

Occupational Outlook Handbook Description of Construction Cost Estimator-Related Occupations – 1949 to Present

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Abstract

The cost estimators have a significant role in the profitability of the construction industry. Technological developments have led to a transformative evolution of the estimator role over time. However, the history of the construction cost estimator position has not been investigated up to the present time. Leveraging the Occupational Outlook Handbook (OOH) as a benchmark for occupational standards in the United States, the study uncovers the dynamic changes in how the role has been described and changed over time. The OOH served as a comprehensive resource, with editions published approximately every other year from 1949 to 2020. The analysis, which was conducted in November 2023, indicates that the earliest descriptions emphasized the importance of hands-on experience for successful estimation work, whereas historically cost estimators were more integrated with building trades roles and needed to have full-time experience plus some higher education as a bonus. It was mentioned, along with building trades roles, as an advancement opportunity for field workers and was taught as part of apprenticeship training for 10 trades. Over time, college education starts becoming mandatory, and part-time or limited field experience is deemed acceptable. Furthermore, the study highlights the shifts in the estimator's role and how it will persist in doing so as projections for future employment prospects decline in the face of technological advancements.

Keywords

Cost estimator, Occupational Outlook Handbook, Construction Occupations.

1. Introduction

The Occupational Outlook Handbook (OOH), published by the United States Bureau of Labor Statistics, is a resource providing a description of most occupations in the United States. These periodicals, first published in 1949, provide occupational profiles including descriptions of the typical duties performed, work environment, education and/or training needed to enter the occupation, opportunities for advancement, typical pay, and future job prospects. Each handbook is categorized by occupational coverage areas, such as professional, service, and administrative occupations.

The role of the "cost estimator" is ubiquitous and longstanding in the construction industry. Basically, an estimator is someone who analyzes a project (or portion of a project) and determines the cost of the work. The estimator role first came about in the United States during the industrial revolution when design and construction tasks became fragmented, and owners desired fixed prices and guaranteed delivery dates for their projects, leading to the advent of the general contractor (Bowen, 2021). In the present day, these individuals can vary greatly, from an experienced craftsman who comes to your house to provide an estimate for renovation work, to a group of preconstruction professionals compiling a bid proposal for a billion-dollar hospital project.

To date, the full history of the construction cost estimator role has not been researched. The purpose of this paper is to begin that research endeavor. The balance of this paper describes a study of how the cost estimator role has been described in the OOH from its inception in 1949 to the present day.

2. Literature Review

The OOH was first conceptualized as a resource for servicemen returning to the United States after World War II to reference when determining a career path. The handbook was developed in conjunction with the U.S. Veterans Administration. Quickly, though, this guide also became a valuable tool for high school guidance counselors as well (Goldstein, 1999). The handbooks were updated approximately every other year and published in a print version until 2012, when it went fully online (Morisi, 2019). A section of each OOH focuses on the building trades, describing typical field roles, which have expanded since the original publication. Office-related construction roles such as construction or project manager were not included in the original works, showing up only in the 1990 version (Burt & Tinker, 2017).

Cost estimating is a cornerstone of the construction industry, yet academic research in this area is limited. Academics have focused their research on job tasks related to the estimator role, such as the need for estimators to contextualize historical productivity data when developing new estimates (Kiziltas & Akinci, 2009) or how decision support tools may increase the effectiveness of novice estimators (Kiziltas et al., 2010). Researchers such as Rachman et al. (2023) and Swei et al; (2017) describe statistical modeling techniques to improve cost estimate accuracy. Furthermore, recent advancements in technology have improved repetitive and time-consuming tasks in the cost estimator role, such as quantity takeoff, by leveraging BIM to quantify building materials (Alathamneh et al., 2024). Additionally, ways to improve how estimating is taught at the college level have received attention by researchers. For example, Kirk (1999) describes in detail his experience in teaching estimating at the University of Nebraska – Lincoln, highlighting the importance of making coursework as real-world and applicable as possible. McFarland (2010) describes how to effectively teach project specifications in estimating courses, while McFarland (2018) illustrates how to incorporate constructability reviews. Sylvester & Dietrich (2010) introduce building information modeling (BIM) into estimating coursework, followed by Elliot et al. (2019) who provide a review of student perceptions of utilizing BIM for material quantification. Collins & Redden (2017, 2021) emphasize ways to improve student's estimating abilities through incorporating hands-on experiential learning, while Zhu & Issa (2017) show how computer-based simulations can be utilized to teach estimating concepts.

3. Research Methodology

The research objective was to determine how the cost estimator role has been depicted in the OOH from its inception in 1949 through to the present day. Specifically, it examined the nature of the occupation and the pathways to becoming a construction cost estimator. To achieve this, a qualitative, archival study approach was employed. The methodology included:

3.1 Records Retrieval and Data Collection

Records have been collected from 1949 to the present. The Occupational Outlook Handbooks (OOH) were published 29 times in hard copy from 1949 until 2010, approximately every two years. Full-text PDF copies of these print versions are available in several online repositories. The authors primarily utilized the FRASER digital library, part of the St. Louis branch of the U.S. Federal Reserve, due to its comprehensive collection. In 2012, the handbook transitioned to an entirely online format, with updates occurring every two years. Although the Bureau of Labor Statistics did not catalogue the online versions, the authors discovered that private publishers created print copies of the online handbooks, which were available for purchase by the general public and libraries. These print versions were acquired and reviewed for the years 2012 through 2020. Additionally, the current online version for 2022 was reviewed.

3.4 Data Extraction and Text Analysis

All records were manually reviewed by the authors using PDF reader software for the digital files and hard copies for the editions from 2012 to 2020. The inclusion criteria for data extraction followed the typical format and order of document titles and subtitles. The process began with the "Management and Business and Financial Operations Occupations" category, selecting two specific occupations: "Construction Managers" and "Cost Estimators." The second inclusion criteria focused on the "Construction Trades and Related Workers" category, including all trades within this category. For each occupation, the text was thoroughly assessed to extract the necessary data. Details about apprenticeships and becoming an estimator were extracted from the "Training, Other Qualifications, and

Advancement" subsection. Employment projections were sourced from the "Employment" and "Job Outlook" subsections. Each periodical was analyzed for descriptions of the cost estimator occupation and mentions of other construction occupations where cost estimating tasks were relevant. The analysis was completed in November 2023. All findings from the analysis were compiled and summarized into a single document for further examination.

4. Results

4.1 Building/Construction Trades Occupations

The 1949 OOH lists 11 separate construction trades, including carpenters, painters, bricklayers, electricians, paperhangers, plumbers and pipe fitters, plasterers, sheet metal workers, structural and ornamental metal workers, construction machinery operators, and glaziers. Each occupation description is broken into sections, including outlook summary, where employed, training and qualifications, outlook, earnings, and where to learn more about the trade. There is also a preamble generally describing the construction trades.

By 1957, there were 18 separate building trades listed, with asbestos and insulating workers, building laborers and hod carriers, cement finishers, elevator constructors, lathers, marble setters, tile setters and terrazzo workers, roofers, and stone masons being added. A notable difference in this publication was the increased focus on describing how individuals work their way up through the trades, starting as an apprentice, progressing up to become a journeyman, and sometimes graduating to become a foreman running crews of journeymen and laborers. Moreover, the 1957 text (and most future versions) appear to have been greatly influenced by labor unions prevalent at the time of publication, specifically related to topics covered in apprenticeship programs, both hands-on and classroom training. Several of the trades mentioned how learning aspects of estimating were included in the classroom training. For example, in the painters and paperhangers' description, it says "He also receives related classroom instruction in color harmony, paint chemistry, estimating costs, and how to make, mix, and match paints." For bricklayers, it notes "he receives related classroom instruction in reading blueprints, layout work, and making measurements and sketches."

In 1949, only one of the 11 occupations, sheet metal workers, includes mention of estimating being taught during apprenticeship training. In 1957, five of the 18 occupations listed (painters and paperhangers, bricklayers, cement finishers, lathers, and marble setters, tile setters and terrazzo workers), or roughly 28 percent, alluded to how estimating concepts were taught to tradesmen during their apprenticeships.

The preamble section of the 1957 publication also described that a foreman may progress to become an estimator for a contractor. It says that as an estimator, "he estimates material requirements and labor costs in order to enable the contractor to bid on the work of a particular construction project." This is the first mention of the estimator role, which was continued through the individual occupation descriptions. In total, four of the eighteen occupations listed (painters and paperhangers, bricklayers, electricians, and plasterers), or roughly 22 percent, mention estimator as an advancement opportunity for the foremen. It should also be noted that most of the occupational descriptions include mention of craftsmen starting their own business, stating "Basic requirements for success as a contractor are adequate financial resources and a sound knowledge of business principles and practices" or something similar. It could be inferred that a business owner would be involved in work as an estimator, but that was not explicitly stated.

By 2010, there were 20 separate occupations that had been described in the OOH. As shown in Table 1, 10 of the 20 occupations (plasterers, electricians, glaziers, masonry workers, painters and paperhangers, plumbers, pipefitters, and steamfitters, sheet metal workers, lathers, concrete workers, and drywall and ceiling tile installers and tapers) had estimating as a topic covered in apprenticeship training. Correspondingly, 11 of the 20 occupations (carpenters, plasterers, electricians, glaziers, masonry workers, painters and paperhangers, asbestos and insulation workers, flooring installers and tile and stone setters, concrete workers, roofers, and drywall and ceiling tile installers and tapers) had estimating noted as an advancement opportunity. Six of the 20 occupations (construction machinery operator, structural and reinforcing iron and metal workers, laborers, elevator and escalator installers and repairers, boilermakers, and hazardous material removal workers) had neither estimating as a topic of apprenticeship training nor estimating listed as an advancement opportunity.

Table 1. Tabulation of Estimating Apprenticeship Training and Advancement Opportunities per Occupation

Occupation	First Year in OOH	Number of Appearances through 2010	Estimating Taught in Apprenticeship Training	Estimating Noted as an Advancement Opportunity
Carpenter	1949	29	0%	28%
Plasterers	1949	23	38%	90%
Electricians	1949	29	3%	48%
Glaziers	1949	28	3%	41%
Masonry workers	1949	29	34%	90%
Painters and Paperhangers	1949	29	90%	79%
Plumbers, pipefitters, and steamfitters	1949	29	24%	0%
Sheet Metal workers	1949	29	7%	0%
Asbestos and Insulation Workers	1951	28	0%	90%
Lathers	1951	13	41%	0%
Flooring installers and tile and stone setters	1951	28	0%	79%
Concrete workers	1951	28	93%	69%
Roofers	1951	28	0%	45%
Drywall and Ceiling Tile Installers, and Tapers	1976	18	59%	10%
Construction Machinery Operator	1949	29	0%	0%
Structural and Reinforcing Iron and Metal Workers	1949	29	0%	0%
Laborer	1951	28	0%	0%
Elevators and escalator installers and repairers	1951	28	0%	0%
Boilermaker	2000	6	0%	0%
Hazardous materials removal workers	2000	6	0%	0%

It should be noted that the format for how each occupation was described changed in 2012 when the OOH went from a predominantly print publication to online. The written descriptions were significantly abbreviated. The authors found that none of the occupational descriptions for the 2012, 2014, 2016, 2018, and 2020 publications noted estimating regarding apprenticeship training or as an advancement opportunity. In the current edition, none of the occupations list estimating as being taught during apprenticeship training, and only three of the 20 occupations (drywall and ceiling tile installers and tapers, painters and paperhangers, and roofers) list estimating as an advancement opportunity.

4.2 Cost Estimator Occupation

The 1988 OOH was the first time that cost estimator was described as a stand-alone occupation. The role was included in the “Managerial and Management-Related Occupations” section of the guide. The description is not provided for only construction cost estimators, but also cost estimators working in manufacturing settings. The cost estimator was described as a professional who predicts the cost of future projects for owners and managers to use in making bids for contracts. These individuals perform takeoff (also referred to as a quantity survey) from a set of construction documents, then develop a complete project cost summary including labor, materials, equipment, subcontracted work, overhead, taxes, insurance, and markup. This information is then given to a chief estimator who prepares the bid proposal. The general cost estimator occupation description has stayed consistent through the present day, except for two key differences: computer technology and field experience.

It was noted in 1988 that computers were increasingly being used by cost estimators, relieving them from some of the drudgery associated with routine, repetitive, and time-consuming calculations, but were not appropriate for completing the entire estimating process. The 2010 OOH provides the first mention of how software is affecting the occupation, where in the other qualifications sections it is mentioned “Familiarity with cost estimation software, including commercial and Building Information Modeling (BIM) software is beneficial. BIM software technology takes standard blueprints and creates three-dimensional models on the computers, allowing for better estimates of the building process.” Moreover, in the job prospects sections, it is noted that “knowledge of Building Information Modeling software would also be helpful.” These descriptions have more-or-less been included in each of the OOH publications through the present day.

Regarding training and qualifications, the handbook notes that most estimators have experience as construction tradesmen. Furthermore, it mentions that individuals who combine postsecondary training in estimating may have an edge in landing a position, while those who have only an academic background with no field experience would be at a disadvantage as compared to experienced applicants for the same job. This description changed in the

2000 handbook, where construction experience is described to come from “tenure in the industry, internships, or cooperative education programs.” This description has also been consistent in each handbook through the present.

Lastly, the OOH provides outlooks for each of the job descriptions. The number of cost estimators is noted in each handbook as a two-year look back. For example, in the 1988 publications, it notes that there were 157,000 cost estimators in 1986. Additionally, the description would provide a comparison to the overall forecasted job growth for all occupations, noting if cost estimator jobs were projected to grow at the same rate as all jobs, at a faster rate, or at a slower or declining rate. Figure 1 below provides a summary of the actual number of cost estimators. As shown, the actual number of cost estimators has generally increased since 1986. In each publication from 1986 through 2022, it was noted that the number of cost estimator jobs would grow at the same rate or at a higher rate as all jobs. The current number of cost estimators is noted as 231,400. Starting in 2008, a projection of the future number of cost estimators was also provided as a ten-year look ahead. For example, in 2008, it was projected that in 2016 there would be 262,000 cost estimators. Figure 1 also provides a summary of these projected values. As shown, the projected number of cost estimators was consistently higher than the actual number of cost estimators. The number of cost estimators was steadily projected downwards, even as the total number of jobs was forecasted to grow as fast or faster than all jobs. This is true up until the current publication, which projects that the employment of cost estimators is to decline by 3% by 2032. The reason for this decline is described as “Cost estimation software is improving the productivity of these workers, requiring fewer estimators to do the same amount of work. This will limit the employment growth of cost estimators.”

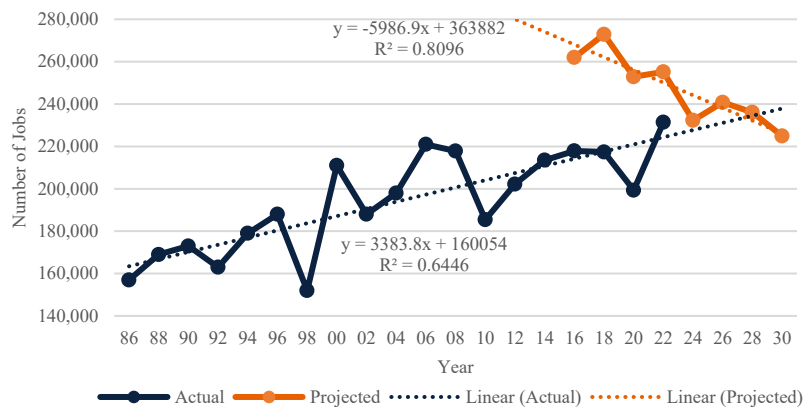


Figure 1. Actual vs. projected number of cost estimators from the OOH 1988 - 2022

The Bureau of Labor Statistics employs a detailed six-step methodology for projecting employment across industries and occupations, including cost estimators. These steps are labor force projections, aggregate economy modeling, final demand estimation, industry output calculation, industry employment estimation, and occupational employment projections. The labor force projections are based on demographic data from the U.S. Census Bureau and participation rates from the Current Population Survey. The aggregate economy projections use the MA/US model, incorporating variables like GDP, energy prices, and policy assumptions. Final demand projections break down GDP into demand categories and commodity groups. Industry output projections utilize input-output models to estimate the output and employment needed for the projected GDP. Industry employment projections derive employment levels using regression analysis of output, wage rates, and productivity. Finally, occupational employment projections allocate industry employment to specific occupations, incorporating structural changes and historical data (*Employment Projections Methods Overview*, 2023).

5. Discussion

The building/construction trade analysis shows that estimating concepts have long been a part of apprenticeship training but not for all trades. Painters and paperhangers, and concrete workers were shown to be the most consistent, as it was noted in over 90 percent of the OOH publications (see Table 1). The OOH, unfortunately, does not describe in detail what specific cost estimating concepts have or currently are being taught. In addition, other trades including plasterers, masonry workers, and asbestos and insulation workers, advancing to become a cost estimator was noted in over 90 percent of the OOH publications, even if estimating concepts weren't taught as part of apprenticeship training as with asbestos and insulation workers. Six of the 20 current building trade occupations never noted cost estimating

concepts as part of apprenticeship training nor cost estimating as an advancement opportunity. This makes sense for the “laborer” occupation as this is arguably the least skilled construction occupation, but the lack of cost estimating for other occupations is surprising. For example, structural and reinforcing iron and metal workers closely align with concrete workers and masonry workers, which both have estimating as an apprentice concept and an advancement opportunity.

The cost estimator occupation analysis shows that surprisingly the occupation, though longstanding in the construction industry, wasn’t recognized in the OOH until the late 1980’s. Furthermore, the analysis shows that technology has greatly affected the occupation over time. First, the earliest occupation descriptions highlight the requisite field experience necessary to work as an estimator, and to even be successful getting a job. The field experience requirement changed over time to include internships and cooperative education programs. Arguably, this alludes to the fact that as cost estimating-related technology changed (e.g., quantity takeoff software, estimating software, BIM), the technological education that individuals gain through university construction management degrees outweighed the tacit knowledge one gains through years of full-time, hands-on experience. A mix of some field experience, as comes with an internship, plus specific cost estimating coursework is seen as sufficient, and even preferred, the opposite of what employers were requiring in the 1980’s and before. This ties with the literature review that shows how construction academics have focused their research on ways to improve cost estimating education in a variety of ways, and how statistics or decision support tools can help make novice estimators more accurate.

It is concerning that future OOH projections are that the number of cost estimators will decrease, even if the accuracy of the projections seems questionable. Figure 1 shows that even with some dips over time, the number of cost estimators has consistently increased over time. Furthermore, the projected values for 2016 – 2022 were significantly higher than the actual number of cost estimators reported in those years. Also, the number of individuals in a linked occupation, construction managers, is currently projected to increase by five percent by 2032, which is faster than the average for all occupations of three percent. It may be possible that the way OOH combines both manufacturing and construction cost estimators is driving the job outlook downwards. If manufacturing and construction were separated, it is possible that the construction cost estimator outlook would be more inline with the construction manager occupation. Additionally, it could be that those individuals at the OOH developing the projections are incorporating potential future advances in technology that may increase productivity even more than what is currently available in the marketplace. The authors do agree with the OOH statement that advances to cost estimation software will improve the productivity of estimators but feel strongly that today (as it was in 1988) software is appropriate for leveraging an estimator's time completing repetitive or time-consuming tasks but is not appropriate for all cost estimating tasks.

6. Conclusions

The OOH is generally seen as the gold standard for occupational descriptions in the United States and has been made widely available and easily accessible since being fully pushed online. Analysis of building construction occupations shows that cost estimating concepts are taught to some apprentices, but not all, and that the cost estimator role is seen as something to advance towards even if technical training is not provided. Investigation of the cost estimator occupational descriptions highlights how technology has changed its role and will continue to do so. The importance of actual field experience has diminished over time, where historically cost estimators needed to have full-time experience plus some higher education as a bonus, to a college education being mandatory and part-time or limited field experience being deemed acceptable.

This study was limited to cost estimator descriptions provided in the OOH. Analysis of other similar publications may yield different results. Future research should seek to compare the results described herein to other publications where the cost estimator role has been described over time. Additionally, future research should seek to better understand how tradesmen can be educated on pertinent cost estimating software or technologies during their apprenticeships so that they may be competitive for cost estimator jobs where they can leverage their tacit knowledge along with technical skills.

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