USDA
United States Department of Agriculture

Product Costing Guide for Wood Dimension and Component Manufacturers

Forest Service
Northern Research Station
General Technical Report NRS-140
December 2014

Abstract

The North American hardwood dimension and components industry plays a critical role in the hardwood forest products industry as the industry is a user of high-value hardwood lumber. Customer expectations, global markets, and international competition, however, require hardwood dimension and components manufacturers to continuously improve their ability to manage their products and businesses. Accurate and timely product costing information is critically important for companies in planning the optimal utilization of company resources. While an overestimation of product costs can lead to loss of potential business and market share, underestimation of product costs can result in financial losses to the company.

This paper introduces a product costing software package called WoodCite, which is designed specifically for small and medium-sized hardwood dimension and components manufacturers. WoodCite allows companies to determine product costs and create competitive bids based on their information. WoodCite uses a regression model to estimate overhead cost of a product based on historical cost information provided by the user. The application is available for free at http://www.nrs.fs.fed.us/tools/WoodCite/.

The Authors

ADRIENN ANDERSCH, graduate research assistant, Virginia Tech.

URS BUEHLMANN, associate professor, Virginia Tech.

JEFF PALMER, information technology specialist, U.S. Forest Service.

JANICE K. WIEDENBECK, research forest products technologist, U.S. Forest Service.

STEVE LAWSER, Executive Director, Wood Component Manufacturers Association (WCMA).

CONTENTS

Disclosure

Selected parts of this manuscript were originally published in contributions to the following journals and are reprinted with permission:

Andersch, Adrienn; Buehlmann, Urs; Wiedenbeck, Jan; Lawser, Steve. 2013. **Status and opportunities associated with product costing strategies in wood component manufacturing.** Forest Science. 59(6): 623-636.

Andersch, Adrienn; Buehlmann, Urs; Palmer, Jeff; Wiedenbeck, Janice K.; Lawser, Steve. 2013. **Product costing program for wood component manufacturers.** Forest Products Journal. 63 (7-8): 247-256.

1. PREFACE

The North American hardwood dimension and components industry consists of an estimated 1,200, mostly small, family owned businesses in the United States and Canada that generated shipments valued at roughly $4 billion in 2009 (Lawser 2010). Industry participants specialize in producing an array of customized wood products, such as edge-glued panels, solid and laminated squares, moldings, stair parts, cabinet doors and parts, turnings, components for bending, and other related products to meet the needs of the furniture, kitchen cabinet, building products, and other manufacturing industries. To remain profitable, the North American hardwood dimension and components industry must continuously adapt its business model to domestic and foreign competition and changing market and customer requirements in respect to quality, styling, performance, and costs. Furthermore, the industry has to cope with a changing regulatory environment. An important component of success is accurate estimation of product costs associated with each order. Competitive bidding is complicated by the fact that many products are customized and thus each bid may involve unique products and processes. Therefore, having an accurate and up-to-date product costing system can ensure the submission of winning (e.g., competitively priced but profitable) bids to potential customers.

This product costing guide, prepared for the hardwood dimension and components industry, includes five main sections:

- An introduction to product costing (section 2)
- An overview of current product costing systems (section 3)
- Results of a product costing survey conducted by Virginia Tech in 2010 (section 4)
- Introduction to the WoodCite 1.0 product costing software package (section 5)
- WoodCite 1.0 product costing software package example (section 6)

An introduction about product costing will be provided in section 2 to develop a common understanding of important accounting and financial terms used throughout this guide.

Over the last decades, cost accounting and product costing systems had to adapt to many changes in the manufacturing and business environment; thus, an array of new product costing systems have been developed. Examples include activity-based costing (ABC), throughput accounting (TA), and lean accounting (LA). These new costing systems were created to solve specific accounting and cost estimation problems. They will be discussed in section 3.

Results of a product costing survey will be presented in section 4. The product costing survey was conducted to assimilate cost accounting information from wood dimension and component manufacturers relating to type, structure, and accuracy of accounting systems used. The study aimed to determine how cost accounting information is used by company managers and what the shortcomings of existing cost accounting systems are.

A product costing software package, WoodCite, specifically created for hardwood dimension and component manufacturers as part of the current study, is introduced in section 5 on page 23.

WoodCite is a Microsoft® Access application that allows companies to determine product costs and create competitive bids. Essentially, WoodCite is a job-order-based costing system that assigns overhead costs to products based on labor and machine hours.

An example using real industry data will be demonstrated in section 6 to get a basic understanding of WoodCite and its different functions.

2. INTRODUCTION TO PRODUCT COSTING

The American Accounting Association defined **accounting** as "… *The process of identifying, measuring, and communicating economic information to permit informed judgments and decisions by users of the information* (American Accounting Association 1966, p 1)." Thus, accounting provides the financial and economic data of an entity (e.g., firm, organization, government agency, individuals) to parties that need to know such information. A meaningful accounting system has to identify and record all accounting transactions and measure the value of all assets and liabilities, revenues and expenses, and gains and losses, and then report them in the general ledger.

One way to classify accounting systems is based on the targeted user of the information collected (Fig. 1). Using this user-based nomenclature, three branches of accounting can be differentiated: management accounting, financial accounting, and tax accounting.

Management accounting is designed for the company's internal users, primarily for a company's managers to gain insights into financial information for planning, controlling, and evaluating business performance. Through its planning and controlling function, management accounting offers insights about the future of the company to managers. Management accounting mostly relies on internal financial reports but also uses more detailed, internal, nonfinancial reports. Examples of such reports pertain to product quality, customer and employee satisfaction, and worker productivity. Internal management accounting reports do not have to follow the generally accepted accounting principles (GAAP) and can be compiled for any period (year, quarter, month, week, and day) that proves useful to a company's management.

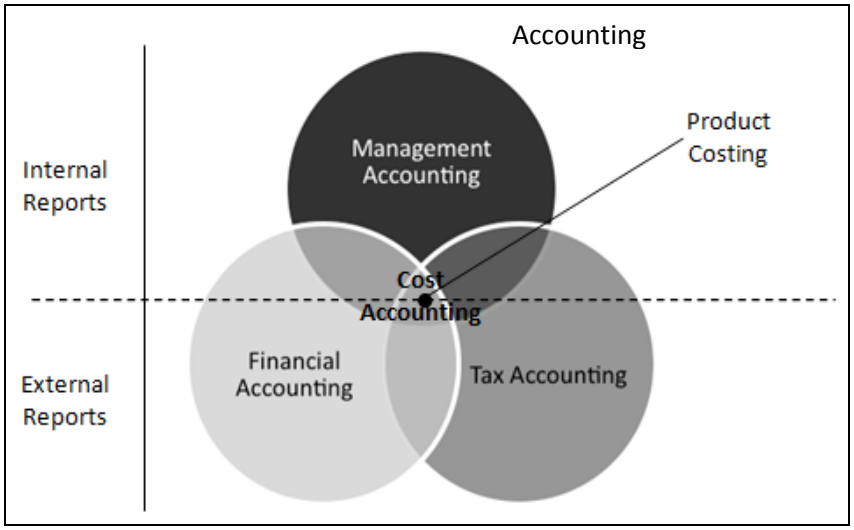

Figure 1.—Structure of accounting.

Financial accounting is designed for external users, such as shareholders, suppliers, banks, government authorities, customers, and other outside parties to provide information about the financial state of a company. To serve its purpose of creating external reports, financial accounting must follow rigid principles, such as the GAAP, as well as the international financial reporting standards. financial accounting summarizes past financial transactions and must focus on completed periods (year, quarter, and month) because it provides financial data for financial documents like income statement, profit and loss statement, and balance sheet.

Tax accounting is designed for external parties, such as government regulatory agencies (e.g., the U.S. Internal Revenue Service or Canada Revenue Agency), to provide information on tax status and liabilities, tax deferral, preparation of personal income tax statements, and treatment of acquisitions or mergers. Tax reports must be created on a yearly basis and follow strict regulations of the Internal Revenue Code, as well as state and local laws.

Managerial, financial, and tax accounting are closely related because they all use the same database to collect the necessary information. This database, the **cost accounting** system, provides information about costs of activities accomplished, such as products produced, services provided, or departments operated. Management is responsible to ensure that all the cost information is captured accurately and is used properly for decision making and corrective actions, if necessary. Responsibilities of cost accounting include product costing, cost projection and budgeting, and "variance analysis" (comparing budgeted and actual amounts) to measure a company's performance.

Product costing is an underlying component of cost accounting. The purpose of product costing is to provide accurate and up-to-date information for management regarding the costs of a company's products. Product costing has an essential role in ensuring that the company's products generate sufficient income to achieve the company's goals. In addition, product costing provides:

- A cost control mechanism across businesses
- An optimization tool for operating and profit margins
- Information for pricing decisions
- A basis for accounting, specifically cost accounting and inventory valuation
- Information to support make or buy decisions

Competitive bidding requires reliable product cost information and a carefully set offering price. The offering price is market-driven and determined after considering customer requirements, competitive offerings, the market situation, and the company's situation. The profit margin is determined after evaluating the company's product cost information, strategy, and internal margin expectations.

A product's total cost consists of direct material cost, direct labor cost, and overhead cost. The overhead cost can be broken down into manufacturing overhead costs and non-manufacturing overhead costs including sales expenses and general and administrative expenses. A 2010 product costing survey reported the cost component breakdown shown in Figure 2. These

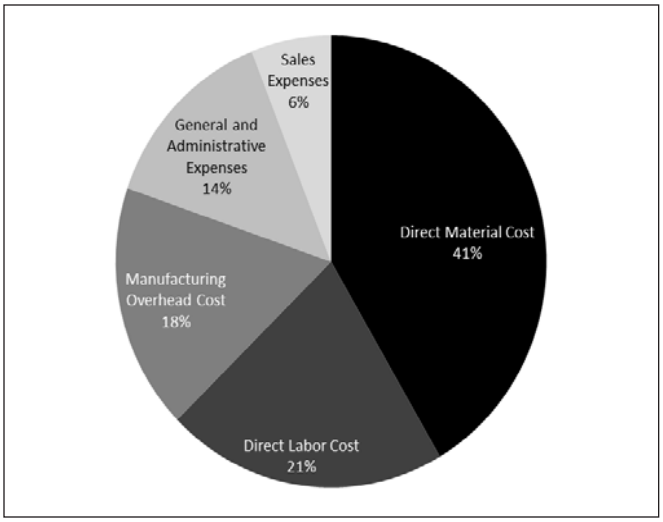

Figure 2.—Average distribution of total product costs of North American hardwood dimension and component manufacturers in 2010.

results show that 41 percent of the product cost derives from direct material cost, 21 percent from direct labor cost, and 38 percent from overhead cost. The overhead costs consist of 18 percent manufacturing overhead cost, 14 percent general and administrative expenses, and 6 percent sales.

Product costing, an underlying discipline of cost accounting, has changed significantly since the 1980s due to changes in the manufacturing environment. Therefore, section 3 will introduce an array of modern cost accounting and product costing systems.

3. TYPES OF PRODUCT COSTING PRACTICES

New manufacturing technologies, such as highly automated, computer aided, flexible, and integrated manufacturing systems adopted by companies over the last three decades, have eroded the role of labor in the manufacture of products. These investments have enabled shorter lead times and lower levels of work in process (WIP) and finished goods inventories, among other things. Besides technological advancements, new management practices such as just-in-time (JIT), total quality management (TQM), and lean manufacturing have also been widely accepted and integrated into manufacturing processes.

Because accounting essentially is the financial reflection of a company's activities, each change in the business has to be reflected in its accounting. Thus, the two systems, business activities and accounting, have to be synchronized because managers otherwise may lack accurate cost information, which can lead to erroneous decision making and, possibly, a decline in an organization's competitive edge in the market. Therefore, to keep up with an altered manufacturing environment, an array of new accounting systems has been developed. However, selecting the most appropriate cost accounting and product costing system can be challenging.

Table 1 provides an overview of the structure of the four most widely used cost accounting systems in manufacturing industries: traditional cost accounting (the most widely used, "traditional" cost accounting system), activity-based cost accounting, throughput accounting, and lean accounting.

Table 1.—The array of cost accounting and product costing practices

Traditional cost accounting	Activity-based cost accounting	Throughput accounting	Lean accounting
Accumulation methods Job order costing Process costing Operation costing Cost control methods Actual costing Normal costing Standard costing Inventory evaluation methods Absorption/full costing Variable/direct/marginal costing	Activity-based costing Time-driven activity-based costing	Theory of constraint costing	Value stream costing Target costing

It is important to understand that multiple cost calculation methods exist under each accounting system because they were designed to deal with different business problems, e.g., product cost calculation, product value determination, inventory valuation, and cost control. The traditional cost accounting system (Table 1, column 1) differentiates three categories for product cost calculations, namely accumulation methods, cost control methods, and inventory evaluation practices. Accumulation practices include job order costing, process costing, and operational costing; cost control methods consist of actual costing, normal costing, and standard costing; inventory evaluation methods include absorption/full costing and variable/direct/marginal costing. An activity-based cost accounting system differentiates two product cost calculation categories: activity-based costing and time-driven activity-based costing (Table 1, column 2). A throughput accounting system relies on the theory of constraint costing practice to calculate product cost (Table 1, column 3). A lean accounting system differentiates two product costing practices: value stream costing and target costing (Table 1, column 4).

Each of these costing systems was created to resolve specific shortcomings of pre-existing costing systems. However, although a particular product costing system may resolve some shortcomings, it likely possesses others. Each company needs to select the system that best fits its needs. According to Gurowka and Lawson (2007), selecting the right product costing system requires constant review and evaluation of the organization's situation following the methodology shown in Figure 3, while being aware of all product costing systems available.

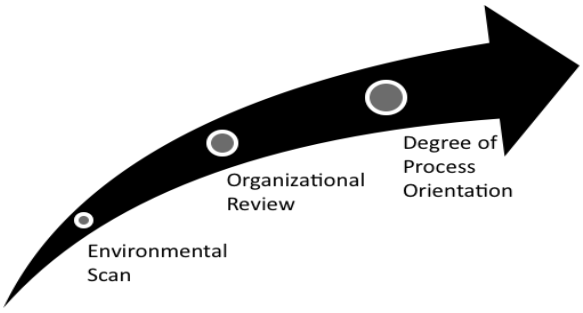

Figure 3.—The organization's evaluation process to select the best fitting product costing system according to Gurowka and Lawson (2007).

The first step of the evaluation process is the environmental scan, which includes the review of the organization's competitive landscape, leadership philosophy, strategic plan, technology platform, and budget. Then, an organizational review is called for because organizational size and diversity, level of centralization, product diversity, product complexity, customer diversity, channel diversity, and product manufacturing diversity all affect the selection of the most appropriate product costing system. Also, different types of organizations, such as manufacturing, service, nonprofit, or government organizations have different needs and different criteria for what constitutes their most useful product costing system. Once the organization has been evaluated, all available product costing systems should be reviewed and matched with the organization's needs before a decision is made about which system to use.

3.1 Traditional Cost Accounting

The conventional and still most widely used product costing system, which is based on traditional cost accounting, was designed in the 1900s to satisfy the requirements of industrial mass production. In the 1900s, products made by manufacturers were homogeneous and the level of automation was low or nonexistent. Therefore, a relatively simple product costing system, such as the traditional product costing system based on cost accounting, served businesses well. Traditional cost accounting calculates product cost as the sum of direct material, direct labor, and all overhead costs, where overhead costs are allocated to products on a volume-related allocation basis, such as labor or machine hours. Three variants of traditional product costing systems exist. Although all three are based on the same principles, they can be categorized according to three different methods that make them more suited for different types of manufacturing. The three different methods are accumulation methods, cost control methods, and inventory evaluation methods.

Accumulation Methods

- The **job order costing system** is suitable for companies producing a wide variety of products. This system is used by businesses in which the product is tailored for a particular customer, such as customized furniture, aircraft, printing, construction, law, and accounting. The job cost sheet is prepared for each job to display the material, labor, and overhead used on each job. Once the order is complete, the total cost of the sheet is compared to the price charged to find the gross margin for the job.
- The **process costing system** is preferred when large masses of homogeneous products are produced, such as chemicals, paper, cement, rubber, steel, beverage, and glass. In the process costing system, the cost of the product is traced as it proceeds from one process to another. The heart of the system is the production report, which is usually prepared on a monthly basis.
- The third type of cost accumulating systems is a hybrid version of the previous two, called the **operation costing system**. This system is used by manufacturers whose processes contain some repetitive process steps through which all units go, yet batches of products are still tailored to specific orders. An automobile manufacturer is a typical example of such a mass producer where processes such as body forming, painting, and assembly are the same in each case, but different paint may be used for different cars. In the operation costing system, a work order sheet is used to trace a batch of products as it goes through the various process steps.

Cost Control Methods

- The **actual costing system** measures all cost components—direct material, direct labor, and manufacturing overhead—at their actual values to calculate product cost. Actual costs provide reliable and current cost information, but are not available immediately when a given product is manufactured because overhead costs are unknown until all bills are received and accounted for.
- The **normal costing system** measures direct material and direct labor costs at their actual values but uses predetermined overhead rates with an actual allocation base based on past data to calculate the product cost. In general, it is agreed that using normal costing systems is a reasonable compromise between real costs incurred (which will not be known for some time) and estimated costs (which are based on historical experience) because normal costing uses estimates only for overhead costs.
- The **standard costing system** allocates all cost elements based on a standard allocation base for the predetermined overhead rate instead of using the actual costs of direct material and direct labor, and estimates of overhead costs. This means that the cost of goods sold reflects the standard costs, not the actual costs of a product. However, because there is often a difference between the actual cost and the standard cost, the costing system has to account for the difference. This difference is called a variance. If the actual cost is greater than the standard costs, the variance is unfavorable, and the company's actual profits will be less than planned. If the actual cost is less than the standard cost, the variance is favorable, and the company's actual profit will be more than planned.

Inventory Evaluation Methods

- **Absorption or "full" costing** implies that all costs of production are absorbed by the products manufactured. Under absorption costing, all costs of production (direct material, direct labor, and manufacturing overhead costs) are considered product costs and included in inventory. Thus, when the company sells a product, the cost of inventory will be transferred to cost of goods sold and the gross profit will be reduced by all costs of production, regardless of whether they are fixed or variable. Costs that increase as volume increases are known as variable costs, while costs that do not increase with reasonable increases in volume are known as fixed costs. The advantage of this costing method is that the product is measured and reported on its full cost; the disadvantage can be that this method may not lead to the best decision on how to price or discount a product because the cost-volume-profit relationship is ignored.
- **Variable costing**—referred to sometimes as direct costing or marginal costing—means that only variable costs of production are included in inventory and in cost of goods sold. Excluding fixed costs ignores profits resulting from inventory buildup instead of sales. Therefore, variable costing helps prevent overproduction so managers can have a better understanding of their performance. However, variable costing can be misleading when sales revenues are greater than production costs or vice versa, because higher profits may mislead management into taking improper action. Therefore, variable costing can be used internally, but not for financial reporting.

3.2 Activity-based Cost Accounting

Activity-based cost (ABC) accounting was developed in the 1970s in response to the growing complexity of the manufacturing environment due to increasing product variability, changing production methods, and automation. Therefore, ABC accounting was designed to be applicable for any kind of organization regardless of product type (homogeneous or heterogeneous), production type, and level of automation. The concept behind ABC accounting is that making a product requires a series of activities that create costs. Therefore, in ABC accounting, product cost is calculated as a sum of direct material, direct labor, and overhead costs, where overhead costs are allocated based on activity and duration.

- In **ABC** accounting the allocation process happens in two steps. In the first step, costs of resources are assigned to activities (e.g., material purchasing, production preparation, material handling, quality assurance, customer contact) based on a cost driver (e.g., administration, depreciation, rent and utilities, office supplies, transportation, business travel). Then, costs of activities are allocated to individual products based on a given product's consumption of "activities."
- In 2003, Kaplan and Anderson introduced an updated version of ABC, called **time-driven ABC**, which puts greater emphasis on process efficiency and capacity utilization. In contrast to ABC, time-driven ABC at first estimates two parameters—units of time required to perform an activity and the cost per unit of time—and then multiplies this information by the quantity of the product. Estimation inaccuracies are revealed in unexpected surpluses or resource shortages, which allow analysts to adjust unit time required to perform certain activities. If managers aim to use the system for strategic decision making, rough estimates (+/- 10 percent) should be adequate. However, for operational control, resource requirements, quality, and cycle times of activities should be closely monitored to encourage continuous improvement activities.

3.3 Throughput Accounting

Throughput accounting (TA) was developed in the 1980s as another alternative to the traditional cost accounting system. TA was designed primarily for a production system that has low overhead and labor costs, e.g., for homogeneous and heterogeneous products with high material costs and different levels of automation. In TA, throughput is calculated based on direct material cost and operating expenses, but TA does not allocate overhead costs to products and services.

Throughput accounting aims to increase accuracy in product cost estimation by measuring throughput, inventory, and operating expenses.

- Throughput is defined as the revenue generated by the company from products sold. It focuses on sold products because unsold products do not create revenue. Therefore, products in work-in-process (WIP) and finished goods inventory do not count as throughput. This ensures that the capacity on a constrained resource (e.g., a bottleneck) is not wasted on overproduction.
- Inventory is viewed as money tied up in the company thereby decreasing the performance of the system. Thus, inventory is a liability that should be reduced gradually as it hides problems and decreases company performance.

- Operating expenses include all the money the company spends for turning inventory into throughput. It contains direct labor, manufacturing overhead, and selling and administrative costs, which are treated as period expenses and are not allocated to products. Operating expenses incurred in a period must be covered by the throughput generated by the system. If the throughput of the company cannot cover period operating expenses, operations will eventually cease.

3.4 Lean Accounting

Lean accounting (LA) is the most recent cost accounting practice introduced (2000 and later). LA is designed to handle mixed models of production, heterogeneous products with high variety, and high levels of automation. In LA, all costs are traced directly to the value stream of a product; overhead allocation is minimal and is, most frequently, based on square footage of the space occupied by a given value stream. LA offers two product costing practices: value stream costing (VSC) and target costing (TC).

- Lean accounting uses a single cost collector, called a value stream. A value stream combines all activities involved in the production of a product from its inception to the ultimate delivery to the customer, including design, manufacturing, transportation, and money collection. In **value stream costing (VSC)**, costs are calculated biweekly or monthly for each value stream. Both direct and (traditional) indirect costs are included in the cost calculation, with costs outside of a given value stream excluded. In the first step, VSC assigns all costs (e.g., labor, material, support services, and facilities) of a given time period to cost pools of each value stream. Cost pools can be defined as groups of associated costs that relate to a specific value stream. In the second step, the accumulated costs in each cost pool are assigned weekly as direct costs to individual value streams. Up to 90 percent of the costs can thus be directly assigned to products and only a small fraction of overhead cost needs to be allocated on a distribution basis such as square footage or materials used.
- **Target Costing (TC)** focuses on cost reduction beginning at the planning and design stage of the product development process and applies it through the product's entire life cycle. Target costing enables companies to determine a more realistic price, improve quality, and create increased value for the customer for its products. Target costing was originally created to provide a better understanding of customer requirements at the earliest possible stage in a product's life cycle. In a lean environment, target costing is primarily used when a company wants to introduce a new value stream or wants to add a new product to an existing value stream. Target costing enables a company to maximize the value of a new product and achieve maximum profitability for a given value stream.

3.5 Selecting the Best Product Costing System

In the previous sections, the array of traditional and alternative cost accounting and associated product costing systems were introduced. Further information about strengths and weaknesses, and benefits and drawbacks of each of these systems are available in the literature. However, no real framework exists for guidance in how to select the best product costing system. Yet, without having the best product costing system in place, industry participants cannot accurately

calculate their products' costs to ensure profitability and submit winning bids to potential customers. Also, and maybe even more challenging, bids from competitors with inaccurate costing data can underprice more realistic bids, thereby hurting the industry in the long term.

Respondents to the 2010 Product Costing Survey indicated that the characteristics that would add the most value to their product costing systems were (listed in order of frequency mentioned):

- easy to operate
- provide accurate cost information for management purposes
- provide easily available, up-to-date information for cost estimates
- easily accessible
- easily customizable

Additional characteristics mentioned as desirable attributes of a costing system included:

- build custom reports
- display historical unit cuts and trends
- handle multiusers
- not time consuming to maintain

Selecting the "best" product costing system requires constant review and evaluation of an organization's situation and a continuous review of the available product costing practices (Gurowka and Lawson 2007). Empirical evidence exists that indicates most companies competing in the hardwood dimension and component industry use traditional costing systems to calculate product costs. This information is confirmed by the respondents of the 2010 Product Costing Survey, in which 74 percent of the respondents reported using a traditional cost accounting system, 13 percent use an activity-based cost accounting system, 4 percent use a lean accounting system, and 9 percent use their own, unspecified setup. Thus, traditional cost accounting systems are the most frequently used, although it has been shown that traditional cost accounting systems distort data on product cost, potentially leading to erroneous decision making. Management accountants in the U.S. advocate using activity-based cost accounting as an alternative system for product cost calculation. However, numerous companies have experimented with ABC accounting and then abandoned the method because it is expensive to validate time allocations and difficult to maintain and update the ABC accounting system. Also, many industry practitioners reject throughput accounting and its underlying discipline of direct costing because the variable portion of direct costing tends to decrease in today's flexible manufacturing making material costs the only variable cost in direct costing. Companies applying lean principles may use a lean accounting system; however, a lean accounting system requires establishing value streams that consist of product families following similar process sequences through a company's operation.

4. RESULTS OF THE 2010 PRODUCT COSTING SURVEY

In 2010, a survey study was conducted by Virginia Tech with the support of the Wood Component Manufacturers Association (WCMA) to investigate the type and structure of product costing practices used by the North American hardwood dimension and components industry. The survey was mailed to a subset of the North American hardwood dimension and component industry. It asked exploratory questions about the type, structure, and reliability of the costing systems used; the purpose of the current versus an imaginary "perfect" costing system; and problems of the current costing system. The survey also asked about ideas for improving the industry's costing systems. The questionnaire consisted of 34 questions: 9 questions related to company information, 15 questions related to the characteristics of product costing systems, and 10 questions addressed products and markets.

An address list of all members of the WCMA containing 137 companies and a second list of contact data for 232 non-member firms operating in the hardwood components production sector were obtained from the WCMA (WCMA 2010). Additionally, the membership list of the Wood Product Manufacturers Association (WPMA 2010) containing 114 companies was used; 45 of these companies were already listed on one of the previous two databases and thus were removed, yielding a total of 69 additional companies from the WPMA list. Finally, addresses for 57 millwork companies were obtained from the 2009 Virginia Industry Directory (Harris Infosource 2009) and from manta.com., an online industry directory (Manta 2010). Thus, the survey database contained a total of 495 addresses of North American hardwood dimension and components producers, 447 in the United States and 48 in Canada.

The final version of the questionnaire, which was identical for all survey participants, was sent to 490 companies (excluding five pretested respondents) during the summer of 2010. The survey was addressed to a senior company manager, preferably the CEO, the President, or the owner. From the initial contact list, 7 companies refused to participate in the research and an additional 37 surveys could not be delivered due to the businesses being closed or an address discrepancy. Thus, the adjusted survey population was 451. During the 8-week-long duration of the survey, 74 valid responses were received, for a response rate of 16 percent. However, because not all questions were answered by all respondents, the number of responses obtained for a given question varied.

4.1 Company Characteristics

Wood dimension and components manufacturing is not separated as an individual category under the North American Industry Classification System (U.S. Census Bureau 2010b), but is folded into other industry subsegments. According to survey respondents, 43 percent classified their business activity as millwork manufacturing (NAICS 32191), 12 percent as kitchen, bath cabinet, or countertop manufacturing (NAICS 33711), 11 percent as household and institutional furniture manufacturing (NAICS 33712), 7 percent as sawmill and wood preservation manufacturing (NAICS 32111), 1 percent as veneer manufacturing (NAICS 32121), 1 percent as office furniture (including fixtures, NAICS 33721); and 24 percent as "other" (NAICS 32199). The "other" category included 12 component manufacturers, 3 wholesalers, and 3 art and design companies.

The majority of respondents, 72 percent, ran a manufacturing business, 23 percent were in trading or brokering, and 5 percent were involved in both activities. Most respondents' companies belonged to the micro (<10 employees) and small (<50 employees) company categories (European Commission 2003) based on their number of employees reported. Thirty respondents (41 percent) reported having fewer than 20 employees, 21 respondents (28 percent) employed between 20 and 49 individuals, 14 respondents (19 percent) employed between 50 and 99 individuals, and the remaining 9 respondents (12 percent) reported having more than 100 but fewer than 499 employees. These results are similar to the average company size in the U.S. millwork industry in 2009 as reported by the U.S. Bureau of Labor Statistics (U.S. Bureau of Labor Statistics 2010).

Seventeen companies (24 percent) reported total annual wood products sales volume in 2009 to be between $5.1 million and $10 million, 15 companies (21 percent) reported between $2.1 million and $5 million, 14 companies (19 percent) reported less than $1 million, 12 companies (17 percent) between $1.1 million and $2 million, and 14 companies (19 percent) reported above $10.1 million total annual wood products sales volume. For 2007, the U.S. Census Bureau (U.S. Census Bureau 2010a) reported an average sales volume of $5.9 million for the U.S. millwork industry. Eighty-five percent of respondents reported that their total annual wood products sales volume in 2009 was smaller than in 2006, before the recession. Seven percent stated that their sales volume was the same in 2009 compared to 2006, and only 8 percent of the respondents reported increases in sales volume.

Most responses were received from the Midwest (31 percent) followed by facilities located in the Northeast (30 percent), the South (27 percent), and the West (5 percent). Seven percent of the responses were received from Canada.

Results from this mail survey have limitations that must be considered when reading, interpreting, and applying the results (Alreck and Settle 2003). Likely, only one respondent from each company (although likely a member of the senior management team) was contacted to answer the survey, possibly creating single response bias (Blair and Burton 1987). Also, respondents may have different perspectives of, and motives for, a costing system either as users or preparers. Thus, findings reported may be biased based on these differences in perspectives. Because the majority (68 percent) of the respondents were owners or CEOs of the company, their involvement in and knowledge of current product costing practices may be limited. In these cases, the respondent might have obtained input from a company expert to answer the questions specific to the product costing system. Also, as only a subset of the industry was contacted for this survey, results cannot be generalized beyond the targeted industry segments. Finally, results may have been affected by the severe recession impacting the industry during the period in which the survey was conducted. Also, the relatively low number of respondents (response rate 16 percent) warrants caution when generalizing the results reported from this study.

4.2 Survey Results

First, the cost accounting and product costing systems currently used by North American hardwood dimension and components manufacturers are described and the purpose of these systems is given. Then, problems that arise from the use of these systems are discussed. And

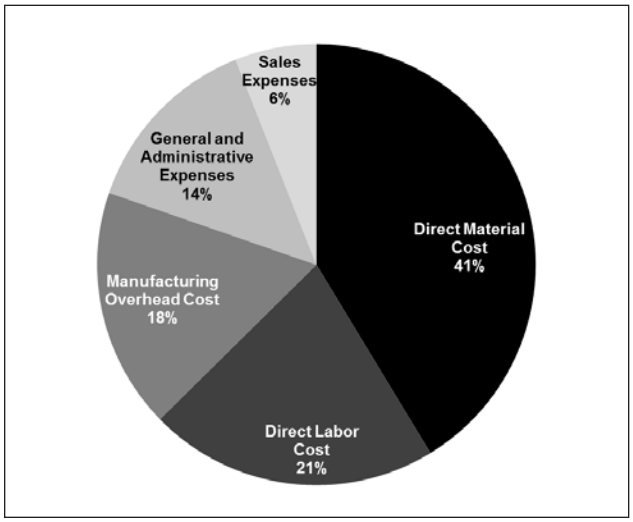

Figure 4.—Average distribution of total product costs of North American hardwood dimension and component manufacturers in 2010 (n=64).

finally, characteristics of a "perfect" system are listed and systems improvements are addressed. Non-parametric tests were conducted among responses by company size and main product category to detect significant differences between respondents ($\alpha = 0.05$).

Figure 4 provides an overview of the average distribution of total product costs of responding companies active in the North American hardwood dimension and components industry. Survey results show that 41 percent of the product cost derives from direct material cost and 21 percent from direct labor cost. Manufacturing overhead cost, e.g., utilities, health insurance, and property tax, among others, represents 18 percent of the total average product cost. General and administrative expenses (e.g., travel expenses, executive salaries, and general support and associated taxes among others) cover 14 percent, while sales expenses make up 6 percent of the total average product cost. The Kruskal-Wallis test performed did not indicate significant differences in the distribution of total product costs of responding companies by company size or by main product category. Half of the respondents reported that they calculated overhead cost on a monthly basis, 26 percent calculated overhead cost on an annual basis, and 14 percent indicated that they calculated overhead costs infrequently (mostly quarterly). Ten percent of the respondents stated that they calculated their overhead costs weekly.

Survey participants were asked to categorize the information their current costing system gives them and to indicate what a "perfect" system would provide. Results shown in Figure 5 illustrate that the vast majority of respondents gather financial information from their current costing system (average overall response rate in the financial information category [current] is 70 percent, 49 responses divided by 70 respondents, Fig. 5). Respondents use this financial information to create financial reports (current system, 84 percent, Fig. 5), tax reports (67 percent), and inventory valuations (69 percent), and to calculate the cost of their products (60 percent).

A smaller proportion of firms indicated that they use their cost accounting system to gain operational information in support of their operational decision making (average overall response rate in the operational information category [current] is 24 percent, Fig. 5). Respondents use this operational information to prepare performance indicators (current

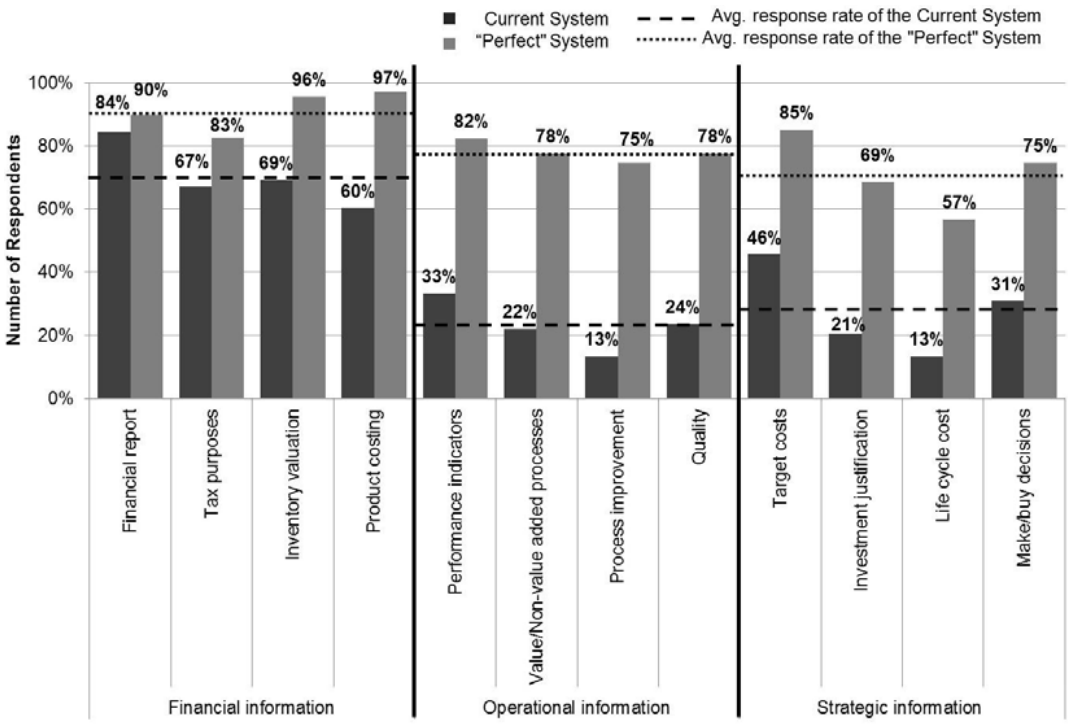

Figure 5.—Information provided by respondent company's current costing system and preferences for capabilities of the "perfect" costing system.

system, 33 percent), define and measure value-added and nonvalue added processes (22 percent), improve processes (13 percent), and measure quality (24 percent).

Respondents indicated they use their current cost accounting system for strategic information with about the same frequency as they use it for operational information (average overall response rate in the strategic information category [current] is 28 percent, 19 responses divided by 68 respondents, Fig. 5). Respondents use this strategic information to calculate target cost (current system, 46 percent), justify investment decisions (21 percent), calculate life cycle cost (13 percent), and come to make or buy decisions (31 percent).

Most respondents believe that a "perfect" costing system should meet, first and foremost, the financial information needs of the organization. The "perfect" system, according to the respondents to this question, should provide operational information more effectively than do current systems. Respondents would also like to use this operational information to prepare performance indicators (82 percent), define and measure value-added and nonvalue added processes (78 percent), measure quality (78 percent), and improve processes (75 percent). Respondents also indicated that the "perfect" system should provide strategic information (72 percent, Fig. 5). Respondents would like to use this strategic information to calculate target cost (85 percent), come to make or buy decisions (75 percent), justify investment decisions (69 percent), and calculate life cycle cost (57 percent).

Survey participants were also asked what type of cost accounting system they are using (Fig. 6). A total of 68 responses were received for this question. Seventy-four percent of respondents reported using a traditional cost accounting system; 13 percent an activity-based

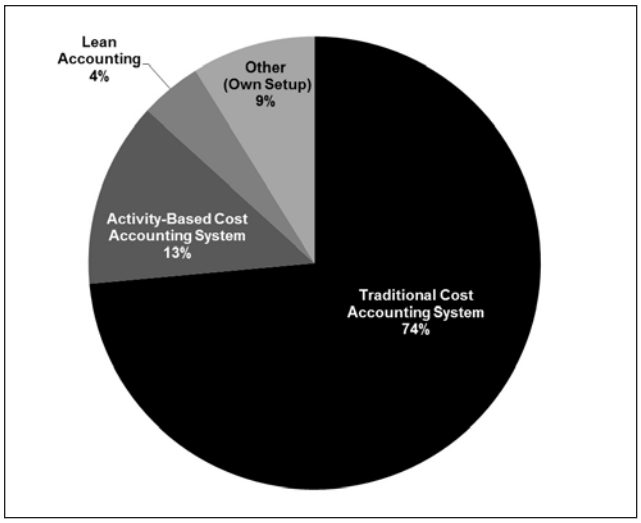

Figure 6.—Type of cost accounting system used by problem type and by respondents (n=68).

cost accounting system; 4 percent a lean accounting system; while 9 percent use their own, unspecified setup. The Kruskal-Wallis test did not show any significant differences in the type of costing systems used by responding companies by company size or by main product category.

Related to their current costing system, survey participants were asked, "Have you ever realized that high volume products carry too much of the overhead burden and become over-priced while the low volume products are underpriced?" (Fig. 7a). Forty-six percent of the respondents) using a traditional cost accounting system experienced this problem, while 67 percent of the respondents that claimed to have an ABC system identified the same problem. Thirty-three percent of the respondents with a lean accounting system reported the same issue and 67 percent of the respondents with their own setup indicated that high-volume products often carry a disproportionately high overhead burden.

Next, participants were asked, "Do you think that your costing process (in general) is too expensive and/or too time-consuming?" (Fig. 7b). Thirty-two percent of the traditional cost accounting users, 44 percent of the ABC users, and 50 percent of the respondents using their own costing setup indicated that their costing process is too expensive and/or too time-consuming to maintain. Zero percent of the lean accounting users perceived this issue to be a problem.

The results to the last question of this section, "Do you use visual performance measures (e.g., hourly production, days of inventory, operational equipment efficiency, etc.) on a performance board on the shop floor?" are shown in Figure 7c. Forty percent of traditional cost accounting users apply performance measures on the shop floor, 44 percent of ABC users, 100 percent of the lean accounting users, and 50 percent of the respondents with their own system do so.

A total of 72 respondents expressed their opinion on the reliability of their costing system. Eleven percent claimed that their costing system provides "outstanding" information (Fig. 8). Thirty-nine percent of the participants rated the information provided by their costing system as "good," 24 percent of respondents rated it as "adequate," 24 percent indicated the information provided by their costing system "needs improvements," and 3 percent rated the information provided as "poor."

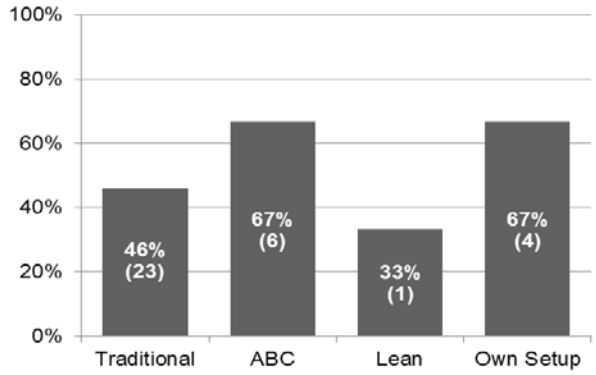

Figure 7a.—Percentage of respondents indicating that there have been times when high volume products have been found to carry too much of the overhead burden and therefore were overpriced, by accounting system employed.

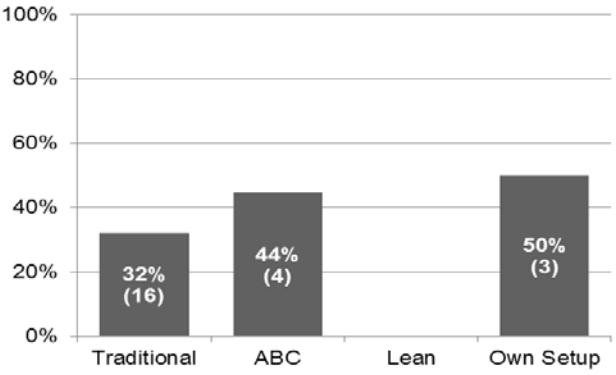

Figure 7b.—Percentage of respondents indicating they believe their costing process (in general) is too expensive and/or too time-consuming.

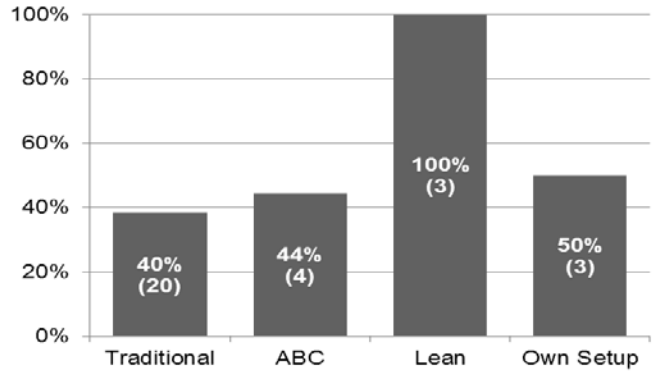

Figure 7c.—Percentage of respondents indicating they use visual performance measures (e.g., hourly production, days of inventory, operational equipment efficiency, etc.) on a performance board on the shop floor.

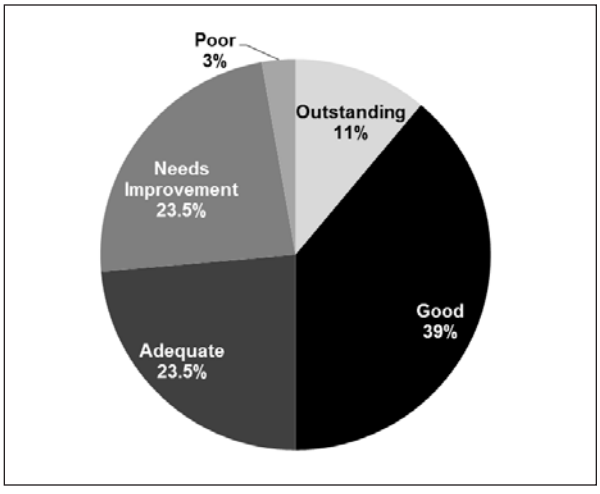

Figure 8.—Respondents' ratings of the quality of the information provided by their costing system (n=72).

Respondents were also asked whether they experienced problems arising from erroneous information provided by their costing systems. A total of 71 respondents answered this question. Six percent of the respondents reported that this issue arises frequently, 77 percent of the respondents claimed that it happens occasionally, while 17 percent of the respondents stated that they never experienced the problem.

Results show that even respondents who indicated high levels of satisfaction with their costing system (e.g., respondents who rated their costing system as "outstanding" or "good") reported occasional problems stemming from erroneous information provided by their system. However, only respondents from the three rankings indicating the lowest level of satisfaction—e.g., "adequate," "needs improvement," and "poor"—stated that problems frequently arise from erroneous information provided by their costing systems. Interestingly, 3 out of the 17 respondents who reported that their costing system needs improvement also reported that they never have problems arising from erroneous information provided by their costing systems.

To gain a deeper understanding of the challenges that respondents face with their costing systems, respondents were asked to provide more details about any problems associated with their system. Results are shown in Figure 9.

The five highest rated problems were "lack of resources" (average response of 3.08 on a scale from 1 [never occurs], 3 [seldom occurs], to 5 [always occurs]), "no link to other management initiatives" (3.07), "no interface to enterprise software" (2.78), "failure to understand the three (financial, operational, strategic) uses of costing system" (2.77), and "lack of data" (2.76). Respondents also could indicate "Other" options in the questionnaire to list problems that were not mentioned in the original table. Respondents listed the following additional problems they encounter with their systems: "human error typing data in," "product costing is not part of the accounting system," "regulations (local, federal)," "redundancy," and "managers do not

Figure 9.—Problems of respondents' costing systems (error bar depicts +/- 1 standard deviation).

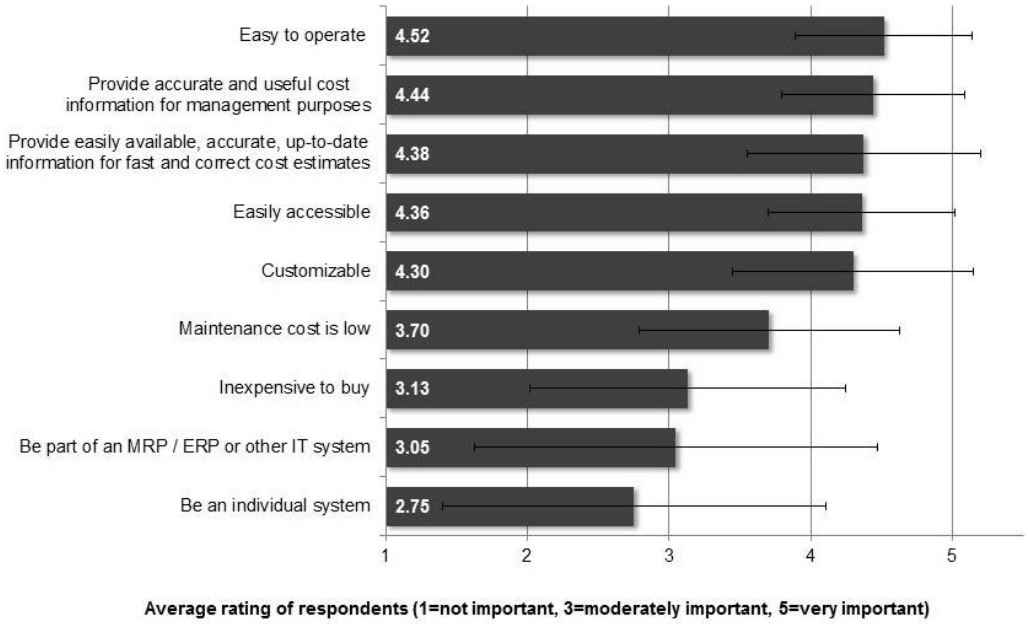

Figure 10.—Costing system objectives important to respondents (error bar depicts +/- 1 standard deviation).

use the data." Results showed that significantly more companies in the size group of 50 to 99 employees tend to complain about "redundant data" than do companies with 1 to 19 employees or companies with 20 to 49 employees. Also, significantly more companies in the size group of 50 to 99 employees tend to complain about "erroneous data" than do companies with 1 to 19 employees). Moreover, significantly more companies in the group of 50 to 99 employees complained about a "lack of data" than did companies with 20 to 49 employees or companies with more than 100 employees. Additionally, results also showed that significantly more sawmills and wood preservative manufacturers reported problems arising from "no interface to enterprise software" than did veneer/plywood/engineered wood products manufacturers or millwork manufacturers.

Survey participants were asked to provide their insights on which objectives of a costing system are the most important. Participants also were asked to compare their desired objectives to objectives that their current costing system already possesses. Responses received for each question are illustrated in Figure 10 (important objectives of a costing system) and Figure 11 (comparison of desired and existing objectives of the participants' systems), respectively.

The five highest rated objectives of a desired costing system were "easy to operate" (average response of 4.52 on a Likert-scale from 1 (not important), 3 (moderately important), to 5 (very important)), "provide accurate cost information for management purposes" (4.44), "provide easily available, up-to-date information for cost estimates" (4.38), "easily accessible" (4.36), and "easily customizable" (4.30). An "Other" option was also provided for respondents where participants were able to list what kind of objectives they believe would add the most value to a costing system. Respondents listed the following additional objectives: "build custom reports," "display historical unit cuts and trends," "handle multiusers," and "not time consuming to maintain."

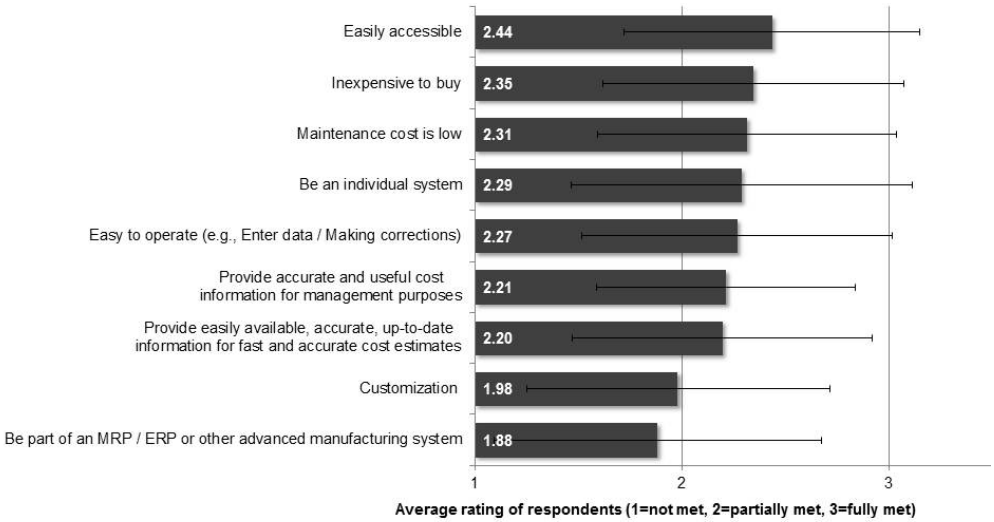

Figure 11.—Objectives of costing software respondents believe are being met by their existing costing software (error bar depicts +/- 1 standard deviation).

Respondents were also asked to indicate which objectives they believed were being met by their existing costing software on a three point scale: 1 (not met), 2 (partially met), and 3 (fully met; Fig. 11). The five objectives that respondents felt were being best met by their current costing systems were "easily accessible" (average response 2.44), "inexpensive to buy" (2.35), "maintenance cost is low" (2.31), "be an individual system" (2.29), and "easy to operate" (2.27).

4.3 Discussion

Traditional cost accounting systems were developed at the beginning of the 20th century when mass production had revolutionized human society's productive capacities, labor costs were cheap and stable for long periods, and labor efficiency and machine utilization rates were the focus of managements' attention (Carnes and Hedin 2005, Plossl 1990). During this time, technological development was slow and major design changes were unusual, which allowed for long product cycles and setup times (Plossl 1990). In the 1960s, direct labor from mainly low-skilled workers made up approximately 25 percent of the total product costs; overhead costs were also relatively small (25 percent) and closely related to direct labor (Plossl 1990). Thus, distortions arising from inappropriate overhead allocations were not substantial. Today, companies produce a wide range of customized products, labor cost represents a smaller part of total costs, and overhead costs play a more considerable role.

This research shows a decreasing trend of labor costs, which now make up 21 percent of total costs on average of all respondents (Fig. 4). The Wood Component Manufacturers Association's cost of doing business survey conducted in 2009 (WCMA 2009) reflects the decreasing importance of direct labor cost even more: 60 percent direct material cost (vs. 41% here), 12 percent direct labor cost (vs. 21 percent here), 14 percent manufacturing overhead cost (vs. 18 percent 9 percent general and administrative expenses (vs. 14 percent), and 5 percent sales expenses (vs. 6 percent from this survey). Although these differences cannot be unambiguously explained with the information available, such differences can arise when cost data from a wide variety of companies are collected. Different products carry different cost allocations. For

example, companies producing low value-added products typically have higher direct material costs and lower labor costs as a percentage of total costs than companies producing higher value-added products. As an example, a company producing custom-made, high-end solid hardwood furniture doors incurs higher labor costs as part of its total cost as compared to a company producing solid hardwood blanks for use in the manufacture of upholstered furniture. Therefore, the difference in the distribution of costs can be explained by the differing products that respondents of the two studies produce.

The purpose of cost accounting systems is to provide financial, operational, and strategic information for decision makers (Player and Keys 1997). Satisfying all three purposes is difficult for a single system because different levels of aggregation, reporting frequency, and measures are required. For instance, for financial reporting requirements, it may not be necessary to accurately measure resources consumed by individual products, but for strategic decision making, accurate product costs are necessary to distinguish between profitable and unprofitable products and activities. Survey results show that respondents are using their cost accounting system primarily to gain financial information instead of gaining information for management or strategic decision purposes. This finding is somewhat surprising, because basic financial data can be obtained from basic accounting systems. However, a way to address the need for more operational information from an accounting system is the use of lean accounting (Crandall and Main 2007; Maskell and Baggaley 2003a,b). Lean accounting uses information generated from the shop floor on a frequent basis, e.g., by the day, and often, by the hour. Lean accounting performs costing, variable reporting, overhead allocation, and budgeting at the value stream level (Maskell and Baggaley 2003), providing accurate, real-time operational information. If lean accounting is aligned with lean practices, waste from all financial and non-financial transactions can be removed by applying visual tools, lean trainings, and employee empowerment. Also, respondents, especially those in the household, institutional, and office furniture categories, underlined the importance of target costing to gain strategic information. Although target costing is a powerful profit and cost management practice that fits with lean accounting (Maskell and Baggaley 2003a,b), target costing is primarily adopted for product development and design processes, rather than accounting (Dekker and Smidt 2003).

Indeed, numerous cost accounting systems can serve all three purposes (financial, operational, and strategic). However, no cost accounting system can serve all three purposes equally well because of the partially conflicting requirements of different users (e.g., financial controllers, line managers, and strategic planners), purposes (e.g., financial accounting, activity analysis for process improvement, and make or buy analysis), levels of aggregation (e.g., company wide data, detailed data, and plant or product line aggregation data), reporting frequency (e.g., periodic, immediate, and ad hoc), and types of measures (e.g., financial, physical, or both, Player and Keys 1997). Because each choice involves tradeoffs, businesses need to clearly understand how they will use the information from their cost accounting system to be able to lay out their system to serve their most critical purposes best.

A majority of respondents (74 percent) reported using a traditional cost accounting system rather than its newer substitutes, such as ABC accounting (13 percent), lean accounting (4 percent), throughput accounting, or their own setup (9 percent). Given that most U.S.

accountants and managers have been educated to use traditional volume-based cost accounting systems that use either machine hours or direct labor hours as an allocation base, it is likely that the proprietary systems reported by 9 percent of respondents (e.g., "own setup") are built according to traditional cost accounting philosophy. The high rate of use of traditional cost accounting practices may also be a function of the size of responding companies. Because most responding companies are small (88 percent of respondents report to have less than 100 employees), they are unlikely to invest in sophisticated or unfamiliar costing systems.

A frequent critique of traditional cost accounting systems is that these systems do not accurately allocate all costs to individual products because high volume products carry too much of the overhead burden and become overpriced while low volume products are underpriced (Johnson and Kaplan 1987). Survey participants were asked to provide feedback on whether they faced this particular problem with their costing system. Yet, only 23 out of 50 respondents (46 percent) who reported to have a traditional cost accounting system indicated they have this cost allocation problem. This number appears low given that experts consistently claim that this misallocation problem is the central weakness of traditional cost accounting systems (Berliner and Brimson 1988, Cokins and Hicks 2007, Goldratt and Cox 1986, Johnson and Kaplan 1987). However, defenders of traditional cost accounting systems maintain that these methods may not significantly distort information provided for decision makers because many volume-related measures of output (e.g., direct labor, machines) are highly correlated with manufacturing overhead (Drury and Tayles 1994). Because four out of six companies who reportedly use their own setup (67 percent) reported the same problem, we speculate that the proprietary cost accounting systems of these companies are based on traditional cost accounting principles. However, six out of the nine respondents (67 percent) who indicated having an ABC accounting system also described the cost allocation problem. Because ABC accounting systems were specifically designed to eliminate this problem, suspicions exist that respondents may not have implemented or are not using their ABC system properly.

The most severe critique of activity-based costing systems, as discussed in the literature, is that the costing process (in general) is too expensive or too time-consuming (Roztocki et al. 2004). However, our study found that 16 out of the 50 traditional cost accounting users (32 percent) responding to our survey also faced this issue, which is surprising because traditional costing systems are considered to be the simplest and easiest to maintain. Only four out of nine ABC users (44 percent) reported the same problem. No respondents using lean accounting indicated that their system is expensive or time consuming, while three out of six respondents (50 percent) with their own setup mentioned the problem.

Survey participants were asked whether they use visual performance measures (e.g., hourly production, days of inventory, or operational equipment efficiency) on a performance board on the shop floor, which is one of the traits of a lean company (Parry and Turner 2006). However, our survey found that visual performance measures are widely used by companies with a variety of cost accounting systems and are not restricted to lean companies.

A survey conducted by Howell et al. in 1987 about management accounting in the changing manufacturing environment indicated that 54 percent of respondents were unsatisfied with

their product costing system (Drury and Tayles 1994). Today, a wide range of cost accounting systems and product costing practices are available for industry participants and improvements to existing systems have been made. However, 27 percent of survey respondents still indicated that they were unsatisfied with their product costing system (Fig. 8). Furthermore, only 23 percent of respondents reported that they obtain adequate information from their costing system (Fig. 8). Another noteworthy observation is that all respondents who rated the information obtained from their product costing system as "outstanding" (11 percent, Fig. 8) had a traditional system. These results suggest that traditional cost accounting systems can be useful and adequate if they are properly designed while newer systems, such as ABC or lean accounting systems, can provide misleading and unreliable data if they are not correctly implemented and/or used.

Problems with costing systems used can be classified into three categories; management related problems, people related problems, and costing systems related problems. The most often cited problem was "lack of resources" (Fig. 9). Most cost accounting systems require significant investments for software packages, outside expertise, and employee training, as well as considerable efforts to maintain the system's data. Thus, the balance between resources invested in cost accounting systems and the quality and extent of the information provided by the system is always challenging.

The second most common problem mentioned by respondents was "no link to management initiatives." This problem can be categorized as a costing system related problem (Fig. 9). It is expected that this problem is at least partially attributable to companies' costing systems having been created to provide information not exactly targeted at what management needs.

The third most common problem listed by the respondents was "no interface to enterprise software" (Fig. 9). Today, cost accounting systems are doomed to fall short of their optimal utility if implemented in isolation. Linkage to other enterprise software and management initiatives, such as enterprise resource planning (ERP) systems, provide valuable cost information with the largest positive impact. Such links are essential because cost information provided by the cost accounting system can encourage or discourage actions related to other enterprise software and management initiatives.

Although respondents indicated that the objectives of easy accessibility and low cost were being met by their current systems (Fig. 11), these systems do not necessarily provide the level of accuracy and up-to-date cost information that some survey participants are seeking (Fig. 10). The need for more accurate cost information may suggest that product costing systems used by respondents requires an update with more modern cost calculation and allocation techniques. Other important objectives indicated by respondents were to have an easily available, up-to-date, and easy to operate product costing system (Fig. 10). Although product costing information is created by a relatively small group of professionals, it can affect the work of other groups within the organization as well. Therefore, appropriate product costing information must be made available to all people involved, directly or indirectly, in the costing process. Anecdotal evidence exists that many industry participants are using Microsoft Excel spreadsheets for product costing because such MS Excel systems are easy to create, operate, and

customize. The sophistication of these spreadsheets varies considerably among companies, and while some may deliver information that is in line with the needs of the company, others may be less sophisticated or less reliable in the information they deliver.

Given the prevalence of traditional accounting systems in the North American hardwood dimension and components industry, this manual describes WoodCite, a software package of a traditional job order based costing system. Consequently, as a next step, a product costing software package based on the findings from the 2010 Product Costing Survey was developed. The system developed and explained in the following section assigns overhead cost to products accurately, at low cost, and with little effort, while creating competitive bids for external customers.

5. WOODCITE 1.0 – PRODUCT COSTING SOFTWARE PACKAGE

WoodCite 1.0 (Palmer et al. 2014) is a product costing software package designed for hardwood dimension and component manufacturers. WoodCite is a Microsoft® Access application that calculates a company's product cost and creates competitive bids for quote requests. Creating competitive bids to external customers requires two steps: (1) defining a competitive selling price by evaluating the company's strategy, competitive situation, shareholder expectations, and other demands, and (2) calculating the cost of the product from the design stage to customer delivery. The gap between the selling price and product cost is the company's profit margin.

WoodCite is a job-order-based costing software package. A job order costing system allows companies to maintain separate records about each quote request, which can be used to estimate similar quote requests in the future. In this type of system, direct material, direct labor, and overhead costs are accumulated by individual products or jobs. Then, the total sum of all the costs of a product or a job is divided by the number of units produced to obtain an average cost per unit.

The structure of WoodCite consists of a menu bar, tool bar, navigator strip, and data entry tables as displayed in Figure 12. The **menu bar**, identical to any Microsoft Access application, includes file, home, create, external data, and database tools. The **tool bar** consists of commands, such as tasks, tools and applications, references, commands, edit company data, view all products, review orders, and view the quote sheet. The **navigator strip** includes selectable icons, such as save, add new customer, delete current customer, add new order, delete current order, search for customer, view charts, and view documentation. Lastly, **data entry tables** allow users to enter information received from customers or information necessary for product cost calculation. The WoodCite application is free and can be downloaded from http://www.nrs.fs.fed.us/tools/WoodCite/.

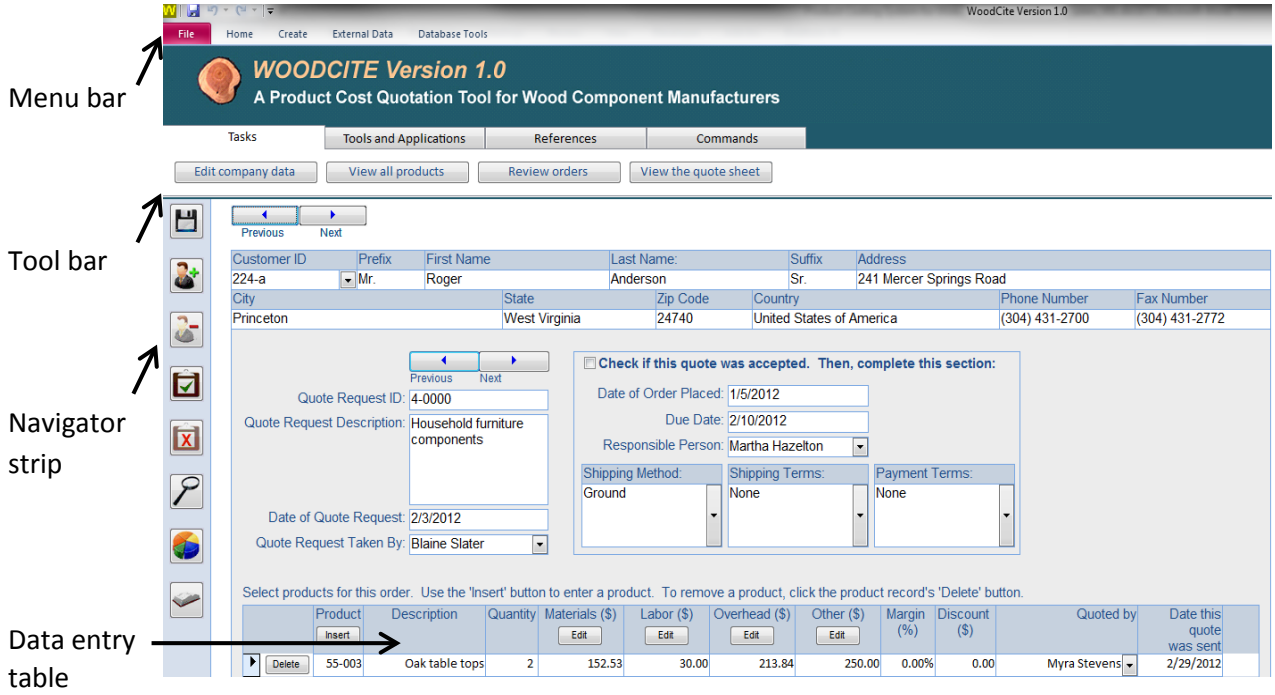

Figure 12.—The structure of WoodCite Version 1.0.

6. WOODCITE 1.0 – PRODUCT COSTING EXAMPLE

The following example demonstrates the capabilities of WoodCite. The wood component manufacturer is referred to as Wood Inc. As a starting point, WoodCite was filled up with historical data records of Wood Inc., including company information, workforce data, activity list, historical overhead costs, shipping and payment terms, material information, and a list of products manufactured. The customer in this example is represented by Mr. John Smith, a potential new client whose contact information was entered and saved into WoodCite with an assigned customer ID (12345, Fig. 13). Mr. Smith, purchasing agent of a major wholesaler business, placed his quote request (JS-0001, Fig. 13) for 120 maple kitchen island legs on January 23, 2013. The quote request was taken by Audrey Clark, administrative personnel of Wood Inc. as is shown in Figure 13.

The product cost calculation begins with calculating the direct material cost (Figure 14). To produce one kitchen island leg, Wood Inc. purchases a premade blank in the size (in inches) of 3.5 x 3.5 x 36, which is equivalent to 3.0625 board feet (calculated as (3.5 x 3.5 x 36) ÷ 144). The unit price of a premade blank varies by species. In this example, it is assumed that one board foot of maple costs $4.50. Therefore, to produce 120 maple kitchen island legs, Wood Inc. needs to purchase 367.5 board feet (calculated as 3.0625 board feet multiplied by 120 kitchen island legs) of premade set of maple blanks. Notice that in this example Wood Inc. purchases a dimension blank that already has costs attributed to the making of the blank, so no investigation into rough mill yield needs to be undertaken. If the company does not buy blanks, the yielded cost applies and the costs to buy lumber and process it into squares have to be taken into account. The lumber cost per board foot for maple ($1.25/board feet) would be inexpensive, but the yielded price (approximately 55 percent yield) plus glue and labor costs would then increase the per board foot price of the dimensioned square accordingly. Also, no freight or other costs are charged by the supplier in this example. Consequently, the total material cost of the requested product is $1,653.75 (calculated as $4.50 multiplied by 367.5 board feet).

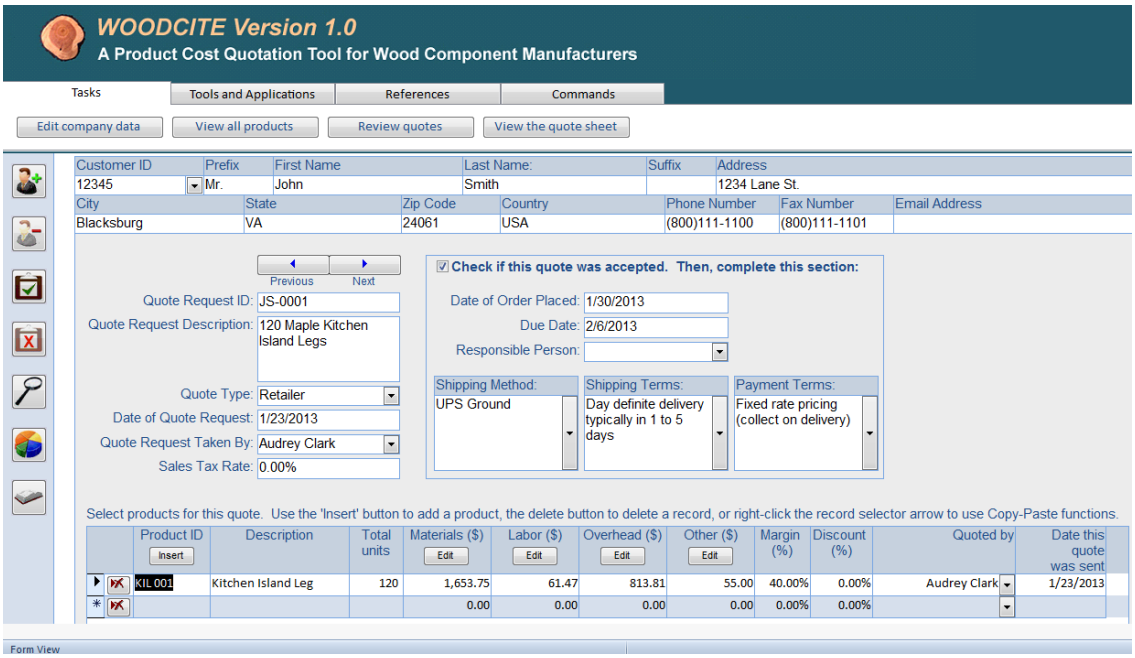

Figure 13.—Customer and product information sheet in WoodCite 1.0.

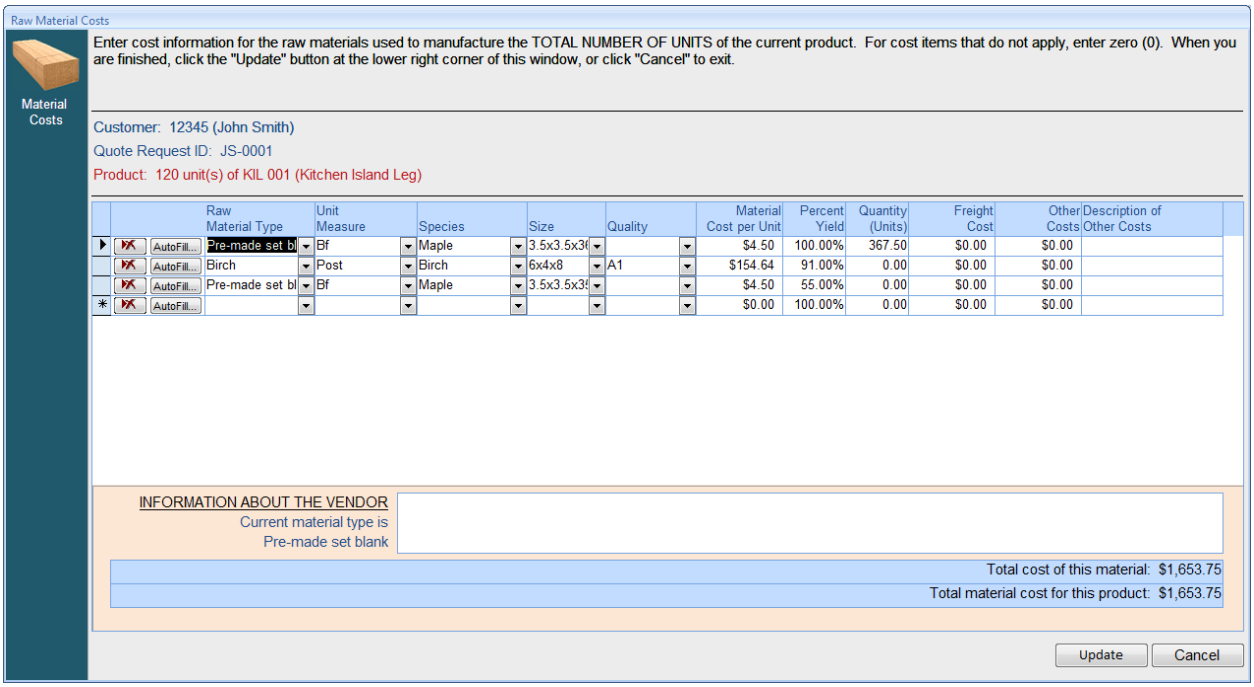

Figure 14.—Material cost calculations in WoodCite.

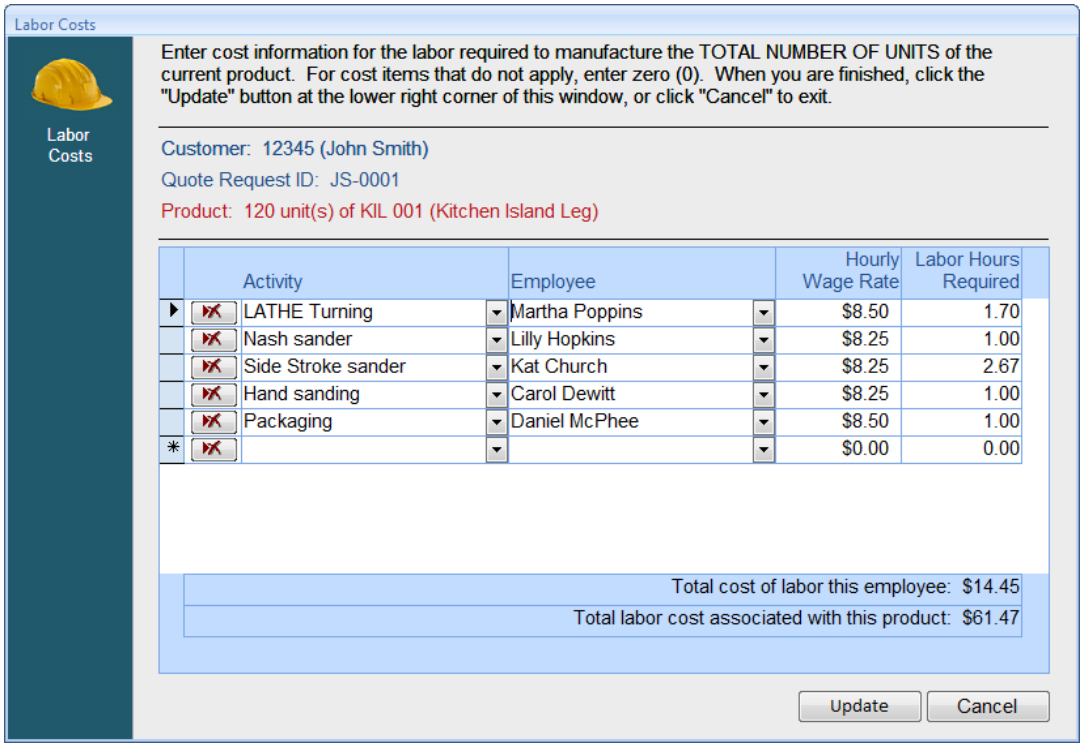

Figure 15.—Direct labor cost calculation table in WoodCite.

In a next step, direct labor cost is calculated (Fig. 15). To produce a kitchen island leg, the purchased premade maple blank must go through the following processes: (1) lathe turning, (2) nash sanding, (3) side stroke sanding, (4) hand sanding, and (5) packaging. Wood Inc. has an assigned employee for each of the above described tasks and the company also recorded the time necessary to perform each task. The employee assigned to lathe turning processes 70 blanks per hour on a $8.50 hourly rate, resulting in a $14.45 (calculated as $8.50 multiplied by 1.7 hours of operation to produce 120 blanks) labor costs. Figure 15 displays the labor cost window of WoodCite containing this information. Similarly, the employee assigned to nash sanding processes 120 blanks per hour on an $8.25 hourly rate, resulting in a $8.25 labor cost; the employee assigned to side stroke sanding processes 45 blanks per hour on an $8.25 hourly rate, resulting in a $22.02 labor cost; the employee assigned to hand sanding processes 120 blanks per hour on an $8.25 hourly rate, resulting in a $8.25 labor cost; and finally, the employee assigned to packaging is able to pack 120 blanks into a United Parcel Service box in one hour on an $8.50 hourly rate, resulting in a $8.50 labor cost. Consequently, the total labor cost of the requested product is the sum of each step's labor cost: $61.47 (calculated as $14.45 plus $8.25 plus $22.02 plus $8.25 plus $8.50).

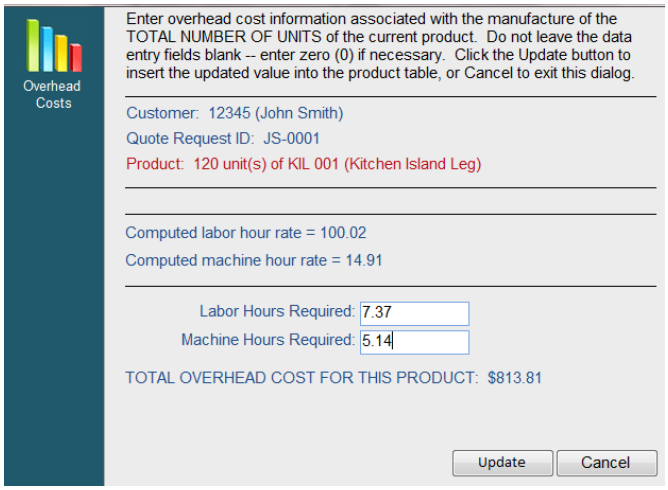

Figure 16.—The overhead cost calculation form.

The next step in calculating the cost of the requested product is calculating overhead cost (Fig. 16). Historical overhead cost data of Wood Inc. for the last 30 months were already entered

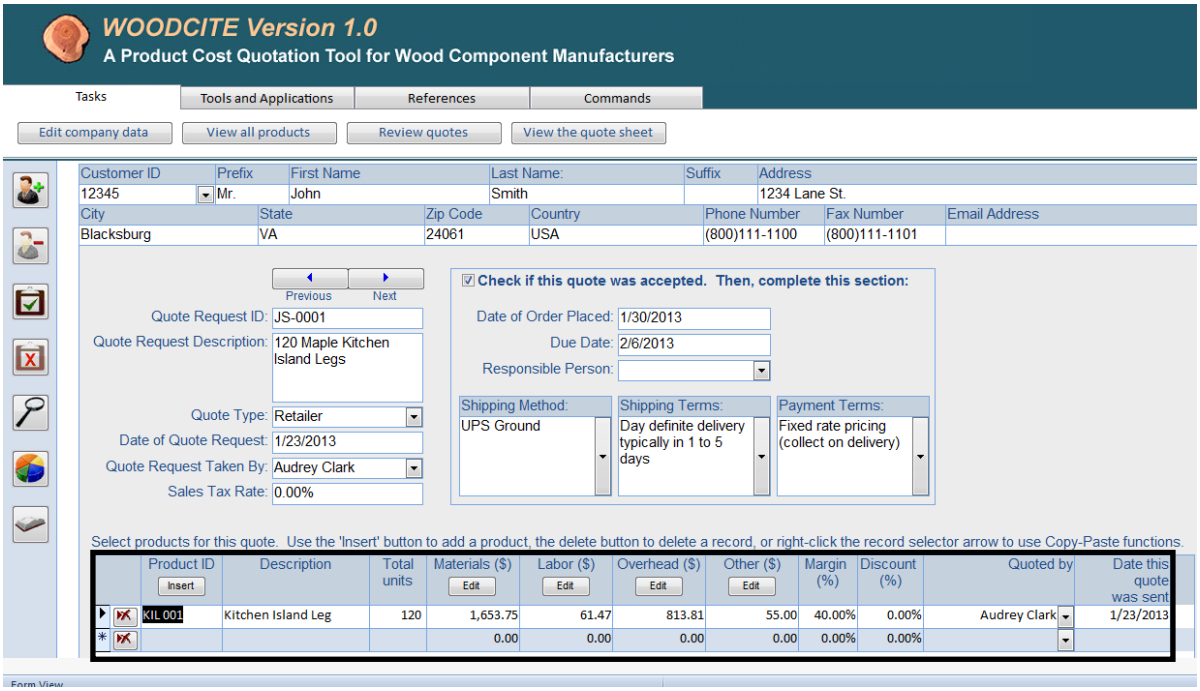

Figure 17.—WoodCite's product cost information table (highlighted).

into WoodCite. Entering the total number of labor hours (7.37 hours) and the total number of machine hours (5.14 hours) enabled WoodCite to automatically calculate the total overhead cost for the requested products: $813.81.

Wood Inc. has a policy of charging a $55 set-up charge for each project; therefore this $55 was entered into the other cost field (Fig. 17). The company decided to apply a 40 percent margin for its high quality product and provide no discount to its customer. As shown in Figure 17, the quote was sent to the customer on the same day it arrived (January 23, 2013) by Audrey Clark.

The quote sheet displayed in Figure 18 shows that the quote Mr. Smith requested was sent on January 23, 2013, by Audrey Clark and is valid for 45 days. The quote sheet lists the contact information of the customer as well as the company information. Also, details about Mr. Smith's inquiry are documented in the quote sheet. The unit price of one maple kitchen island leg is listed as $35.89, and the total price of all 120 requested legs is listed as $4,306.72. The quote sheet also shows that Wood Inc. proposes a UPS ground delivery, typically in 1 to 5 days, to the potential customer (Fig. 18).

Wood Inc.
We build your dreams!

Product Quote

1650 Ramble Rd.
Blacksburg, VA 24061
Phone: (540) 540 - 5411 Fax: (540) 540 - 5412
Email: info@woodcite.com
Web: http://woodproducts.sbio.vt.edu/woodcite/

Date:	1/23/2013
Customer ID:	12345
Number of Days This Quote is Valid:	45

SALESPERSON: Audrey Clark
LOCATION: 560 Halloween St.

TO: Mr. John Smith
1234 Lane St.
Blacksburg, VA 24061
(800)111-1100

Quote ID	Shipping Method	Shipping Terms	Estimated Shipping Date	Payment Terms	Requested Delivery Date
JS-0001	UPS Ground	Day definite delivery typically in 1 to 5 days	2/6/2013	Fixed rate pricing (collect on delivery)	2/6/2013

Product ID	Description	Units	Unit Price	Total Price	Discount	Line Total
KIL 001	Kitchen Island Leg	120	$35.89	$4,306.72	0.00%	$4,306.72

Subtotal:	$4,306.72
Sales Tax Rate:	0.00%
Total:	$4,306.72

Quotation prepared by: Audrey Clark

This document is a quotation on the goods and/or services described, and is subject to the conditions and terms of the seller.

To accept this quote, sign and return: _____ Date: _____

THANK YOU FOR YOUR BUSINESS!

Figure 18.—The product quote sheet in WoodCite.

REFERENCES

Alreck, P.L.; Settle, R.B. 2003. **The survey research handbook.** 3rd ed. New York, NY: McGraw-Hill/Irwin.

American Accounting Association. 1966**. A statement of basic accounting theory.** Sarasota, FL: American Accounting Association. http://aaahq.org/. [Accessed November 7, 2014].

Andersch, A.; Buehlmann, U.; Wiedenbeck, J.; Lawser, S. 2013. **Status and opportunities associated with product costing strategies in wood component manufacturing.** Forest Science. 59(6): 623-636.

Ansari, S.; Bell, J.; Swenson, D. 2006. **A template for implementing target costing.** Cost Management. 20(5): 20-27.

Berliner, C.; Brimson, J.A. 1988. **Cost management for today's advanced manufacturing: the CAM-I conceptual design.** Boston, MA: Harvard Business School Press.

Blair, E.; Burton, S. 1987. **Cognitive processes used by survey respondents to answer behavioral frequency questions.** Journal of Consumer Research. 14(2): 280-288.

Carnes, K.; Hedin, S. 2005. **Accounting for lean manufacturing: another missed opportunity.** Management Accounting Quarterly. 7(1): 28-35.

Cokins, G.; Hicks, D. 2007. **Where does ABC fit amongst the clutter of managerial accounting?** Cost Management. 21(2): 21-28.

Corbett, T. 1998. **Throughput accounting: TOC's management accounting system**. Great Barrington, MA: North River Press.

Crandall, R.; Main, K. 2007. **Lean accounting – fad or fashion?** Working Paper Series. Boone, NC: Appalachian State University.

Cunningham, J.E.; Fiume, O.; Adams, E. 2003. **Real numbers: management accounting in a lean organization.** Durham, NC: Managing Times Press.

Harris InfoSource. 2009. **2009 Virginial Industrial Directory.** East Rutherford, NJ: D.B. Harris InfoSource.

Dekker, H.; Smidt, P. 2003. **A survey of the adoption and use of target costing in Dutch firms.** International Journal of Production Economics. 84(3): 293-305.

Drury, C.; Tayles, M. 1994. **Product costing in UK manufacturing organizations.** European Accounting Review. 3(3): 443-469.

European Commission. 2003. **SME definition - Small and medium sized enterprises (SME) - enterprise and industry.** http://ec.europa.eu/enterprise/policies/sme/facts-figures-analysis/sme-definition/index_en.htm. [Accessed May 1, 2011].

Goldratt, E. M.; Cox, J. 1986. **The goal: a process of ongoing improvement.** Great Barrington, MA: The North River Press.

Gurowka, J.; Lawson, R.A. 2007. **Selecting the right costing tool for your business needs.** Journal of Corporate Accounting & Finance. March/April: 21-27.

Horngren, C.T.; Foster, G.; Datar, S.M. 1997. **Cost accounting: a managerial emphasis.** Upper Saddle River, NJ: Prentice Hall.

Johnson, H.T.; Kaplan, R.S. 1987. **Relevance lost: the rise and fall of management accounting.** Boston, MA: Harvard Business School Press.

Kaplan, R.S; Anderson, S.R. 2003. **Time-driven activity-based costing.** Harvard Business Review: 1-18.

Lanen, W.N.; Anderson, S.W.; Maher, M.W. 2008. **Fundamentals of cost accounting.** New York, NY: McGraw-Hill.

Lawser, S. 2010. **Success in 2010: today's woodworking industry.** Presentation at Weinig's Wood Technology Expo; 2010 April 29-30; Portland, OR. http://woodcomponents.org/app/portal/mm/LawserWeinigExpo20102.pdf. [Accessed Nov. 6, 2014].

Manta. 2010. **Company profiles and company information on Manta.** http://www.manta.com. [Accessed April 15, 2011].

Maskell, B.H.; Baggaley, B.L. 2003a. **Lean accounting: what's it all about?** Target. 22(1): 35-43.

Maskell, B.H.; Baggaley, B.L. 2003b. **Practical lean accounting: a proven system for measuring and managing the lean enterprise.** New York, NY: Productivity Press.

O'Guin, M.C. 1991. **The complete guide to activity-based costing.** Englewood Cliffs, NJ. Prentice-Hall.

Palmer, J.; Andersch, A.; Wiedenbeck, J.; Buehlmann, U. 2014. **Users guide for WoodCite, a product cost quotation tool for wood component manufacturers [computer program].** Gen. Tech. Rep. NRS-126. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station.

Parry, G.; Turner, C. 2006**. Application of lean visual process management tools.** Production, Planning and Control. 17(1): 77-86.

Player, S.R.; Keys, D.E. 1997. **Lessons from the ABM battlefield: getting off to the right start.** Cost Engineering. 39(1): 13-18.

Plossl, G. 1990. **Cost accounting in manufacturing: dawn of new era.** Production Planning and Control. 1(1): 61-68.

Roztocki, N.; Valenzuela, J.F.; Porter, J.D.; Monk, R.M.; Needy, K.L. 2004. **A procedure for smooth implementation of activity based costing in small companies**. Engineering Management Journal. 16(4): 19-27.

Rushinek, Avi. 1983. **Cost accumulation for different costing systems and their computer applications.** Managerial Finance. 9(1): 19-22.

Thomas, E.; Buehlmann, U. 2003. **Performance review of the ROMI-RIP rough mill simulator.** Forest Products Journal. 53(3): 80-85.

U.S. Bureau of Labor Statistics. 2010. **Databases, tables and calculators by subject.** http://www.bls.gov/data/#employment. [Accessed: April 15, 2011].

U.S. Census Bureau. 2010a**. Millwork (NAICS 32191) industry facts report 2007.** http://smpbff1.dsd.census.gov/TheDataWeb_HotReport/servlet/HotReportEngineServlet?emailname=vh@boc&filename=mfg1.hrml&20071204152004.Var.NAICS2002=32191&forward=20071204152004.Var.NAICS2002. [Accessed April 5, 2011].

U.S. Census Bureau. 2010b**. NAICS - Structure of the manufacturing sector.** http://www.census.gov/cgi-bin/sssd/naics/naicsrch?chart_code=31&search=2007%20NAICS%20Search. [Accessed November 5, 2010].

Wood Component Manufacturers Association (WCMA). 2010. **Membership directory.** http://woodcomponents.org/pages/Publications-v3.html. [Accessed June 29, 2010].

This page intentionally left blank

Andersch, Adrienn; Buehlmann, Urs; Palmer, Jeff; Wiedenbeck, Janice K.; Lawser, Steve. 2014. **Product costing guide for wood dimension and component manufacturers.** Gen. Tech. Rep. NRS-140. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station. 31 p.

The North American hardwood dimension and components industry plays a critical role in the hardwood forest products industry as the industry is a user of high-value hardwood lumber. Customer expectations, global markets, and international competition, however, require hardwood dimension and components manufacturers to continuously improve their ability to manage their products and businesses. Accurate and timely product costing information is critically important for companies in planning the optimal utilization of company resources. While an overestimation of product costs can lead to loss of potential business and market share, underestimation of product costs can result in financial losses to the company.

This paper introduces a product costing software package called WoodCite, which is designed specifically for small and medium-sized hardwood dimension and components manufacturers. WoodCite allows companies to determine product costs and create competitive bids based on their information. WoodCite uses a regression model to estimate overhead cost of a product based on historical cost information provided by the user. The application is available for free at http://www.nrs.fs.fed.us/tools/WoodCite/.

KEY WORDS: WoodCite, product costing software, traditional product costing, hardwood dimension and components, small and medium-sized enterprises

Manuscript received for publication 19 November 2013

Published by:
U.S. FOREST SERVICE
11 CAMPUS BLVD SUITE 200
NEWTOWN SQUARE PA 19073

December 2014

For additional copies:
U.S. Forest Service
Publications Distribution
359 Main Road
Delaware, OH 43015-8640
Fax: (740)368-0152
Email: nrspubs@fs.fed.us

Northern Research Station

www.nrs.fs.fed.us