the industry would need only a limited number of highly skilled workers who would perform the more skill-intensive tasks and monitor the production process (Bilginsoy 2007). Also, the increasing dependence on prefabricated construction materials and techniques complements this method of production (Bilginsoy 2007). Bilginsoy further postulates that, if this conjecture is correct, a permanent bifurcation of workers along the wage/skills spectrum would develop and that the overall picture is disconcerting for workers because, currently, open-shop construction accounts for three-quarters of the industry's workforce (Bilginsoy 2007).

### 3. Enter Academia: Construction Management Education

Historically, the ranks of management in construction have been filled by those people who worked in the trades or those whose families' owned the company. Because one still does not need a high school diploma to get hired for a construction job and, even

for union work, one usually needs only a high school diploma or GED for hiring, besides a few people who had technical-school degrees or who had acquired degrees in other areas and then changed course and went into construction, the ranks of management in construction, more often than not, were not peopled with those having college degrees. However, during the later part of the 20th century, a new field of study was created in the university system, generally a Bachelor of Science degree with most degree titles including "construction management" in their wording.

Today, while many managers in construction still come from the trades, a growing portion now enter management with the training they received from baccalaureate, associate, or certificate programs in construction management. As construction changes, and thus management with it,—using computerized technology at a consistently increasing rate, for example—these management skills are more often proficiencies that do not easily transfer for people working in the field.

College and university programs in construction management contain coursework reflective of the skills needed for management employment, including scheduling, estimating, concrete design, construction documents, and safety. Many programs require business courses, and many have an internship/apprenticeship/co-op element in their curriculum.

North Dakota State University's construction management program currently has internship credits available to students but does not require completion of an internship in order to graduate. A number of NDSU's peer schools—those accredited by the American Council for Construction Education (ACCE) —with baccalaureate programs in construction management have a similar design regarding internships. Schools like South

Dakota State University (SDSU), the University of Southern Mississippi (USM), and the University of Nebraska at Lincoln (UNL) have the credits available and strongly encourage students to participate in internships. They have guidelines including minimum hours worked: 400 hours for SDSU and USM, for example. Other requirements for SDSU include requiring 50% of the hours a student works to be in some management endeavor, a report of work activities submitted daily, a presentation about the internship work the following semester, and employer verification of work. USM gives students the option of an internship or a technical elective with either counting for three semester credit hours. The University of Northern Florida (UNF) does have an internship requirement but also has a loophole for students to be able to substitute the internship with a class during downturns in the construction economy.

Not having the internship as a requirement but still having it as an option allows for more flexibility in a program and for its students. As one professor pointed out, if programs make internships a requirement, schools will then be ultimately responsible for finding students an internship or, worse, accepting a work experience that is not construction related (e.g. golf course maintenance, Menard's lumber stock person, etc.).

On the other hand, many ACCE-accredited schools require internships and often include job/internship placement coordinators in their department staff to assist students with this requirement. Purdue's Building Construction Management program has a full-time job/internship placement coordinator and an internship model essentially based purely on hours a student works. Students can work in management or the trades. The student must complete 800 hours (about 2 summers) of work and turn in an employer verification form. East Carolina University (ECU) has a Construction Work Experience & Professional

Development course where, as one requirement for the course, students work at least 500 documented hours with a state-licensed general contractor, subcontractor, construction management company, or other instructor-approved employment.

Moreover, numerous programs have a fairly extensive list of requirements for students and their internships. The University of Maryland, Eastern Shore (UMES) requires students to work with a construction firm under the supervision of a superintendent or project manager for a minimum of 6 weeks during each internship. Work experience can be in the office or field, preferably both. Also, written evaluations from supervisors and the student must be submitted. A summary paper or project is required for a final grade of satisfactory or unsatisfactory. Each course (CMTE 295 and 395) is worth 2 credits. The University of Wisconsin at Stout (UWS) requires a 2-credit Cooperative Education Experience. The course is a 400-level (junior/senior) course. The students must seek employment on their own, and once they have established a potential hire with a company, they are required to have the company submit a "position description" for department review. The description is reviewed to ensure that the student will have some management duties during his/her co-op. Work for the student can range from estimating, cost control, scheduling, owner meetings, quality control, and/or safety, but students cannot count being a laborer for credit. UWS students must establish a set of learning objectives and strategies to achieve those objectives. Those objectives must then be approved by the Faculty Mentor in a one-on-one meeting with the student; only then can the student register for the co-op credits. Further, the student must have a minimum of 90 earned credits to even apply for the co-op course for credit.

Colorado State University (CSU) has two job/internship placement coordinators and a fairly extensive internship requirement. CSU requires that any student seeking a Bachelor of Science degree in Construction Management complete a minimum of 500 hours of documented work experience in the construction industry prior to a full-time, structured internship. The intent of this work experience requirement is to ensure that, at a minimum, a student will have 500 hours of on-the-job training. Then, the student must take a CON267 Pre-Internship Seminar course. Students may enroll in internships provided they are of at least junior standing and have completed the required prerequisites. For both internship options, students must pass CON267 (Pre-Internship Seminar), CON317 (Safety Management), and CON367 (Construction Contracts & Project Administration). Students who wish to take the 12-week internship must also submit and be approved for the 500-hour work experience requirement prior to taking CON267.

Colorado State's Phelps Placement Office (PPO) assists in placing students with internships via the Career Fair or during a week of on-campus interviews conducted by employers each semester, or the student may contact the PPO with a requested placement site. The PPO will match students with companies for interviews based upon the student's interests (as provided in the student's CON267 interview request form) and the requests of the company (as provided in the Company Profile). During the scheduled interview week, industry representatives interview students and, over the next few weeks, extend job offers to selected candidates.

There are many more programs with internships/apprenticeships/co-ops, but the programs listed are essentially the gamut that construction management internship programs currently run as officially designed. They are devised to give students work

experience within the profession in which they are, ostensibly, studying to have careers. The programs are often designed with course prerequisites, parameters for the type of work, required hours worked, and verification of hours worked. Slightly less often but still common is to have students keep a log of work performed, write a paper or report about the experience, and/or give a presentation about the experience.

### 4. Cognitive Apprenticeship

Traditionally, apprenticeships have been designed for trade work or hands-on skills without necessarily addressing the thought processes behind those skills or addressing the processes behind the "thinking" skills accompanying management. One way to address a lack of overtly developing cognitive processes within apprenticeships or internships is by adopting learning theories from social constructivism. Social constructivists embrace the idea that sociocultural contexts in which teaching and learning occur are critical to learning itself and that learning is culturally and contextually specific (Palincsar 1998). Because construction management education prepares students for a specific occupation, this idea of the culture and situation of the learner is, ostensibly, an appropriate fit.

Constructivism was developed by psychologists in the 20th century but has since been appropriated in education. How constructivism can be applied within education is contentious, but one common thread among post-modern constructivists is rejection of "the view that the locus of knowledge is in the individual" (Palincsar 1998, p. 348). Instead, constructivists see learning and knowledge as inherently social, cultural activities (Palincsar 1998). This theory suggests that thought, learning, and knowledge are not just influenced by social factors but are, themselves, social phenomena (Palincsar 1998).

Lev Vygotsky, beginning in the 1920s, originally defined much of what constitutes social constructivism, including the idea of social processes as a mechanism for learning (Palincsar 1998). Vygotsky was concerned with an interdependence of leaning and development, and introduced the zone of proximal development (ZPD) (Palincsar 1998). Vygotsky used the ideas of actual and potential levels of development where "actual" describes what a child can demonstrate alone or independently and "potential" (ZPD) is what a child can do with assistance (Palincsar 1998). From a Vygotskian perspective, "cognitive development is studied by examining the processes that one participates in when engaged in shared endeavors and how this engagement influences engagement in other activities" (Palincsar 1998, p. 353).

From Vygotskian and other social constructivist theories of learning, Allan Collins, John Seely Brown, and Susan E. Newman created cognitive apprenticeships (CA). As Collins, Brown, and Newman state, the cognitive apprenticeship model "is aimed primarily at teaching the processes that experts use to handle complex tasks. . . . [It] refers to the focus of the learning-through-guided-experience on cognitive and metacognitive, rather than physical, skills and processes" (Collins, Brown, and Newman 1989, p. 457).

Through observing traditional apprenticeships where the learning of skills and knowledge is always placed in a functional context, Collins and peers concluded that: "the interplay between observation, scaffolding, and increasingly independent practice aids apprentices both in developing self-monitoring and correction skills and in integrating the skills and conceptual knowledge needed to advance toward expertise" and, also, that apprentices derive "many cognitively important characteristics from being embedded in a subculture in which most, if not all, members are participants in the target skills." (Collins,

Brown, and Newman, 1989, p. 456). Based on the above conclusions, the researchers proposed an extension of traditional apprenticeships to include exploration of the learners' cognitive processes during this type of embedded learning. From the historical method of instruction in an apprenticeship, they created a new model fitting a cognitive framework within modern education: the cognitive apprenticeship model.

The first item distinguishing CA from traditional apprenticeships is that the method is aimed primarily at teaching the processes experts use to handle complex tasks. (Collins, Brown, and Newman 1989). Second, as previously stated, CA refers to the focus of the learning-through-guided-experience on cognitive and metacognitive levels, rather than physical processes (Collins, Brown, and Newman 1989). Where traditional apprenticeships have evolved to teach target skills that are external and, thus, readily available to both student and teacher for observation, comment, refinement, and correction, applying apprenticeship methods to largely cognitive skills requires the externalization of complex thought processes (Collins, Brown, and Newman 1989). Therefore, cognitive apprenticeship teaching methods are designed to bring these thought processes into the open (Collins, Brown, and Newman 1989).

Traditional apprenticeships teach a specific set of skills for a specific trade (i.e., how to wire a building for an electrical apprentice), and those individuals trained are not expected to take that knowledge and apply it to settings outside their workday. With CAs, the emphasis is on decontextualizing knowledge so that it can be transferred to different and new settings (Collins, Brown, and Newman 1989). CA differs in method by giving students practice in applying these methods in diverse settings and increases the complexity of tasks slowly, without the driving force being immediate economic advance (Collins,

Brown, and Newman 1989). At the same time, Collins, Brown, and Newman recognized some benefits of having one's skill-learning set within an overt economic feedback loop: "apprentices have natural opportunities to realize the value, in concrete economic terms, of their developing skill: Well-executed skills result in saleable products" (Collins, Brown, and Newman 1989, p. 459). Hence, there is some value in creating a culture of expert practice for students to participate in and aspire to as well as devising meaningful benchmarks and incentives for progress within CAs (Collins, Brown, and Newman 1989).

The CA learning structure includes the following four essential elements: 1.) **Content** consisting of Domain Knowledge, Heuristic Strategies, Control Strategies, and Learning Strategies; 2.) **Methods** consisting of Modeling, Coaching, Scaffolding and Fading, Articulation, Reflection, and Exploration; 3.) **Sequence** consisting of Increasing Complexity, Increasing Diversity, and Global Before Local Skills; and 4.) **Sociology** consisting of Situated Learning, Culture of Expert Practice, Intrinsic Motivation, Exploiting Cooperation, and Exploiting Competition (Collins, Brown, and Newman 1989).

### 5. Summary

This chapter was a historical review of apprenticeships and the historical elements that have led to construction management baccalaureate programs as well as the use of internships within these programs. Also included was the historical development of cognitive apprenticeships.

# CHAPTER III. PROBLEM DEFINITION

## 1. Formal Definition of the Problem

Employment growth is expected at a faster-than-average rate in the construction management field (U. S. Bureau of Labor 2008). Excellent job opportunities will exist as the number of job openings exceeds qualified applicants due to an expanding field. The employment of construction managers is estimated to increase by 16 percent during the 2006-16 decade with a high number of projected retirees (U. S. Bureau of Labor 2008). Population and business growth will result in more construction of residential homes, office buildings, shopping malls, hospitals, schools, restaurants, and other structures; that creation will require construction managers (U. S. Bureau of Labor 2008).

As stated in a U.S. Bureau of Labor report, managers who have skills to deal with the growing intricacies of construction projects will be needed:

> The increasing complexity of construction projects will also boost demand for specialized management-level personnel within the construction industry. Sophisticated technology and the proliferation of laws setting standards for buildings and construction materials, worker safety, energy efficiency, environmental protection, and the potential for adverse litigation have further complicated the construction process. Advances in building materials and construction methods; the need to replace portions of the Nation's infrastructure; and the growing number of multipurpose buildings and energy-efficient structures will further add to the demand for more construction managers. (2008)

The above-stated increase in demand is good news for those interested in working construction; however, escalation in the complexity and demands of construction projects means managers have to be skilled and, thus, well-trained to run these projects.

Prospects for individuals seeking jobs in construction management, architectural and engineering services, and construction contracting firms should be best for people with a bachelor's or higher degree in construction science, construction management, or civil

engineering plus practical experience working in construction (U. S. Bureau of Labor 2008). College degrees, internships, and a strong background in building technology will increasingly be preferred of applicants in this field (U. S. Bureau of Labor 2008). Hence, there is a clear, implicit mandate for construction management baccalaureate programs to produce students who are well versed in construction technologies, and classroom and field trained to work with the complex demands of current and future construction projects.

### 2. Research Question

For this study, the general question is as follows: "How can construction management programs at the baccalaureate level be improved so that graduates are better prepared to enter the construction field now and have the abilities and skills to adapt to future changes in technologies and increasing regulations?" Within the context of this query, the thesis deals with the specific question: "Can the internship program currently used by construction management baccalaureate programs be advanced to increase the preparedness of future construction managers by instituting a cognitive apprenticeship model?"

### 3. Specific Research Objectives

This thesis attempts to create an improved construction management internship in the form of the RCMCAP in order to provide better-trained managers for residential construction. With the above goal in mind, objectives of this project include expanding the scope of the residential option within the CM&E Department at NDSU and supporting the department in establishing stronger ties with residential construction firms. Hence, a formal and rigorous program for residential construction interns has been developed based on the

theory of cognitive apprenticeships. Unlike traditional apprenticeship programs, which primarily focus on manual skills, this proposed internship program will focus on the development of cognitive managerial skills specifically related to the residential construction industry. Rethinking the apprenticeship/internship from a cognitive aspect is one way to address the complexity of thought and action required in managing construction projects today. It gives students a comprehensive managerial framework to learn and integrate analytical skills regarding management that can be transferred to different companies and job sites. With coursework and internships, students in construction management programs are not generally required to fit their learning into a comprehensive system of management. It is implied that courses like concrete, scheduling, and soils will converge once students enter the field of work. While some programs do have an upper-level course attempting to coalesce student learning, it, again, does not necessarily put the curriculum together in an overt manner.

The RCMCAP integrates fieldwork with a management framework from Jack H. Willenbrock's *Management Guidelines for Growth Oriented Homebuilding Firms* (1994). *Management Guidelines for Growth Oriented Homebuilding Firms* provides a comprehensive presentation of the management practices that are applicable to growth-oriented homebuilding firms. The text addresses the evolution of leadership, the nature of managerial work, a systems approach to management, and the Management Growth Model, which was developed by the residential housing program at Penn State by Walter A. Music and Jack H. Willenbrock.

# CHAPTER IV. RESEARCH METHODOLOGY

## 1. Data Collection

Because qualitative inquiry is useful for questioning assumptions, cultivating an appreciation for complexity, and expanding frames of reference an historical inquiry methodology is useful for this thesis (Edson 1990). Utilizing an historical investigation into apprenticeship in construction, this research seeks to examine current apprenticeships in a larger context, examine what has been and can still be improved upon in trades and construction apprenticeships, and to better understand what is worth using and keeping in construction management baccalaureate internships/apprenticeships. By examining historical sources discussing the history of apprenticeship in the U.S.; trades' apprenticeships; baccalaureate programs curriculum; and the origins of cognitive apprenticeships in education and psychology, it is hoped the structure of qualitative inquiry, manifested in gathering a breadth of information, will broaden understanding of the RCMCAP design.

This research project included 1.) documenting the historical development of the apprenticeship concept, 2.) documenting the use of the apprenticeship model in the construction trades, 3.) documenting the mechanics of existing residential construction internship programs at the baccalaureate level, 4.) reviewing previous "cognitive apprenticeship" applications and how they can be adapted to residential construction management, 5.) integrating the apprenticeship with the management theoretical framework provided in *Management Guidelines for Growth Oriented Homebuilding Firms* (Willenbrock 1994), 6.) using all of the above information to create a Residential Construction Management Cognitive Apprenticeship Program (RCMCAP), and 7.)

surveying select residential construction industry professionals and NDSU construction management students to solicit feedback for improving the RCMCAP.

A practical model for a Residential Construction Management Cognitive Apprenticeship Program was developed; the model can be used by institutions of higher learning to increase the quality of graduates entering residential construction. This preliminary model was then presented to the two groups who will benefit most from the RCMCAP: professionals in the construction industry as well as students in the construction management and engineering program. As such, these groups were asked for feedback regarding the design of the apprenticeship program.

In surveying the construction professionals, a one page description of the apprenticeship program was composed and sent with a survey link asking six questions: 1.) Name, Position, and Company Name & Location (optional); 2.) After reviewing the Residential Construction Management Cognitive Apprenticeship Program (RCMCAP) document what do you think would be some advantages of participating in this program (to both the apprentice and the company)?; 3.) Do you think the RCMCAP can assist in developing some of the management skills required in your company and, if so, how?; 4.) What questions do you have concerning the program?; 5.) What suggestions do you have for improving the program?; and 6.) Would your company be willing to participate in the program? Why or why not?

This description and survey was sent to the Homebuilders Association of Fargo-Moorhead (HBA), and the HBA then sent the apprenticeship description and survey to organization members via email in January 2010. Two percent of people who received the survey completed all questions.

Second, the NDSU Construction Management Capstone 412/612 class was presented with a PowerPoint description of the program during its lecture time in March of 2010. After students listened to the presentation and asked questions, they were presented with a paper survey: Current Grade Level (circle one): Fr So Jr Sr; 1.) After reviewing the Residential Construction Management Cognitive Apprenticeship Program (RCMCAP) what do you think would be some advantages of participating in this program?; 2.) What questions do you have concerning the program?; 3.) What suggestions do you have for improving the program?; and 4.) Would you participate in the program? Why or why not?

One hundred percent of students attending class that day completed the survey. Responses to both surveys were read and analyzed, looking for respondents' perceived benefits of the program, concerns, and suggestions for improvement.

**2. Survey Analysis**

In the responses from people currently working in the construction field when asked "What would be some of the advantages for participating in this program (to both the apprentice and the company)?," builders tended to see more advantages for students/apprentices. One builder blatantly stated: "I have worked with students in these applications before. The benefits are all for the students." Other responses included "Good field related experience."; "The student can really get into a company to review their future career lifestyle."; "Benefits to the mentee would be the hands-on and field experience that would be obtained through the program. They may also create a life long mentorship with the person they were partnered with." Even a comment about benefits to mentors was more altruistic: "Benefits to the mentor are the reward of helping someone though the same

issues they may have struggled with. They also will be able to reconfirm their knowledge and increase their expertise. Studies show the best way to reconfirm learning is to teach!"

When builders were asked "Do you think the RCMCAP can assist in developing some of the management skills that are required in your company—," all builders agreed that it could. A couple responses were "Any field experience is beneficial to the student and the company." and "The base knowledge from the Univ. level can be building blocks for real world application."

In answering "What questions do you have concerning the program?," some builders expressed concern that the industry mentor would not have enough time to really teach the apprentice in his or her areas of study. One builder was concerned about what level of skill the students would have coming into the program, stating "I am not sure of the prior knowledge you may be giving to any student. But I am concerned that it is important for the success of your program and for the benefit of each student that each of them are pre qualified specifically for any application they are given to work with—" Another professional was concerned about the work load given to students: "The number of hours that need to be logged for each phase as well as the reports, etc seem to be lengthy. Ensuring those that enter the program will be able to manage the workload should be considered prior to launching."

Suggestions for improvement repeated concerns about the number of hours a student would be required to log and the academic requirements being too extensive as well as suggesting that the length of time required to learn just one of the management areas would take up one summer, and also, pre-screening of students was suggested in order to present which areas of management would be their strong suits.

When builders were asked if they would be willing to participate in RCMCAP, none were willing to fully commit, stating that they were not home builders or that their company could not provide the right mentor.

Overall, student response on the survey was positive about the RCMCAP. In response to the question "After reviewing the Residential Construction Management Cognitive Apprenticeship Program (RCMCAP) what do you think would be some advantages of participating in this program?," students overwhelmingly cited the work experience gained and making connections with possible future employers. A typical response to this question was "–hands-on experience of what we learn; good experience for us on our resume; building a good relationship with the industry people or potential employer while in college."

To the question "What questions do you have concerning the program?," reoccurring responses from the majority of the students centered on employer participation and the consequences if students are unable to find an apprenticeship. A typical response to this question was "Why would companies want to participate in this? What do they have to gain? What if you can't find an internship? Do you fail if you can't?" Also, because internships are not currently integrated into the program at NDSU, students questioned why they would be "paying to work" when they can work over the summers, not pay for internship credits, and gain all their required credits during the academic year. A question along this theme was as follows: "What credits do these go towards? Would kids pay for unnecessary credits?"

The third question on the survey was "What suggestions do you have for improving the program?" Repeatedly, students suggested that NDSU create and then provide students

with a list of employers that are willing to participate in the program. Typical responses were "It would help if the program has a list of employers that would be willing to partake in the project so students wouldn't have to hunt so much to find an internship." and "Work with the local HBA and other industry organizations is going to be essential. Possibly open up a program with municipalities as well. Many are in need of quality students and have funding set aside for such programs." A few students also suggested expanding the program beyond residential construction to include apprenticeships in commercial and industrial construction.

To the fourth and final question on the survey, "Would you participate in the program? Why or why not?," the vast majority of students responded, "Yes." Typical responses included "Yes, because practical education is more important than the book knowledge. We can learn a hundred times better when we directly experience the situation." and "Yes, I would. I feel this will be beneficial to the individual. I wish it would have been implemented earlier." Reasons for "No" responses could be grouped into three types: students did not want to pay for the credits; they were graduating soon and did not need the credits; or they were not interested in residential construction/construction management itself. Typical answers were as follows: "No. Personally, I've decided not to go into CM so participating in this would be unnecessary."; "No, unless it was required. I do not like to pay for things I do not have to."; "No, I'm a senior and don't need credits."; or "No, not interested in residential likely better pay elsewhere. I would as a last resort."

### 3. Analysis of Survey Presentation

Themes that emerged from all survey responses are that the benefit to student participants in the RCMCAP can be anticipated, and, in part, to fully realize the

apprenticeship program, it would have to be an embedded part of the CM&E curriculum. Also, there would likely have to be underpinning in place by the department to assist students in acquiring the apprenticeship worksites. (A number of peer programs have one or more employees who specifically work on helping students find jobs and internships.) Benefits for the employers would more likely best be articulated by the employers once the program was instituted, and that study is another thesis topic. However, one advantage would include the ability to prescreen workers who have high levels of management understanding. Further benefits to employers would certainly be assisted by a well-run program on the department end, including making sure students are prepared for their internships with solid coursework and are professional and willing to put forward a good work ethic. Also, the administration of the program should be supported fully so that it runs smoothly and can seamlessly guide the students and employer participants though the phases.

Successful implementation of the model will require dedicated resources from both the academic program and the residential construction industry (in the form of mentors and willing company participants) as well as the student apprentices.

# CHAPTER V. RESEARCH RESULTS

## 1. The Residential Construction Management Cognitive Apprenticeship Program

This Residential Construction Management Cognitive Apprenticeship Program (RCMCAP) employs a cognitive apprenticeship learning structure to educate students in residential construction management methods. The content for teaching residential construction management includes Jack H. Willenbrock's (1994) *Management Guidelines for Growth Oriented Homebuilding Firms.* Willenbrock's model is a theoretical framework from which apprentices can gain the ability to analyze management systems in residential construction. This type of apprenticeship requires students to apply the analysis of homebuilding firms to the experiences of residential construction work, i.e., to their internship work.

The apprenticeship program is designed for students working toward a Bachelor of Science in Construction Management and Engineering at North Dakota State University. As such, the RCMCAP is arranged as a progressive, three-phase program integrating itself into any of the student's semesters but most likely carried out during summer semesters.

In this apprenticeship model, the first step for each student is to secure a job/internship with a company engaging in some type of residential construction. The preference would be that the student participates in some type of management work, but tradework in residential construction is acceptable as the student will still be able to learn about management, albeit from a different angle. For example, a student could be studying scheduling. If the student works in the office on the overall schedule for a large and complex job, he or she will be incorporating more "big picture" information into the

analysis. If one is in the field helping pour concrete, then he or she can focus on time-use and management on a per-job/jobsite smaller-scale angle. Both aspects are important in managing schedules. With 10 areas of management to study and students being allowed to choose which area(s) to investigate, they will be able to choose an area having a direct correlation with their apprenticeship work.

To begin the internship, the participating students will be required to present to the academic adviser of the program with a form stating which company has hired them and have that form signed by the person who will be their direct supervisor on the jobsite. The direct supervisor will then act as the industry mentor for the student during that semester/phase of the internship and agree to fulfill certain tasks (i.e., complete an evaluation of the apprentice's performance; allow a visit from the NDSU faculty adviser, if requested; etc.). The RCMCAP flexibility also allows for a participation range of industry mentors (or on-the-job supervisors). The steps required of an industry mentor are minimal—basically signing a form stating the student has been hired and writing an evaluation—yet the industry mentor is encouraged to share knowledge with the student. Hence, the design of the apprenticeship is created to encourage the sharing of knowledge by the industry mentor but does not penalize a student if a company or mentor is less forthcoming.

Then, depending on whether an apprentice is in the first, second, or third phase of the program, he or she will carry out the tasks in Phases I, II, or III (respectively) of the RCMCAP. The apprentice will be studying the 10 areas of management identified by Willenbrock (1994) which are as follows: Quality Management, Customer Service, Safety, Estimating, Cost Accounting, Cost Control, Scheduling, Subcontracting, Business

Planning, and Office Management. Figure 2 is a brief description of Willenbrock's Managerial Proficiency Levels for Safety. The "Levels of Safety" is an outline description

| **Level I** | **Level II** |
|---|---|
| 1. Superintendent is responsible for safety.<br>2. No formal safety program.<br>3. No safety manual.<br>4. Physical approach to safety.<br>1. No formal safety inspections.<br>2. No safety training.<br>3. No job safety planning.<br>5. No formal investigation of accidents. | 1. Superintendent is responsible for safety.<br>2. No formal safety program.<br>3. No safety manual.<br>4. No behavioral approach to safety.<br>5. Physical approach to safety.<br>1. Safety inspections, safety checklist.<br>2. Informal training.<br>3. No job safety planning.<br>6. No formal investigation of accidents. |
| **Level III** | **Level IV** |
| 1. Safety committee.<br>2. Formal safety program.<br>3. Development of a safety manual.<br>4. Behavioral approach to safety.<br>1. Reduction of pressure on workers.<br>2. Job-safety meetings.<br>3. New-worker orientation.<br>5. Physical approach to safety.<br>1. Formal safety training.<br>2. Safety inspections.<br>3. Job-safety planning.<br>6. Accidents are formally investigated.<br>7. Safety records are maintained. | 1. Safety Committee<br>2. Formal safety program.<br>3. Development of a safety manual.<br>4. Behavioral approach to safety.<br>1. Reduction of pressure on workers.<br>2. Job-site meetings.<br>3. New-worker orientation.<br>5. Physical approach to safety.<br>1. Formal safety training.<br>2. Safety inspections.<br>3. Job-safety planning.<br>6. Thorough investigation of accidents.<br>7. Proper maintenance of safety records. |

Figure 2. Brief Description of Willenbrock's Levels of Management for Safety.

of safety programs a company might have in place. The students will use Willenbrock's (1994) levels to analyze where the company they work for is at in the company's safety management practices—if the student has chosen to study safety management. Throughout the internship process, NDSU will provide a faculty adviser to guide students through the Managerial Model and the phases of this program.

Further described in figures 3, 4, and 5 below are the three phases of RCMCAP.

**Phase I**

**Learning Objectives**

To acquire basic knowledge of residential construction management theory and to gain work experience in residential construction.

**Methods**

Work for a residential construction company for a minimum of 300 hours, logging tasks and work hours weekly on the Blackboard site. Study Willenbrock's (1994) management model for residential construction, and then take and pass one online exam on the management model. Also, choose one management system—for example, scheduling—and benchmark where the company is in Willenbrock's management model (i.e., Level I, II, III, or IV). Attend Phase II and III participant presentations.

**Demonstrated Outcomes**

1. Have logged 300+ hours of work in residential construction.
2. Industry mentor will have completed and turned in to the faculty adviser an evaluation of the apprentice's satisfactory work performance.
3. Have passed a comprehensive exam on Willenbrock's residential construction management model. [See Appendix E for example exam.]
4. Have turned in a paper discussing a benchmarked management system.
5. Have attended Phase II and III presentations.

Figure 3. Description for Phase I of RCMCAP.

**Phase II**

**Learning Objectives**

To develop an analytical applied knowledge of residential construction management through work with a residential company and through applied analysis of the company's management delivery systems.

**Methods**

Work for a residential construction company for a minimum of 300 hours, logging tasks and work hours weekly on the Blackboard site. Inform the industry mentor about chosen areas of study for this phase which includes choosing two of Willenbrock's (1994) management systems—estimating and office management, for example—and constructing a benchmark analysis of where the company is on Willenbrock's four levels of growth management. Then, take one of the two benchmarked management systems and produce a practical, applicable plan that can be instituted in moving the company to the next level. Prepare a presentation of analysis and present it to peers. At above-mentioned presentation, the intern will fill out feedback forms for all other students presenting information.

**Demonstrated Outcomes**

1. Have logged 300+ hours work with a residential construction company.
2. Industry mentor will have completed and turned in to the faculty adviser an evaluation of the apprentice's satisfactory work performance.
3. Have written a report analyzing the company in two areas of management and creating a growth plan for one of those areas.
4. Have presented findings to peers and the faculty program adviser at NDSU.
5. Have completed feedback forms for all peers presenting information.

Figure 4. Description for Phase II of RCMCAP.

**Phase III**

**Learning Objectives**

To further develop an analytical and applied knowledge of residential construction management processes through work with a residential construction company and through developing a practical growth plan for the company.

**Methods**

Work for a residential construction company for a minimum of 300 hours, logging tasks and work hours weekly on the Blackboard site. Also, inform the industry mentor about chosen areas of study for this phase which include creating a report analyzing three areas of management within the company, benchmarking where the company is on Willenbrock's (1994) growth model (I, II, III, or IV) in those three areas, and subsequently producing a practical, applicable plan for the three management systems that can be instituted in moving the company to the next level(s). Present report findings to peers at the end of the term. At the presentation, the intern will fill out feedback forms for all other students presenting infomation.

**Demonstrated Outcomes**

1. Have logged 300+ hours of residential construction work.
2. Industry mentor will have completed and turned in to the faculty adviser an evaluation of the apprentice's satisfactory work performance.
3. Have written a report analyzing three areas of management in the company and the practical, applicable steps the company can take to move to next level(s) of management in chosen three areas of study.
4. Have presented findings in a report to NDSU peers and the faculty adviser.
5. Have completed feedback forms for all peers presenting information.

Figure 5. Description for Phase III of RCMCAP.

### 2. The Cognitive Aspects of RCMCAP

As Collins, Brown, and Newman state in their article "Cognitive Apprenticeship: Teaching the Craft of Reading, Writing and Mathematics," the cognitive apprenticeship model "is aimed primarily at teaching the processes that experts use to handle complex tasks.... [It] refers to the focus of the learning-through-guided-experience on cognitive and metacognitive, rather than physical, skills and processes" (1989, p. 457).

The model for cognitive apprenticeships is organized under four major headings: Content, Methods, Sequencing, and Sociology. The subcategories listed under these headings are what Collins, Brown, and Newman consider as necessary parts to a cognitive

apprenticeship. In Figure 6, the four areas are more specifically defined and related to the RCMCAP.

| CONTENT | METHOD |
|---|---|
| **1. Domain Knowledge**<br>**2. Heuristic Strategies**<br>**3. Control Strategies**<br>**4. Learning Strategies** | **1. Modeling**<br>**2. Coaching**<br>**3. Scaffolding and Fading**<br>**4. Articulation**<br>**5. Reflection**<br>**6. Exploration** |
| **SEQUENCE** | **SOCIOLOGY** |
| **1. Increasing Complexity**<br>**2. Increasing Diversity**<br>**3. Global Before Local Skills** | **1. Situated Learning**<br>**2. Culture of Expert Practice**<br>**3. Intrinsic Motivation**<br>**4. Exploiting Cooperation**<br>**5. Exploiting Competition** |

Figure 6. Outline of Cognitive Apprenticeship Structure.

### 2.1 "Content" in the RCMCAP

The first content area required of a cognitive apprenticeship is "domain knowledge," i.e., subject matter expertise or knowledge about a specific field of interest generally passed on in textbooks and classroom lectures. Students acquire domain knowledge in the RCMCAP through coursework at NDSU and their learning of Willenbrock's (1994) management model.

The next content area required is "heuristic strategies" or knowledge based on experimentation/trial-and-error. During the on-the-job aspect of RCMCAP, there will be times when the student's supervisor will not be available and students will have to figure

out methods of working out tasks given to them through heuristic strategies. Also, in Phases II and III of the apprenticeship, students will be creating their own "growth plan," requiring them to use heuristic strategies to a certain extent in their attempt to describe a way for a company to improve its management delivery systems.

Third is "control strategies," i.e., the ability to determine the best method for carrying out a task because, as students acquire more heuristic strategies combined with domain knowledge, it becomes important for them to choose the best method for executing a task. Here, as students gain knowledge about work in residential construction while getting feedback from co-workers and their industry mentors, as well as gaining an understanding of Willenbrock's (1994) management theories, they will be gaining methods of management. The knowledge gains over their academic years and through the phases will allow students to be more efficient managers/workers and better able to make the best decisions when managing construction jobs.

Finally, in the content area of the cognitive apprenticeship model is "learning strategies," simply strategies for learning any type of content. Learning strategies for this apprenticeship model include academic-year coursework in construction management, on-the-job training through summer jobs in residential construction, and the academic component of on-the-job training which includes studying *Management Guidelines for Growth Oriented Homebuilding Firms* (Willenbrock 1994) and taking an exam on the management guidelines, writing papers/reports benchmarking construction companies' management systems, presentation of findings, and attending and offering feedback to peer presenters.

### 2.2 "Method" in the RCMCAP

Methods are the systems used for teaching in traditional apprenticeships and include six steps. Methods is the next part of a cognitive apprenticeship. The first component is "modeling," involving the expert carrying out a task so that a student can observe. For RCMCAP, the 300+ hours per phase of on-the-job training involves an expert modeling tasks executed in residential construction. Apprentices will also be able to observe their co-workers during work.

"Coaching" consists of an expert observing the learner while he or she is carrying out a task and then offering feedback. Coaching will be two-tiered in the RCMCAP. Grades given by professors as well as feedback on academic work are part of coaching in this model, and the on-the-job feedback that students get as well as mentors' evaluation forms are all parts of coaching.

"Scaffolding and fading" is the third element of methods and is the support a teacher provides to student to carry out a task with the gradual removal of supports as students acquire skill. In the case of the RCMCAP, as the student progresses through the phases of the internship, the tasks required by the student are designed to increase analytical skills and independent thought in applying Willenbrock's (1994) management model to the construction and academic work. Also, during the students' 900 hours of on-the-job training, the tasks assigned to them should increase in scope and difficulty, and they should be able to work more independently on those tasks.

"Articulation" is the fourth method. Articulation means the apprentice being able to describe knowledge, reasoning, or problem-solving processes. In the RCMCAP, students

will discuss their benchmarking analysis and growth plans which will include supporting how they arrived at their stated conclusions.

Next is "reflection" which enables a student to compare his or her own problem-solving processes with those of an expert; another student; and, ultimately, an internal cognitive model. Through presentations to their peers and faculty adviser; students compare—via feedback provided—their analysis and learning with that of their peers and with the knowledge of their faculty adviser and industry mentor.

The final method is "exploration," i.e., pushing students into a mode of problem solving on their own. By having the students, in Phases II and III, analyze an actual construction company they worked for and create strategies for that company to improve its operations and grow, students acquire internalized critical analytical skills applicable in future construction work.

### 2.3 "Sequence" in the RCMCAP

The next part of a cognitive apprenticeship model is sequencing. Sequencing includes, first, "increasing complexity." The three phases of the RCMCAP are designed to build on the student's knowledge from the previous phase and coursework, requiring more in-depth and complex tasks for subsequent phases. The next facet of sequencing is "increasing diversity," and in this program, as students progress through coursework, a diversity of content will be experienced. Also, it is expected that, as the students progress through their summer internships, tasks given will be diversified and the difficulty increased.

Then, finally, regarding sequencing is "global before local skills." This idea is that what is taught in cognitive apprenticeships is thought processes transferable between

subjects or jobs, for two examples. Because the students will learn Willenbrock's (1994) comprehensive model of management for residential construction and they will be taking what they observe/learn from their specific internships and analyzing it within this comprehensive system, apprentices will obtain management knowledge and analytical skills that can be transferred to any construction company.

### 2.4 "Sociology" in the RCMCAP

The fourth feature of cognitive apprenticeship is what Collins et al. (1989) label sociology. Sociology includes five elements. The first element is "situated learning"; a model of learning in a community of practice or learning that takes place in the same context in which it is applied. In this apprenticeship, a primary source of learning will be on-the-job work as the students participate in a minimum of 900 hours of work with a residential construction company.

The second part of sociology is "culture of expert practice," or the creation of a learning environment in which participants actively communicate about, and engage in, a community of practice. For students in this program, participation in a "culture of expert practice" will be threefold: first, through their work with a construction company during their apprenticeship phases; second, through coursework as a construction management student at NDSU from the knowledge of professors and resources used within the classroom; and third, with their peers who are also participating in the apprenticeship program because they will be required to present their work to their peer apprentice group.

The third element of sociology is "intrinsic motivation" (related to a self-defined goal). In the RCMCAP, because it will be assumed the students are interested in pursuing a career in residential construction management and wanting to be successful in that field or

at least wanting to acquire good grades during their college education, intrinsic motivation should be inexistence with participating students. Fourth is "exploiting cooperation," i.e., having students work together in a way that fosters cooperative problem solving. The presentations by students at the end of their summer apprenticeships, and for first-year participants the attending of those presentations, will allow students to connect with those who are interested in working in residential construction. Further, the required feedback of each student for their peers' presentations will allow for analysis of peer work and sharing of learning and understanding between similar situations.

Finally, there is "exploiting competition," giving students the same task to complete and then comparing what each student produces. Although students will be working at different companies and likely performing a range of tasks, not necessarily the same tasks of their peers during the RCMCAP, all students will be required to work the same minimum number of hours and to perform the same academic tasks. They will, in Phases II and III, all be presenting their work to peers, thus allowing the students and sponsoring professor to compare work.

# CHAPTER VI. CONCLUSIONS AND DISCUSSION

## 1. Summary of the Research

This study has investigated how to improve construction management education. More specifically, it has re-examined the idea of the internship or apprenticeship used in construction and applied a cognitive apprenticeship structure in creating a new type of construction management internship titled the Residential Construction Management Cognitive Apprenticeship Program.

## 2. Significance of the Research

The design and development of the RCMCAP informs two aspects of construction management. First, it has the potential to advance NDSU's Construction Management and Engineering internship program and curriculum specifically for students seeking to work in the residential field. Second, it explores a new way of learning for construction management students and has the potential to be applied industry-wide. The RCMCAP is a rigorous and structured program, but it has the potential to help foster the development of future leaders in the residential construction industry. Graduates of NDSU's CM&E program who participate in RCMCAP should not only have the advantage of three internships, but also a model of management analysis which is geared toward business growth.

## 3. Future Research Areas

The next phase of this research is implementing the Residential Construction Management Cognitive Apprenticeship Program at North Dakota State University.

Successful implementation of the model will require dedicated resources from both the academic program and the mentors of the participating residential companies, as well as preparation and a professional attitude and willingness on the part of the apprentices. Specifically, because CM&E students who were surveyed most often suggested wanting a list of employers willing to participate in the RCMCAP and because employers wanted value from their apprentices, successful implementation will have to be sensitive to the above two desires.

Also, since Willenbrock's model was developed in 1994, while still valuable, work could be done to review and update all aspects of the model to make it more tailored to the RCMCAP and make it a continuing useful tool in the 21st century. Finally, once the model is in place, research involving the efficacy of the cognitive apprenticeship within construction management internships can be done. Questions like "How can managerial skills of CA students be measured?" and "How do they compare to skills of students in more standard internships or with students not participating in internships?" should be investigated.

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## APPENDIX A

Power point presentation consisting of 7 slides presented to NDSU CM&E students on during the Construction Management Capstone course in order to elicit feedback on the RCMCAP.

# North Dakota State University
# Fargo, North Dakota

## Construction Management and Engineering

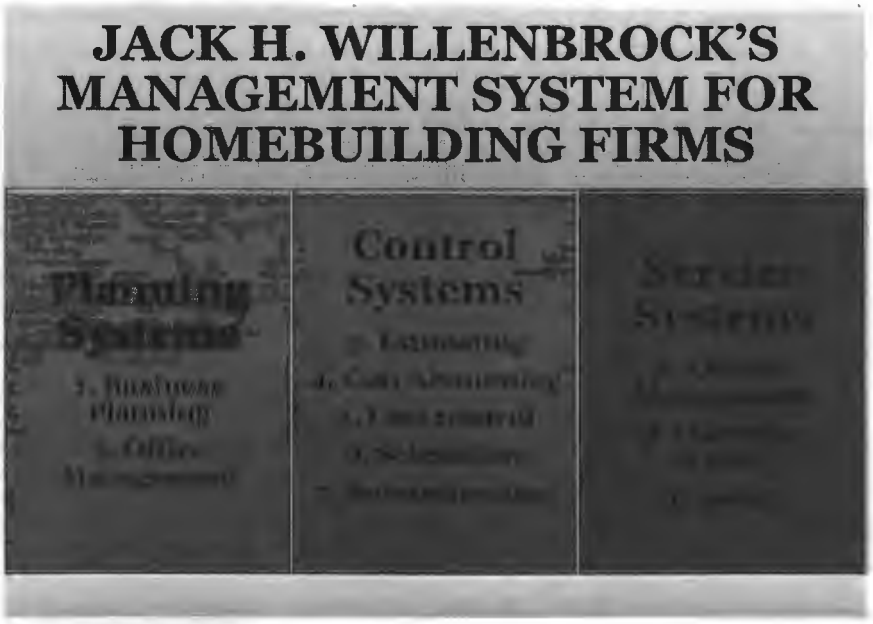
## NAHB HELP grant
## for
## Cognitive Apprenticeship Program
## in
## Residential Construction Management

**The RCMCAP consists of three distinct phases which can be completed during the summer or during an academic semester.**

**The student will work with both an industry and faculty mentor. The industry mentor guides the student in their daily work activities and introduces the student to the business side of home building. The faculty member monitors and documents the students' learning progress.**

**The RCMCAP requires that the student becomes knowledgeable of the various "business systems" of the residential contractor, namely, Planning Systems (Business Planning and Office Management), Control Systems (Estimating, Cost Accounting, Cost Control, Scheduling, and Subcontracting) and Service Systems (Quality Management, Customer Service, and Safety).**

**Students receive 3 credits for completion of each phase of the program.**



# Phase I

**Learning Objectives:**

To acquire basic knowledge of residential construction management theory and gain work experience in residential construction.

**Methods:**

Work for a residential construction company a minimum of 300 hours logging tasks and work hours weekly on blackboard site. Study Willenbrock's management model for residential construction then take and pass one on-line exam on the management model. Also, choose one management system—for example, scheduling—and benchmark where the company is in Willenbrock's management mode (i.e. Level I, II, III, or IV). Attend Phase II and III participant presentations.

**Demonstrated Outcomes:**

1. Have logged 300+ hours of work in residential construction.
2. Industry Mentor will have completed and turned in to faculty advisor an evaluation of apprentice's work performance.
3. Have passed a comprehensive exam on Willenbrock's residential construction management model.
4. Have turned in paper discussing benchmarked management system.
5. Have attended Phase II and III presentations.

# Phase II

**Learning Objectives:**

To develop an analytical applied knowledge of residential construction management through work with a residential company and applied analysis of the company's management delivery systems.

**Methods:**

Work for a residential construction company a minimum of 300 hours logging tasks and work hours weekly on blackboard site. Inform industry mentor of chosen areas of study for this phase which includes: choosing two of Willenbrock's management systems—estimating and office management, for example—and constructing a benchmark analysis of where the company is on Willenbrock's four levels of growth management. Then, taking one of the two benchmarked management systems and producing a practical, applicable plan that can be instituted in moving the company to the next level. Prepare presentation of analysis and present to peers. At above mentioned presentation, will fill out feed-back forms for all other students presenting.

**Demonstrated Outcomes:**

1. Have logged 300+ hours work with residential construction company.
2. Industry Mentor will have completed and turned in to faculty advisor an evaluation of apprentice's work performance.
3. Have written a report analyzing company in two areas of management and creating a growth plan for one of those areas.
4. Have presented findings to peers and faculty program advisor at NDSU.
5. Have completed feed-back forms for all peers presenting.

# Phase III

**Learning Objectives:**

To further develop an analytical and applied knowledge of residential construction management processes through work with a residential construction company and through developing a practical growth plan for the company.

**Methods:**

Work for a residential construction company a minimum of 300 hours logging tasks and work hours weekly on blackboard site. Also, inform industry mentor of chosen areas of study for this phase which includes: create a report analyzing three areas of management within the company benchmarking where the company is on Willenbrock's growth model (I, II, III, or IV) in those three areas subsequently producing a practical, applicable plan for the three management systems that can be instituted in moving the company to the next level(s). Presentation of report findings to peers at end of term. At presentation, will fill out feed-back forms for all other students presenting.

**Demonstrated Outcomes:**

1. Have logged 300+ hours of residential construction work.
2. Industry Mentor will have completed and turned in to faculty advisor an evaluation of apprentice's work performance.
3. Have written report analyzing three areas of management in company and practical, applicable steps the company can take to move to next levels of management.
4. Have presented findings in report to NDSU peers and faculty advisor.
5. Have completed feed-back forms for all peers presenting.

# PHASES OF APPRENTICESHIP

| | | | | | |
|---|---|---|---|---|---|
| **I.** | | | | | |
| **II.** DEMONSTRATED OUTCOMES | Have logged 300 hours of work in residential construction. | Industry Mentor will have completed and turned in to faculty advisor an evaluation of apprentice's work performance. | Have written a report benchmarking company in two areas of management and creating a growth plan for one of the benchmarked areas. | Have presented findings to peers and faculty program advisor at NDSU. | Have completed feed-back forms for all peers presenting. |
| **III.** DEMONSTRATED OUTCOMES | Have logged 300 hours of work in residential construction. | Industry Mentor will have completed and turned in to faculty advisor an evaluation of apprentice's work performance. | Have written report analyzing three areas of management in company and practical, applicable steps the company can take to move to next levels of management. | Have presented findings in report to NDSU peers and faculty advisor. | Have completed feed-back forms for all peers presenting. |

## APPENDIX B

**Residential Construction Management Cognitive Apprenticeship Program**
**Student Feedback**
**Current Grade Level (circle one): Fr So Jr Sr**

1. After reviewing the Residential Construction Management Cognitive Apprenticeship Program (RCMCAP) what do you think would be some advantages of participating in this program?

2. What questions do you have concerning the program?

3. What suggestions do you have for improving the program?

4. Would you participate in the program? Why or why not?

# APPENDIX C

**National Housing Endowment - Homebuilding Education Leadership Program (HELP)**
**North Dakota State University**
**"Residential Construction Management Cognitive Apprenticeship Program (RCMCAP)"**

The Department of Construction Management and Engineering (CM&E) at North Dakota State University (NDSU) in conjunction with the NAHB National Housing Endowment has developed a model for a Residential Construction Management Cognitive Apprenticeship Program (RCMCAP). Unlike traditional homebuilding/construction management internship programs, the RCMCAP requires students to work closely with both an industry mentor and a faculty advisor within the framework of a structured course with well-defined and demonstrated program outcomes. The industry mentor would guide the apprentice in their daily work activities as well as offering assistance in the area of business management. The RCMCAP requires that the apprentice become knowledgeable of the various "systems" that are typical of a residential homebuilding company, namely, Planning Systems (Business Planning and Office Management), Control Systems (Estimating, Cost Accounting, Cost Control, Scheduling, and Subcontracting) and Service Systems (Quality Management, Customer Service, and Safety).

The RCMCAP is designed as a three semester apprenticeship that would most likely be executed during the summers, but students would have the option of enrolling in the program during the spring or fall semesters. An outline of the "Demonstrated RCMCAP Outcomes" for each of the three phases of the program is provided below.

**Phase I - RCMCAP**
1. Register for CM&E 397(a) - Independent Study (1 credit).
2. Log 300+ hours of work in residential construction.
3. Submit evaluation form (industry mentor and apprentice).
4. Pass a competency exam (for residential construction management systems).
5. Submit a Phase I written report (observations / measurements of company management systems).
6. Submit Phase I final evaluation form.
7. Attend Phase II and III presentations and complete peer evaluation forms.

**Phase II- RCMCAP**
1. Register for CM&E 397(b) - Independent Study (2 credits).
2. Log 300+ hours of work in residential construction.
3. Submit evaluation form (industry mentor and apprentice).
4. Submit Company Analysis Report I (Planning, Control, or Service Systems).
5. Present (oral presentation) of Company Analysis Report I to peers and faculty.
6. Submit Phase II final evaluation forms
7. Attend Phase II and III presentations and complete peer evaluation forms.

**Phase III - RCMCAP**
1. Register for CM&E 397(c) - Independent Study (3 credits)
2. Log 300+ hours of work in residential construction.
3. Submit evaluation form (industry mentor and apprentice).
4. Submit Company Analysis Report II (Planning, Control, and Service Systems).
5. Present (oral presentation) of Company Analysis Report II to peers and faculty.
6. Submit Phase III final evaluation forms.
7. Attend Phase II and III presentations and complete peer evaluation forms.

## APPENDIX D

**Residential Construction Management Cognitive Apprenticeship Program**
**Residential Builder Feedback**

**1. Name, Position, and Company Name & Location**

2. **After reviewing the Residential Construction Management Cognitive Apprenticeship Program (RCMCAP) document what do you think would be some advantages of participating in this program (to both the apprentice and the company)?**

3. **Do you think the RCMCAP can assist in developing some of the management skills required in your company and, if so, how?**

4. **What questions do you have concerning the program?**

5. **What suggestions do you have for improving the program?**

6. **Would your company be willing to participate in the program? Why or why not?**

## APPENDIX E

### Comprehensive Exam for RCMCAP Level I Apprentice (Example Exam)

1. (Fill in the blank) is the process of predicting all of the costs which will be incurred during a building project.
   Answer: Estimating (p 87)

2. List the "direct cost" categories generally used in a construction company.
   Answer: Direct labor, direct material, subcontracts, equipment costs (p 103)

3. Name 5 disadvantages associated with subcontracting.
   Answer: Less direct control over work performed; competition with other builders for reputable subcontractors; subcontractors may be financially unstable; subcontractors may have a monopoly in a certain area and thus charge higher prices; quality control becomes more difficult (p 118)

4. Within management guidelines for growth oriented homebuilding firms, what does T.Q.M. stand for?
   Answer: Total Quality Management (p 127)

5. Builders who implement comprehensive safety programs in their companies see improvements in what three areas?
   Answer: Profits, production, and public image (p 150)

6. Proper business planning is critical to the success of a construction company because (complete the sentence).
   Answer: --it enables the organization to anticipate problems and to develop measures of avoidance before they occur and, also, opportunities can be anticipated and taken advantage of. (p 61)

7. Understanding a competitor's product is necessary if the organization is to (complete the sentence).
   Answer: --develop strategies which will outperform the competition in the marketplace. (p 65)

8. List four common methods used for estimating a construction project.
   Answer: Unit cost/square foot estimate, factor method, parameter method, detailed estimate (p 87)

9. Name the subsystems of management listed under "Planning Systems".
   Answer: Business planning and office planning (p 161)

10. Name three safety practices that could be implemented by management to help move a company from Level II to Level III in the area of safety.

Answer: (any three of the following) Maintain safety records; formally investigate accidents; implement formal safety training; implement job safety planning; reduce pressures on workers; hold job safety meetings; hold new worker orientations; develop a safety manual; develop a formal safety program; create a safety committee (p 153)

11. A good quality management program must be (fill in the blank).

Answer: pro-active (p 127)

12. A written subcontract agreement describing the (fill in blank) and (fill blank) of the company, its (fill in blank) requirements, (fill in blank) routines and any (fill in blank) procedures will prevent or solve most of the problems related to subcontracting.

Answer: policies, procedures, schedule, change order, callback (p 118)

13. Describe the differences in cost control systems used between a Level I builder and Level II builder.

Answer: A Level I company generally has no cost control systems in place. A Level II builder generally has manual cost control, work item definition, time cards, labor cost reports, purchase order system, material status report, job progress form, job control sheet. (p 105)

14. What management systems would a Level IV builder generally have in place?

Answer: computerized accounting system; accrual basis job cost system integrated with general ledge accounts via subsidiary ledgers; financial analysis; profitability analysis at the company and project level (p 99)

15. True or False: Cost control systems should be integrated with other management systems such as planning, estimating, scheduling, and accounting.

Answer: True (p 102)

16. Name 6 advantages associated with subcontracting.

Answer: reduction of risk; less capital investment; less bookkeeping; improved quality; less overhead; less detailed day to day supervision (p 117-118)

17. Describe what a Level I builder has in place (and does not have in place) for management of customer service.

Answer: The owner is responsible for customer service; no formal customer service program; no pre-customer inspections; includes a customer inspection with inspection checklist; no post-closing follow-up; no customer service quality control. (p 146)

18. Name the main federal agency responsible for regulating the safety practices on construction sites.

Answer: Occupational Safety and Health Administration (OSHA) (p 150)

19. List three elements vital to the accurate preparation of a detailed estimate.

Answer: Accurate determination of the quantity of work, of the productivity of the resources needed to perform the work, and of the cost of the resources to be used for the work. (p 87)

20. The business plan is the framework for integrating all organizational planning including (name four other planning areas).

Answer: Market planning, production planning, organizational planning and financial planning (p 61)

21. In most organizations the (fill in the blank) is traditionally given the responsibility for insuring that the houses being constructed meet or conform to building code requirements.

Answer: Superintendent (p 129)

22. Name 6 primary functions of a fully developed customer service management system.

Answer: pre-customer inspections, inspection and acceptance of the housing units from the production department; formal delivery of the housing units to the customers; establishment of a communication channel between the builder organization and customers; instructions for customers—customer service policy, home care and maintenance, home warranty information; performance of service work through a callback service; feedback through periodic checks of delivered homes. (p 143)

23. Name the subsystems of management listed under "Control Systems".

Answer: Estimating, cost accounting, cost control, scheduling, and subcontracting (p 161)

24. What is generally included in the "office organization" of a Level IV builder?

Answer: Organizational chart outlining general and specific responsibilities as well as authority and job descriptions (p 83)

25. In two words, an effective cost control system does what?

Answer: Protects profits (p 102)

26. Name the two types of cost accounting systems typically maintained by construction companies.

Answer: Financial accounting and managerial (i.e., job cost) (p 96)

27. Successful business planning incorporates a straightforward process and (complete the sentence).

Answer: --practicality, good judgment, and common sense. (p 61)

28. True or False: Like the automobile industry, the construction industry is dominated by a few large corporations.

Answer: False (p 4)

29. A trustworthy customer service department must establish a mechanism for evaluating the quality of the service provided. Two ways of evaluating the company's service include:

Answer: Cross-checking random samples of completed work by the customer service department and writing or calling customers for feedback (p 145)

30. Name the subsystems of management listed under "Service Systems".

Answer: Quality management, customer service, safety (p 161)

31. The components of a detailed construction estimate include: (list 7)

Answer: quantity take-off, pricing of direct labor and material, determining equipment costs, subcontractor's estimates, determination of job overhead, determination of company overhead, profit (p 90)

32. Proper planning for material deliveries (i.e., just-in-time delivery) reduces costs associated with (fill in blank) and (fill in blank).

Answer: Theft, waste (p 114)

33. The financial accounting system is also known as (fill in the blank).

Answer: The general ledger system (p 96)

34. The basic business planning process includes the following:

Answer: Defining the business, market planning, production planning, organizational planning, development schedule, financial planning, writing the plan (p 62)

35. The chart of accounts and the general ledger accounts can be organized into 5 account categories, list those accounts.

Answer: Revenue, expense, asset, liability, net worth (or equity) (p 98)

36. What are the primary responsibilities associated with office management?

Answer: Development of a procedures manual, record keeping, office staffing (p 77)

37. The scheduling system a construction company needs depends on 4 major factors. Which item on the list is *not* generally considered one of the 4: 1) size of the organization 2) scheduling program knowledge of employees 3) the volume of work 4) project size 5) type of construction.

Answer: 2) scheduling program knowledge of employees (p 110)

38. At what managerial proficiency Level(s) are accidents generally NOT investigated?

Answer: Levels I and II (p 153)

39. True or False: Subcontracts account for the majority of the direct work done in homebuilding companies.

Answer: True (p 117)

40. Name the interpersonal roles of a manager.

Answer: Figurehead, leader, liaison (p 22)

41. The use of (fill in blank) allows builders to reduce their permanent fulltime workforce and therefore minimize the potential for business failure during depressed economic periods.

Answer: Subcontractors (p 117)

42. Name two key factors that improve the physical conditions in approaching manager and worker safety.

Answer: Employee safety training and project planning (p 152)

43. What are the communication procedures/methods of a Level II builder with its subcontractors?

Answer: No written subcontract agreement; plans and specifications are provided; company policies and procedures are verbally provided (p 122)

44. The primary function of the managerial accounting system, or job cost system is (complete the sentence).

Answer: --the collection and presentation of the cost information received from the payroll and accounts payable journals. (p 96)

45. (Fill in the blank) provides a general understanding about the nature of the business enterprise. Builders should ask (fill in the blank) and (fill in the blank).

Answer: Defining the business, what is my business and what should it be (p 61)

46. The primary components of a homebuilding firm's managerial proficiency are suggested to be the following:

Answer: the builder's management systems, management techniques, organizational structure and educational attitudes (p 160)

47. Dr. W. Edwards Deming is credited with creating public awareness of T.Q.M. List 6 of Deming's 14 outlined points for T.Q.M.

Answer: (any 6 of the following) create constancy of purpose toward improvement of product and service; adopt the new philosophy; cease dependence on mass inspection; end the practice of awarding business on the basis of price tag; find problems; institute modern methods of on-the-job training; institute modern methods for supervising production workers; drive out fear so that everyone can work for the company; break down barriers between departments; eliminate numeric goals, posters, and slogans that ask for new levels of productivity without providing methods; eliminate work standards that prescribe numeric quotas; remove barriers that stand between the hourly workers and their right to pride of workmanship; institute a vigorous program of education and retraining; create a structure with in top management that pushes on the above 13 points every day (p 129-130)

48. Groups able to (fill in the blank) are the ones most likely to be successful in competitive situations.

Answer: Unify internally (p 13)

49. Today's builder, in addition to being proficient in the construction of residential units, must also be proficient in (complete the sentence).

Answer: --financing, marketing, cost control and scheduling and they must have the ability to adapt to a rapidly changing construction environment. (p 1)

50. The ownership of a typical business usually occurs in one of the 3 following forms:

Answer: sole proprietorship, partnership, or corporation (p 9)