

Teaching Process Cost Accounting

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Abstract

Process costing is alive and well and is in use in industries where homogenous products are manufactured, or where a common process is applied, either in continuous or in batch operations. From an examination of the somewhat limited literature on process costing it is clear that by the beginning of the 20th century general practice had evolved to include the cascading of actual costs from one process to the next in sequence, and the inclusion of the equivalent units of partly completed work within process inventory. That approach became enshrined in textbook treatment of the topic. Research carried out towards the end of the 20th century shows that actual costs had been supplanted by standard costs; that the cascading was no longer done; and that the equivalent units calculation had been discontinued. Tragically, the textbook content has failed to keep pace with these developments, and textbooks now teach a version of process costing that has no relation to current practice. Because most of the textbooks are out of date, the teaching that they support is also out of date. This paper recommends that the following changes be made to both the textbooks and the teaching of process costing: firstly that discussion of equivalent units be eliminated; secondly that systems based on actual costs be replaced with those based on standard costs; thirdly that the cascading of costs from one process to the next be eliminated; fourthly because equivalent units would not be taught, the use of different inventory flow assumptions be eliminated..

Introduction

This paper will start by tracing the evolution and development of process manufacturing and associated cost accounting from medieval times through to the present day. It will be shown that process costing has developed to meet the needs of users, and then has been further refined to accommodate the changing climate of manufacturing.

The teaching of process costing has not, however, kept up with developments in practice. The result is that process costing as currently expressed in the textbooks, teaches a version of the topic that is no longer representative of business reality. This is very problematical. If we are sending graduates out into the workplace with a misunderstanding of how process costing either is, or should be, carried out, we are doing neither them nor their employers a good service.

Section one of this paper starts the historical path of manufacturing in the middle ages, when all costing systems were in their infancy, and through the industrial revolution, when process costing as we may know it today was developed. In section two we note the substantial contribution of early 20th century writers to the application of process costing in specific industries. This establishes the pattern of how process costing was taught then and is still taught through textbooks and professional accounting examination syllabuses as of this writing (2013). In section three we refer to empirical evidence from the late 20th and early 21st centuries that indicates the movement to a more modern streamlined approach to process costing that is currently in use in process industries. In section four the current content of US professional accounting examination syllabuses is compared to the content of university accounting courses.

In section five the textbook content of 28 US management and cost accounting textbooks is discussed and is contrasted with current application by process cost users and a wide disparity is observed. In section 6 the implications for the teaching of process cost accounting and for resolving this disparity are made. In section 7 we make suggestions about the limitations of this study and the opportunities for further work in this area.

1: Early history

Process industries manufacture more or less homogenous products using either continuous or repetitive batch processes. Their technical origins can be traced back at least to the Medici family enterprise in medieval Italy, in the manufacture of cloth and the Fugger enterprises in mining and related foundries in Germany, records for both of which still exist (Garner 1954, pp. 5 et seq.).

The Medici enterprise is typical of many early examples of process manufacturing using a “putting out” system: raw materials or partly processed goods would be sent to the workshops of craftsmen who would carry out their specialist activity and return the work to the entrepreneur when they had completed their stage of the process. This would be repeated until all processes were complete and the goods were ready for sale.

A medieval example would be embroidery, some of which would be repetitive in the sense of a completely homogenous product and some of which would be a homogenous process applied to differentiated batches of raw materials or to make differentiated products. Skinner (1978) reported that operations costing was more common amongst his research sites than was pure continuous processing of homogenous products

Outwork craft embroiderers would be issued with the work, consisting of cloth and embroidery yarns, which would be weighed. On completion the embroidered work would be returned to the manufacturer where it would be weighed and the outworker would be paid for his work. Any loss in weight was subject to a deduction from the outworker’s pay. The work would also be checked for quality. If the work did not meet precise quality standards it would be destroyed and the outworker would receive nothing for his or her labour. (Victoria and Albert Museum, 1993, Kearny, 2013)

Because of the nature of these outsourced transactions the accounting was fairly straightforward. There would be inventories of raw materials and partly processed goods on hand, and also similar inventories in the hands of the outworkers. Because no payment was made until the outwork was complete there would be a clear point in time when the whole of the outwork cost was incorporated into the value of the product and its cost would have been unambiguously knowable. However, as Garner observes (*loc cit*), early manufacturers were not necessarily very good at recording their costs.

That ease of cost determination was not available to the Fuggers in respect of their mines and their foundries where costs were predominantly internal rather than crossing the boundary between the enterprise and the outside world. There was, however, some attempt to discover the cost of production and the net gain for the year.

The industrial revolution gradually changed the pattern of putting out. As mechanization took over from the craftsmen, a greater and greater proportion of the work was carried out within the factory. As a residue of the putting out system, initially this internal work was contracted to gangs of workers, who would be paid by the piece for the work they did. The implication is that the accounting dimension had not changed: from a payment perspective work was either done or not done and no intermediate stages existed for inclusion in the accounts of the manufacturer.

Eventually this regimen gave way to the employee who was paid by the hour and the employer took over a greater responsibility for who did what and when they did it. This change caused the manufacturer to have a different set of accounting problems. Now the wage costs were gradually accumulated as the degree of completion of the product was gradually achieved. Internalization of the process had destroyed the clear divide between work not started and work completed. This created a need for an accounting regimen that could incorporate the measurement of partially completed work in process.

“But when the factory system began to displace the domestic system, production fell under the direction of enterprisers who paid wages, bought materials and supervised the process of producing goods for the profit they could obtain by selling the goods created at prices above the costs. They had a motive for records, therefore, which the family or the solitary producer had not” (Littleton, 1933, p. 320).

“Cost accounting, therefore, is one of the many consequences of the industrial revolution” (Littleton, 1933, p. 321).

At the same time the mechanization of processes caused a shift in the cost structure. A manufacturer who had installed expensive machinery to carry out tasks originally contracted to craftsmen could only justify the investment by a reduction of the workers' pay. There was a shift from wage costs to overhead costs. Thus a secondary issue was that the costs of overhead had, to a greater extent, to be included in product costs. The "burden" or overhead recovery rate had to be invented.

This did not happen immediately. As Garner observes (1925, Ch V, p 122), when manufactured goods replaced pure craft goods they were able to price products somewhat lower than the previous market price: because they were more efficient manufacturers than were the crafts persons, they would automatically be profitable. Cost data was unnecessary. Only as competition increased did it become desirable to calculate the cost of products either to manage those costs or to price products most advantageously.

Managing the internal cost situation then emerged as a key success factor. Accountants and their employers would be reluctant to share their cost accounting knowledge with other accountants or competing companies for fear of losing a competitive advantage. As a result of this information asymmetry and climate of secrecy there is a significant gap in published information about how early industrialists dealt with process costing.

One early exception to this situation is from France. Payen (1817) describes systems for accounting for a carriage making enterprise (clearly what we would now call a job-shop situation) and a glue works (clearly what we would now call a process industry). Payen's writings are summarized by Littleton (1933) and Edwards (1937), whose summaries are, in turn, summarized by Garner (1954, pp. 43-52).

The glue works accounting showed the following significant features:

- The use of both a journal "in kind" and a journal expressed in money;
- A ledger account headed "The Business" (distinguishing transactions relating to the factory from those relating to the proprietor and his personal affairs);
- The inclusion of assets, expenses, costs and sales in the "Business" account;
- The inclusion of the ending "inventory" of the assets "boilers" and "utensils" at figures lower than their costs, thus effectively introducing a depreciation expense calculation;
- The calculation of a unit cost for the glue produced.

Clearly Payen was in the forefront of accounting thought in respect of manufacturing concerns. However, his publication, while not unique, was one of very few that appeared in public as cost accountants were very secretive about how they carried out their work.

2: The early 20th Century

By the 20th century much of the aura of secrecy had disappeared and was replaced by a willingness to share information among accountants. The NACA Bulletin was the professional journal of the (US) National Association of Cost Accountants and it was published from 1925 to 1957. During that 38 year period it published no less than 128 articles describing how accounting was done in particular process-type industries. Out of over 2,000 articles published in the NACA Bulletin in that period these represent just fewer than 6% of the total. Lang (1944 section 9, pp. 423 et seq.) summarized the typical ones. These referred to the application of process costing in industries as diverse as:

Bread baking (Henry, 1939: NACA Bulletin vol. 20)

Cement manufacture (Smith, 1941: NACA Bulletin vol. 23)

Cotton milling (Bennett, 1940: NACA Bulletin vol. 21)

Glass manufacture (Harrold, 1939: NACA Bulletin vol. 21)

Leather tanning (Stevenson and Slack, 1933: NACA Bulletin vol. 14)

Manufacture of rubber products (Halligan, 1937 NACA Bulletin vol. 19)

Mining (Avery, 1941: NACA Bulletin vol. 22)

Soft drinks (Jones, 1935: NACA Bulletin vol. 17)

While not all the above specifically refer to the calculation of equivalent units in their industries, where it is discussed the general tenor is that it is considered normal and essential for accurate cost calculations. However, Lang goes on to make the following contrary observations:

“**SHORT CUTS FOR VALUING WORK IN PROCESS.** - The method outlined in the preceding pages for the proper costing of work in process is somewhat cumbersome, but is undoubtedly accurate. Williams (NACA Bulletin, Vol. 5) proposes a short-cut by doing away with work in process inventories at the end of a period. He describes a procedure for a foundry consisting of foundry, machinery, polishing, cleaning, packing, storage and shipping departments. Production being continuous, there is always a large number of articles on hand in every stage of completion. The physical production turned out by the foundry department in the course of a month forms the basis of the cost calculation. Production orders are issued for maximum quantities only. At the end of the month there is entered as the quantity to be produced the same quantity that was processed through the first operation. Williams states:

In closing the November accounting we had December labor and overhead charged to November costs and appearing in the November inventories, but this was offset by the item accrued payroll and the credit to the expense distribution account. When closing the cost of orders, all cards stamped November were posted as though the work had been done in November, but the regular December cards were posted to the cost sheets for the month of December. By this method, on the 5th of December, every cost sheet for November showed only completed work, and the laborious work of getting costs on partially completed work was done away with.

Another suggestion for shortening the work comes from Schlatter (Elementary Cost Accounting), who advocates omission from consideration of work in process inventories, provided:

1. Amount and value of work within a process at the end of a period are small when compared to the total amount and value passing through the process in a given period.
2. Amount and value of work in process inventory are constant, i.e., remain approximately the same.

In such cases, he states:

The inventory may be ignored without materially affecting the reliability of unit cost figures...But if the variation in the amount is considerable and the value is high, the inventory must be given consideration because to ignore it would seriously affect the reliability of the unit cost figures.

In support of this theory, Mengel, discussing work in process in anthracite mining (NACA Bulletin vol. 22) states:

This is a term practically unknown in anthracite. Although today some labor, materials and power are expended in loading a mine-car that may not reach the surface until tomorrow, no attempt is made to set this up against tomorrow's cost, because yesterday the same thing happened. Then end of each working day completes a cycle which started yesterday or before, but which is fairly constant day by day.

Elimination of Work in Process Account. - If a plant manufactures only one product by a single process, there may be no work in process inventory, since the product is either still in the raw material stage or else is finished. This is especially the case where the product takes less than 24 hours to complete. Examples are bread-making, sulphur mining, etc. In such cases a Work in Process account is not even necessary, since all costs can be charged to a Cost of Production (i.e., Finished Goods) account. Adamson (NACA Bulletin, vol. 15) states:

We have no In Process inventory just as in the producing end of the oil business there is none. Sulphur either has been produced or it has not been produced. When melted it is pumped to the surface almost 100% pure and does not undergo any sort of treatment or processing whatsoever.” (op. cit. pp. 468/9).

In short, according to Lang and the practitioners and textbook authors he cites, the calculation of equivalent units of ending work in process is:

- 1: necessary in general for accurate product cost calculation;
- 2: time consuming;
- 3: unnecessary in those situations where work in process is immaterial in quantity and value or of a constant amount in successive periods.

The consensus of the NACA descriptive treatments of actual practice published between 1919 and 1957 is that process costing during that period consisted of the following key elements:

- 1: the recording of actual costs;
- 2: the averaging of a period's costs over the production for that period;
- 3: the inclusion of equivalent units of work-in-process in calculation of the work done;
- 4: the application of either the weighted average or the first-in-first-out inventory flow assumption;

5: the cascading of actual costs through sequential processes to arrive at a final figure of the actual cost of goods manufactured.

6: and in some cases the separation and separate reporting of normal losses (the costs of which are impounded in the cost of good product) and abnormal losses (the costs of which are separately reported as an expense).

These five (or sometimes six) ideas have become firmly entrenched in the teaching of process costing up to the 21st century. To the extent that process costing is covered in management accounting, cost accounting and management control textbooks they appear without dissent, though not every textbook covers them in full. The idea that calculating the equivalent units of ending work in process might be unnecessary in some situations is not discussed in depth by any current text in this area (see section five below for a more fulsome description of the textbook coverage).

After the NACA Bulletin changed to the NAA Bulletin (1957 to 1965) and then to Management Accounting (1965 to 1999) and then to Strategic Finance (1999 to date) the number of articles describing the application of process costing in particular industries dropped off substantially. By the 21st century they had become virtually extinct. Practitioners' tales from the trenches were still being published, but process costing war stories became supplanted by other topics (for example: cost-volume-profit analysis; activity-based costing and, most recently, the balanced scorecard and the integration of strategic costing).

3: Late 20th and early 21st Century

Process costing in the more academically oriented peer-reviewed journals has had sparse treatment.

Hornigren (1967) reported a survey of Chicago area process cost manufacturers who were asked whether, in their process cost calculations, they used weighted average or FIFO inventory flow assumption. All reported the use of the weighted average method. Given that this survey was carried out by Hornigren's students, we should be cautious in accepting the findings uncritically.

Skinner (1978) carried out a more comprehensive survey of eleven process manufacturing companies in Australia and another eleven in the UK. His principal finding was that WIP was "always constant and usually negligible", and that none of the companies, therefore, included any calculation of the equivalent units of WIP. This is a substantial criticism of the version of process costing as presented in the textbooks, both then and now.

Partington (1979) responded to Skinner along two lines: one that it was sometimes the task of the academic profession and their textbooks to lead practice, where a better way of doing things was known; and two that even if the textbooks were not teaching received practice, the learning involved would be good for students in much the same way that learning a dead language (such as Latin) would be good for their intellectual development. In a reply Skinner (1979) rejected Partington's criticisms.

Macdonald and Richardson (2011) have pointed out that in the management/cost accounting discipline it is frequently the case that practice leads theory. Textbooks tend to play catch-up with best industrial practices, rather than leading practice with normative theory.

Given that Skinner (1978) had made a quite devastating attack on the way process costing was presented in the textbooks and (we presume) taught, we might have expected a flurry of research to shed additional light on the topic; research that would have showed him to be either right or wrong. That did not happen.

The implications are fairly serious. Had Skinner been proven wrong textbook writers could have breathed a sigh of relief and continued with the materials that had been their stock-in-trade for 50 years or more. Had Skinner's criticisms been upheld it would necessitate a complete rewriting of the process cost chapters in virtually every textbook in use.

Parkinson (2011) replicated Skinner's study in a US environment. While coming to the same general conclusion as Skinner (namely that equivalent units are not measured and are not incorporated into process cost calculations), his reasons were somewhat different.

Parkinson's first observation was that virtually all process manufacturers in USA use standard costing as the main plank of their costing systems. The implication of using standard costs is that, unless the standard is changed between two accounting periods, the weighted average and the FIFO inventory flow assumptions yield identical results. Dosch & Wilson (2010) also report that the process industry they studied use standard costs.

This finding also has implications for the suggestions published by Metzger (1990) and Ghosal (1990) both of whom suggested that the LIFO inventory flow assumption should be used in process costing. Standard costs render LIFO as redundant as weighted average and FIFO in producing different reported costs in all situations where the standards do not change from one period to another.

Parkinson's studies also found that the cascading of costs from one process to the next was not done. Instead, separate processes were treated as a cost centres in their own right, and managed as such. When it was desired to know the cost of manufacture for a product the costs of each process would be summed. In addition (and somewhat detracting from the preceding remark) some organizations did not distinguish between individual technical processes in defining process cost centres: either some or all technical processes could be amalgamated for process cost purposes. At the extreme, whatever the complexity of the production process, all process costs would be put in a single process cost centre, and averaged out over the period's output. This gives the effect of calculating total product cost, but the cascading element is omitted.

Parkinson, as had Skinner, observed the tendency to smallness and constancy of WIP, but not universally so. For WIP to have an effect on reported costs it is necessary for it to be a materially large dollar amount, and it also has to be volatile. The combination of the two is rare but not completely absent.

Two exceptions were reported: beer brewing and aluminium manufacture. In both of these situations there is the possibility that WIP could be large and valuable and that it could fluctuate by a large margin.

Both beer brewers and aluminium manufacturers reported that the equivalent units of WIP were approximated. In brewing raw materials were approximated as 100% and conversion costs were approximated as 0%, no matter how complete a batch might be. In aluminium manufacture the anodes (which represented the WIP) were approximated as 50% complete for all inputs, no matter how complete they might be.

Thus, even in the situations of a large and variable WIP identified by Schlatter (1935) the actual measurement of equivalent units of work in process and their precise incorporation into process cost measurement was not carried out. *A fortiori*, it would be reasonable to assume that it is not done in any situation.

Two other studies have been published recently: Gurreiro et al (2006) and Dosch & Wilson (2010). The former is a large scale survey of manufacturers in Brazil, the latter an interview-based study of three US process manufacturers in the packaged goods industry.

Gurreiro, Cornachione and Catelli (2006) looked at how equivalent units should be calculated, and who actually did the calculation. They sent out 175 questionnaires to South American companies that were likely candidates for using process costing. 50 responses were obtained. 43 of those respondents were using continuous processes (i.e. process costing), while 7 used a production order system' (i.e. job costing). This is in sharp contrast to Skinner's findings that most companies in his survey used operations costing. Although a fairly large group of respondents replied that they used equivalent units, only one respondent provided sufficient information to understand how that was done, and that respondent used an approximation rather than a precise assessment of the degree of completion: this is congruent with the approximations used in beer brewing and aluminum processing mentioned earlier.

Dosch and Wilson (2010) investigated process costing in the packaged goods industry in USA. They carried out in-depth interviews with personnel at three companies: one large, one small and one of intermediate size. Their focus was to see how process cost information was used for strategic management accounting and control. In all three companies the WIP inventory was valued using the standard cost systems. They found that all three organizations relied heavily on process cost information to support management control. All three companies used standard costing and variance analysis to achieve this aim. The two larger companies relied extensively on ERP systems to establish the quantity and degree of completion of ending work-in-process. In the smaller company ending work-in-process was physically counted, and the equivalent units were calculated on the basis of 75% completion (regardless of the actual degree of completion).

In order to fully comprehend the situation reported by Dosch & Wilson (2010) it is necessary to further elaborate on the concept of work-in-process. For financial accounting purposes, work in process is any manufacturing inventory that lies somewhere between raw materials and finished goods. Skinner (1978) observed that where a process cost calculation is done to establish the cost of a process, it is only work within that process that is relevant to the process cost calculation.

Work between processes, (i.e. work that has completed one process but not yet started a subsequent process) should never be part of the process cost calculation of either of the two processes it lies between. It is not altogether clear whether the WIP reported in these three situations (Horngren, 1967, Gurreiro et al (2006) and Dosch & Wilson (2010)) was the WIP as defined for financial accounting or the work within process that Skinner (1978) describes as the one that is relevant for process cost calculations.

4: Process Costing: Professional Examination Requirements and University Course Coverage

Process costing is included in the examination syllabuses of both the major US professional accounting bodies:

American Institute of Certified Public Accountants:

General Business Knowledge: Cost Measurement & Pricing:

Knowledge:

398. Cost accumulation methods: activity-based, job order, and process costing methods.

(AICPA, 2013).

Institute of Management Accountants:

C. Cost Management (25% - Levels A, B, and C)

2. Costing systems

a. Job order costing

b. Process costing

c. Activity-based costing

d. Life-cycle costing

(IMA, 2013).

Fuller et al (2011) conducted an examination of “the curriculum of selected programs at a variety of institutions” and “consulted with an external panel of accounting and finance professors representing a wide range of educational programs”. They found that in both undergraduate accounting degrees and Master of Accountancy programs, process costing coverage was “heavy” in cost accounting courses and “moderate” in management accounting courses. MBA programs had “moderate” coverage in management accounting courses.

From the above we can conclude that process costing is being both taught and examined in the professionally oriented accounting education system. It is therefore be appropriate that it be done correctly.

5: Process Costing: Textbook Content

A large number of textbooks with the titles “Management Accounting” and “Cost Accounting” (or close variations on those themes) exists. In Appendix 1 we indicate, for 28 US texts in wide use, the chapter(s) where they deal with process costing.

The range of coverage is substantial. We would suggest that the Horngren et al (2012) “Cost Accounting” treatment is amongst the most comprehensive, and, at the other extreme, the Atkinson et al “Management Accounting” (2012) and Noreen et al “Managerial Accounting for Managers” (2011) are the most perfunctory. In between these extremes every gradation of completeness is represented. However, none of the textbooks disagrees with the generality of content; they merely choose to include more of it, or less of it. In the Horngren text the following topics are specifically included in chapters 17 & 18:

1. That the cost system is intended to match the flow of costs to the flow of identical products;
2. That the product flow may be continuous on a 24/7/365 basis;
3. That the cost to be accounted for will include raw materials, direct labour and both variable and fixed manufacturing overhead and that because of mechanization, the manufacturing overhead may include a large proportion on fixed costs;
4. That at the end of accounting periods a process engineer will measure the degree of completion of the actual work-in-process, and that this will be used to calculate the equivalent units of WIP;
5. That the calculation of period process costs will be done using one of three approaches:
 - a. Weighted average process costing;
 - b. First-in, first-out process costing;
 - c. Standard costing.

6. In chapter 18 the treatment of process costing is further expanded by the inclusion of how spoilage should be treated, with normal spoilage being included with the cost of good output and carried forward as a part of product cost and abnormal spoilage being reported as a loss, separate from product cost.

In respect of the Horngren materials, we would offer the following commentary:

#1 above (cost matching) is precisely correct;

#2 above is true of many applications, but it is not universal. Homogenous products or processes (and therefore appropriate process cost situations) also cover discontinuous operations, batch operations and operations costing. It is typical (though perhaps not universal) of these latter that there is no WIP at accounting period ends.

A bakery is a good example. All the bakeries investigated by this writer work on the basis of shifts, where production shifts (often two per day) are followed by a non-production shift (when cleaning and maintenance is carried out). In a discontinuous process such as a bakery, there is no end of period WIP, so its equivalent unit value is always zero.

At the start of Chapter 17, Horngren et al (2012) use Royal Dutch Shell's oil refining activities to illustrate a typical user of process costing techniques for a continuous process. While it is true that Royal Dutch Shell uses process costing to account for their refining activities, from Parkinson (2011) we know that the within-process inventory in the oil refinery he interviewed is virtually identical at the start and the end of any given accounting period. Therefore incorporating the equivalent units of opening and closing work-in-process inventory becomes an exercise in redundancy, as it would mean the addition and subtraction of the same dollar value. Oil refining companies do not adjust for equivalent units of WIP when calculating monthly process costs (and please put aside for the moment the issue of calculating the WIP value to put on the balance sheet: this article is about accurately measuring periodic process costs, not constructing precise balance sheets).

#3 above lists the costs to be accounted for, and Horngren et al specifically refer to a full cost model. While true in many situations, this is untrue in other situations. In the brewery investigated by Parkinson (2011), the costs included in the process costing system were limited to those that were controllable at the process level: raw materials and direct labour. Variable production overhead was trivially small and fixed production overhead was beyond the control of process managers, so both were excluded from the monthly cost control reports used to control production activities. The implication is that the process cost system was being used to control controllable costs, but was not being used to measure full product costs.

#4 above refers to someone (such as a process engineer) making actual measurements of the quantity AND degree of completion of ending WIP. Parkinson (2011) could find no examples of this happening. On the other hand Dosch & Wilson (2010) and Gurreiro et al (2006) both report examples of WIP being measured either by individuals or by the ERP system.

In order for it to be worthwhile to measure WIP at the end of a period two things are necessary: firstly the WIP has to be a significant dollar amount: and secondly it has to vary by a significant amount from one period to another (Schlatter 1935). For the most part either one or both of these is untrue.

Lean production and tight control of inventories militate against large WIP quantities and dollar values. In Horngren's illustration of process costing (pp. 668 et seq.) he proposes a situation where 400 units of product are started into production, and by the end of the month 175 have been completed and transferred out, while 225 are still in process. When teaching process costing this author frequently illustrates process manufacturing by showing students segments of the Discovery Channel TV program "How It's Made", many of which are available on YouTube. These programs show in detail the steps through which a manufactured product goes through from raw materials to finished product. Many of the clips are about process industries. It is clear from most of these clips (1) that overall process time is typically brief and (2) in a modern process manufactory there is nowhere to put any substantial quantity of "within process" inventory. Horngren's example is unrealistic. However, the Horngren et al example is necessary to their pedagogical purpose: without a substantial change in inventory quantities, combined with a substantial change in actual period costs, there would be no difference between the costs reported under the weighted average and the FIFO inventory flow assumptions.

In general, this issue is tied in with the question of the length of the production process. While it is true that lengthy processes exist (some pharmaceutical applications measure process time in months, for example), these are the exceptions. Process times are typically short: hours or even minutes.

With a short process time (say 4 hours or fewer) and a monthly reporting cycle (say 720 hours) it is mathematically implausible to have a WIP inventory of more than 5.55% ($1/(720/4)$) of a month's throughput, and it is typical to have far less.

This issue is also connected with the degree of variability of the WIP. If the opening and closing WIP are similar, then for periodic cost reporting purposes, they do not matter: the same dollar value is added and subtracted. Only where the WIP is likely to exhibit substantial swings from one month to another will it make a significant difference to the reported cost.

This does happen. Although Skinner (1978) did not find any, Parkinson (2011) reports two examples of WIP that was both large and variable: these were beer brewing and aluminium production. In both cases Parkinson found that although this had the potential to represent the received view of process costing, in practice it was not, as the topic was finessed through the use of estimates. In both cases the quantity of WIP was accurately known from production and accounting records (this was the number of litres of beer in the vats in use in the case of brewing and the number of anodes being built in the case of aluminium production) their degrees of completion were, however, decided arbitrarily: the beer was assumed to be 100% complete for materials (a slight overstatement) and 0% complete for conversion costs (clearly an understatement in almost every case), while the anodes were always assumed to be 50% complete (which would be randomly inaccurate each month, but probably a reasonable approximation over the longer term).

In sum: teaching students that equivalent units are brought into the calculation of periodic process costs is untrue in virtually every situation in which they may find themselves in the real world, and cannot even be defended as being a normatively superior practice.

#5 above refers to three supposedly different process cost flow approaches: weighted average, FIFO and standard costs. Without any end of period WIP (for which see #4 above) all three approaches will give the same results. Even more tellingly, Dosch & Wilson (2010) and Parkinson (2011) both report that in the US, all respondents used of standard costs. With a standard cost approach and no change in standards, there is never a difference between weighted average and FIFO.

Standard costing also has profound implications for the reporting of losses. Whereas Horngren et al find it necessary to dichotomize normal and abnormal losses (normal losses to be added to product cost, abnormal losses to be excluded from product cost and reported as exceptions); standard costing builds normal loss rates into the standards themselves, so any loss (i.e. a variance) is by definition an abnormal loss. Parkinson could not find any users of process costing who reported losses split into normal and abnormal categories in the way Horngren suggests.

Textbooks other than Horngren either replicate the topics covered in Horngren, or present a subset thereof. It is unusual, for example, to go into Horngren's depth of coverage of process losses. Texts aimed at introductory courses or MBA programs may present only the weighted average method, or present the weighted average method in the body of the chapter and the FIFO method relegated to an appendix.

One of the more interesting treatments is that found in Atkinson et al (2012) and Noreen et al (2011). Their treatments are almost perfunctory; they explain that in a process cost system period costs are averaged out over the period's production output. They present little or nothing by way of detailed illustration or calculation. By omitting all the equivalent units elements, they actually present an accurate depiction of process costing. In neither case, however, do they explicitly deny the veracity of the more complex methods that involve equivalent units.

Macintosh & Quattrone (2010) do not cover the mechanics of process costing.

6: Implications for Teaching Process Cost Accounting

Wilson (2011) observes that accounting has a dual qualification system, where a degree is combined with assessment of professional practice.

“The critical disadvantage of this system is the separation of ‘theory’ from ‘practice’ (or ‘knowledge’ from ‘doing’). It means that the university component is based on propositional knowledge and discipline-based methods of enquiry, both within a strictly academic frame of reference, which largely overlooks the problems of developing and using such knowledge in the professional arena” (loc cit). and, “If accounting education (i.e. within the academy) is limited wholly on teaching the techniques of accounting practice, this risks a circular approach which can be characterized as “accounting is what accountants do’ but this fails to allow for either an evaluative or a developmental dimension (reflecting what accounting *could* or *should* be) hence raises non-trivial questions about the extent to which the practice of accounting can be viewed as a *learned* professional occupation in which the greater public good is a central concern” (loc cit, original emphasis).

A dual qualification system ought to militate against the “gap” between theory and practice: “There has long been a communication gap between the work of academic researchers and that of practicing accountants” (Gordon and Porter, 2009) however, this seems not to have occurred in respect of process costing.

Cooper (2006) discusses how the need for management accounting as a taught discipline, needs to adapt to a changing environment. His main focus is on the necessity of additional breadth (for example the inclusion of a strategic focus, and the incorporation of the issues relating to non-manufacturing enterprises. In his survey of members of the Chartered Institute of Management Accountants he found strong support for the retention of more traditional topics:

“Variations in topic importance across business sectors have only been considered in certain more recent studies, which have emphasized the distinctiveness of the manufacturing sector. Khan et al (2000) found that those in this sector tend to attribute much greater importance to costing techniques and inventory control and less to implementing strategy. Furthermore Tan et al (2004) using three categories (manufacturing, retail and service), identified a tendency for those in manufacturing to rate process costing more highly than those from other sectors...” (loc cit, p. 289)

While not a surprising finding, it informs us that process costing is no dead topic. Sadly Cooper’s survey only asked questions about product costing, rather than going into detail about process costing and fine delineations within process costing.

Ferguson et al (2006) discuss textbooks as “Cultural and Political Artifacts”. Although they focus on financial accounting texts, the concept is robust. What is the purpose of a textbook? In their view they refer to textbooks as “...’cultural artifacts’ which may reflect the cultural, ideological, and political interests of particular groups in society” (loc cit), and that they may “have the potential to reinforce cultural homogeneity through the advancement of shared attitudes: (loc cit). By contrast, we would hope that management accounting textbooks exist to illustrate and teach both the positive aspect of the discipline (what accountants do) and the normative aspect (what accountants should do).

On the basis of the Skinner (1978) evidence and the Parkinson (2011) replication (neither of which have been seriously challenged by other empirical work) it appears that the topic of process costing in all US textbooks needs to be radically revised.

Discussions of equivalent units need to be eliminated;

Systems based on actual costs should be replaced with those based on standard costs;

The cascading of costs from one process to the next should be eliminated;

Because equivalent units would not be taught, the use of different inventory flow assumptions should disappear.

The dichotomization of normal and abnormal loss reporting should be discontinued.

The result would be that process costing would be taught very much as it is currently applied in practice and as it is presented in the Atkinson et al (2012) and Noreen et al (2011) texts, though illustration of the application would need to be expanded, preferably with real-world examples.

Practice consists of a simple averaging of a period’s accumulated standard costs in a process over its production output. Textbooks could be slimmer and a topic that has always proved unnecessarily challenging to the student could be simplified to the point where it makes common sense and accords with best practice as is found in real-world applications.

7: Limitations of this Study and Further Work

The Gurreiro et al (2006) study was based on a large scale survey. While large scale surveys are an efficient way of accumulating a large number of responses, they can only do so effectively where the research question is clearly defined and unambiguous. Questions about process costing are seldom clearly defined and unambiguous. Horngren (1967), Skinner (1978), Dosch & Wilson (2010) and Parkinson (2011) all used semi-structured interviews. This research method is referred to as a “cross-sectional field study” (Abernathy & Lillis (1995); Bruns & McKinnon (1993); Merchant & Manzoni (1989); Lillis & Mundy (2005). We believe that it is the correct approach in this situation where the research questions are relatively obscure (which makes mail surveys problematical) and where multiple sites must be investigated (making the in-depth case-study approach unwieldy). While the findings are robust and informative, they lack some detail and they may lack generality. Future work is needed to flesh out this topic. One avenue would be to extend it to new geographical areas. Another would be to investigate individual process industries in depth through the case study method, and to include detailed actual examples of the process cost calculations used in practice.

Appendix 1: 28 US Textbooks in the Areas Management Accounting and Cost Accounting:

Author:	Title:	Publisher	Latest edition	Year	Process costing covered in:
Atkinson, Kaplan, Matsumura & Young	Management Accounting	Pearson	6	2012	Ch 4 (topic 6)
Balakrishnan, Sivaramkrishnan & Sprinkle	Managerial Accounting	Wiley	1	2009	Ch 15
Blocher, Stout, Cokins & Chen	Cost Management	McGraw-Hill Irwin	6	2013	Ch 6
Braun & Tietz	Managerial Accounting	Prentice Hall	3	2013	Ch 5
Brewer, Garrison & Noreen	Introduction to Managerial Accounting	McGraw-Hill Irwin	5	2010	Ch 4
Brock, Herrington & Ramey	Cost Accounting	McGraw-Hill Irwin	7	2007	Chs 11, 12, 13, 14
Davis & Davis	Managerial Accounting	Wiley	1	2012	Ch 4
Easton, Halsey, MacAnally, Hartgraves & Morse	Financial & Managerial Accounting for MBAs	Cambridge	2	2010	Module 17
Elderburg & Wolcott	Cost Management	Wiley	1	2011	Ch 6
Edmonds, Tsay & Olds	Fundamental managerial Accounting Concepts	McGraw-Hill Irwin	6	2011	Ch 12
Garrison, Noreen & Brewer	Managerial Accounting	McGraw-Hill Irwin	14	2012	Ch 4 & Appendix
Hansen & Mowen	Cornerstones of Cost Accounting	South Western	1	2013	Ch 6
Hartgraves & Morse	Managerial Accounting	Cambridge	6	2012	Ch 5
Hilton	Managerial Accounting	McGraw-Hill Irwin	9	2011	Ch 4
Hornsgren Datar & Rajan	Cost Accounting	Prentice Hall	14	2012	Chs 17 & 18
Hornsgren, Harrison & Oliver	Financial & Management Accounting	Prentice Hall	2 (r)	2012	Ch 17 & Appendix
Hornsgren, Sundem, Scahtzberg & Burgstahler	Management Accounting	Prentice Hall	16	2014	Ch 14
Jaimbalvo	Managerial Accounting	Wiley	5	2013	Ch 3
Kinney & Raiborn	Cost Accounting: Foundations & Evolution	South Western	9	2013	Ch 6
Lanen, Anderson & Maher	Fundamentals of Cost Accounting	McGraw-Hill Irwin	3	2011	Ch 8
Macintosh & Quattrone	Management Accounting & Control Systems	Wiley	2	2010	Not explicitly covered
Maher, Stickney & Weil	Managerial Accounting	South Western	11	2012	Ch 2
Mowen, Hansen & Heitger	Cornerstones of Managerial Accounting	Nelson	1	2008	Ch 6
Noreen, Brewer & Garrison	Managerial Accounting for Managers	McGraw-Hill Irwin	2	2011	Short note in Ch 5
Vanderbeck	Principles of Cost Accounting	South Western	13	2012	Chs 5 & 6
Weygandt, Kieso & Kimmel	Managerial Accounting	Wiley	5	2010	Ch 3
Whitecotton, Libby & Phillips	Managerial Accounting	McGraw-Hill Irwin	1	2011	Ch 3
Wild & Shaw	Managerial Accounting	McGraw-Hill Irwin	3	2012	Ch 3

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