The perseverance of Pacioli's goods inventory accounting system.

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Abstract.

This paper details sources of the "undoubtedly strange" (Yamey, 1994a, p119) system of goods inventory records described in Pacioli's 1494 bookkeeping treatise and traces the longevity and widespread use of this early perpetual inventory recording (**EPIR**) system in English language texts. By doing so and contrasting this system with the bookkeeping treatment of modern texts it is shown that the **EPIR** system persisted as the dominant form of goods inventory accounting for between 400 and 500 years and that the reasons for its demise are worthy of further consideration and research.

Keywords

Pacioli, Inventory/Stocks, Bookkeeping, History

Introduction.

This paper arises from a sharp contrast between the way that the records of goods inventory accounts are described in Pacioli's treatise[1] (1494) and the ways that the double entry of inventory (stock) accounting are taught and operated in many systems today. The difference is such that the method used by Pacioli is in effect derided in Wood & Sangster (one of the leading introductory technical business accounting books in the UK and many other parts of the world) with the phrase "Maintaining an inventory account on this basis [the basis described by Pacioli] would … serve no useful purpose." (2008, p 29). Yamey, one of the most prolific writers on Pacioli in the English language, has also criticised this aspect of Pacioli's accounting for goods inventories, together with Pacioli's comments on the valuation of goods inventory entries, as "undoubtedly strange" [2] (Yamey, 1994a, p119, point 12.19). However, despite these criticisms there is evidence that the method described in Pacioli's treatise was repeated by other authors of bookkeeping treatises over at least the following three centuries (see for example Manzoni, 1540; Mellis's 1588 edition of Oldcastle, 1543; Dafforne, 1660; Webster, 1759; and Hamilton, 1788) before being replaced by the teaching and use of other methods.

This paper describes in detail the method of inventory recording described in Pacioli's treatise of 1494, details the methods used in current teaching and practice, compares these methods and traces the developments to Pacioli's method as described in other early texts and texts through to the end of the 19th Century.

The research reported here is based primarily on bookkeeping texts, which are primary sources with regards to the teaching materials themselves and secondary sources in relation to the bookkeeping practices of the time. In this way the approach is akin to that of Edwards, Dean and Clarke (2009): the creation and support of arguments that are a feasible interpretation of the past, as they say - to use the available evidence and arguments to make "*justified* statements" as discussed in Napier (2002). Our comfort in taking the content of texts as a reflection of practice is enhanced when the texts include explicit statements of usefulness from the authors, a feature of Pacioli's treatise and many of the early double entry bookkeeping texts.

The next part of this paper (after a brief note on terminology) details the mechanics of the treatment of goods inventory accounting in the context of Pacioli's treatise. This is followed by a brief description of the alternative treatments in current bookkeeping texts, and a comparison of the methods described (see Table 1). After which a sketch is provided outlining the development of goods inventory accounting in texts over the past 500 years, before concluding with observations on the potential contribution that this history of recording methods might have on the development of accounting and student learning of the discipline.

A note on terminology.

There is a potential confusion in using the term "inventory" in relation to early bookkeeping and accounting not least as Pacioli uses the term *inventario* (which would normally be translated into English as "inventory") to mean something other than goods held for trade. As noted in Appendix 1, Pacioli uses the term *inventario* in his treatise for the initial recording of merchants' belongings, and early writers in English use "inventory" for the same purpose. Further, in early writings it also appears that the terms "inventory" or "stock" are rarely used in the generic way that they have been used in modern times, to mean the stock or inventories of goods held for sale. Instead, it appears that stocks or inventories (as we are meant to refer to them under current international accounting standards) were commonly referred to in the bookkeeping records either as "goods", as "merchandise" or, more often, by the real name of the goods in question[3].

There is an additional issue of terminology that has the potential to cause confusion in looking at early English language texts, especially from the 16th to 19th centuries (for example Mellis, 1588; Dafforne, 1660 (in Geijsbeek, 1914); Foster, 1866; and, from the USA, Crittenden, 1861) where "stock account" is commonly used to denote the proprietor's accounts, including capital and profit and loss balances: hence the use of "stocks" to mean shares and other investment instruments (see, for example, Greeley, 1920).

Parker (1994) provides a more extensive discussion of the use of English language terms representing accounting concepts, including the use of the term "stock" in relation to its meaning as proprietors' capital and the use of "inventory" in the context of a list of assets and liabilities: a similar usage to Pacioli's use of *inventario*.

In this paper stocks or inventories will be referred to as "goods inventories".

Pacioli on goods inventory accounting:

Goods inventory accounts in Pacioli's treatise and other early treatises.

Pacioli describes the entries in the record books[4] necessary for the acquisition and sale of goods in several chapters of the treatise, as his description of the different books progresses. The principal sections that relate to this issue are outlined below.

In chapters 3 and 4 Pacioli deals with the recording of goods in the (opening) inventory[5], specifying that the records ought be detailed and specific, providing some examples that clearly indicate the importance of making proper records of both the quantities and values of the goods held for trade purposes. In chapters 8 and 9 he describes the necessary entries in the memorandum[6] at the opening of the books including, when recording trading goods, noting the need to record, *inter alia*, specific descriptions quantities and prices ("… do not leave out anything in the said memorial,"; Pacioli, 1494, per Gebsattel and Yamey 1994, p50). In chapter 12 Pacioli describes the necessary journals for opening the account, including the need to open appropriately detailed goods inventory accounts and to record full descriptions quantities & values. In chapters 15 & 16 the instructions and example entries to the goods inventory accounts make it clear that details of description and quantities ought to be entered in these accounts. This direction is in contrast to his instructions for other accounts, relating to which he writes "… you need not give details since you have already done so in the journal," (Pacioli, 1494, per Gebsattel and Yamey, 1994, p58). Chapter 19 makes clear that purchases should be entered in the memorandum, journal and ledger in similar detail, whilst chapters 17 and 18 deal with the entries for sales tax, noting the need to debit taxes incurred on purchases to the relevant goods inventory account. These instructions are repeated, including the need to debit to goods inventory accounts other costs of holding the goods, in chapter 37[7].

Sales entries are introduced in chapter 19 and the detail of chapter 20 makes it clear that credit entries, even in recording transactions by barter, in the journal and the ledger should include full details; description, quantity and appropriate cash value of the sales. This advice is repeated in chapter 37. Pacioli also indicates the possible need to open separate accounts for bartered goods "... in order to know which was the best deal" (Gebsattel and Yamey 1994, p67). The crediting of goods inventory accounts with the sales value is further reinforced in the descriptions of the entries required for (outside) shop sales, chapter 23.

In outline Pacioli's treatment of purchases and sales is as follows:

On acquiring goods[8]:

Dr	Goods inventory account	at the "usual" value (cost[9])	
Cr	Cash or Creditor's personal account		at the "usual" value (cost)

On selling goods

Dr	Cash or Debtor's personal account	at the sales value	
Cr	Goods inventory account		at the sales value

With full descriptions, including quantities, recorded in the journals and ledger for each transaction.

Note that the debits to goods inventory accounts are recorded at the usual value, which is cost or opening valuation[10], and that sales are recorded at sales value (not cost). It is this asymmetry of unit costs within the goods inventory accounts that is criticised by Wood & Sangster (2005, p.29) and which Yamey (1984 and 1994a) appears to object to on the grounds that the resulting balance on the account, what he calls the simple arithmetic balance (1994a p.119), does not represent the asset's value in any meaningful way.

The entries required on the closing of a goods inventory account when all the merchandise is disposed of are detailed in chapter 27 where Pacioli states the need to balance the account, therefore enabling closing it. The balance on the merchandise account is then taken to the Profit and Loss Account in the ledger so, as Pacioli states, "…you will be able to see readily and at a glance whether you made a profit or a loss, and how much" (Gebsattel & Yamey, 1994, pp. 78). It is notable that the description implies that the merchant must know when to close the account, i.e. when there is zero stock: reinforcing, by implication, the need to review the recorded quantities in these accounts, even though Pacioli does not describe the use of “inner columns”[11] to record quantities, or to be aware of physical goods inventory levels (though it is clear that Pacioli accepts that the merchant could not always be in the position to be aware of physical stocks, for example when operating through a shop managed by an employee, see chapter 23, therefore suggesting the need for the account books to indicate when stocks are all sold).

In summary, the journal entry according to Pacioli on closing a goods inventory account is:

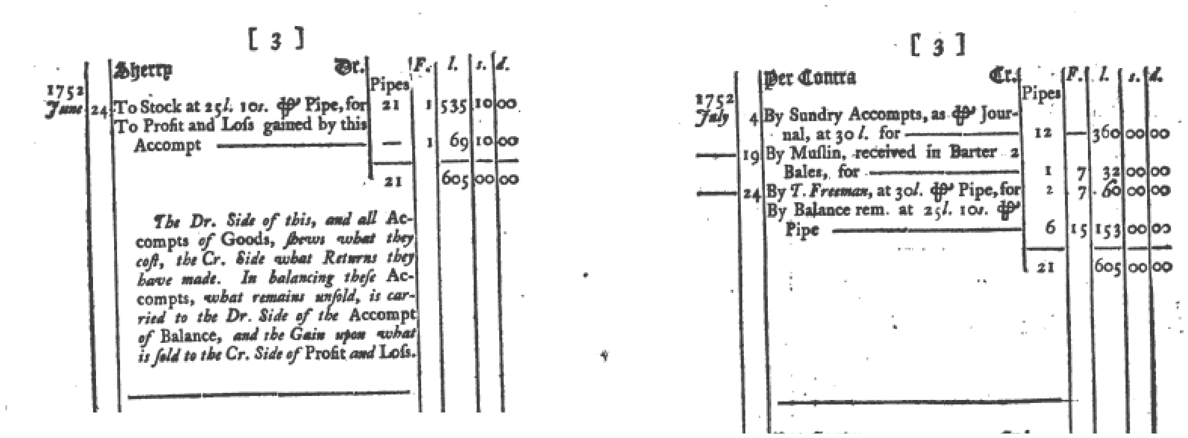
> On closing a goods inventory account as all the specific stock is sold (assuming a profit was made: reverse for loss)

Dr	Goods inventory account	The balance on the account (= profit made)	
Cr	Profit and loss account[12]		ditto

There is considerable debate (see for example Yamey, 1994a; Nobes, 1995) on the interpretation of Pacioli’s treatment of the balancing of the books and closing of accounts at the end of a period, or set of books: the debate concerns both the interpretation and rationality of Pacioli’s instructions in chapters 34 and 36. To contextualise this issue, it is important to note that at that time it is likely that accounts were not necessarily closed in a formal way on a regular periodic basis. Though Pacioli does advise that “… it is always good to close the books each year, especially if you are in partnership with others” (Chapter 29: Geijsbeek 1914, p.67) it was not uncommon (as noted by Yamey; 1994b) for ledger accounts only to be closed on an irregular basis, possibly only when the ledger books were full. Further, in Pacioli’s time and place the bookkeeping system was likely to be tailored to the recording of ventures, the profits of which would have been determined at the completion of the venture (when all goods had been sold), and in such a system there is no need to periodically close the goods inventory accounts (or indeed value closing stock: as there would be none) (Macve, 1996, note 5)[13]. Looking to the writers following Pacioli (many of whom followed very closely Pacioli's text in most other respects) the common treatment of the closing of accounts is illustrated by the extract from Webster (1759) shown in figure 1. Similar treatments are evident in, *inter alia*, Melis's 1588 edition of Oldcastle (1543), Dafforne (1660, in Geijsbeek, 1914, p176-177) and Hamilton (1788) and were described by Yamey (1994b) in relation to 14th to 17th century Italian practice.

Figure 1: Closing a Merchandise account (Sherry) -

extract from Webster (1759) folio 3 of the Ledger



[3]

1752		Sherry Dr.	Pipes	F.	l.	s.	d.
June	24	To Stock at 25*l.* 10*s.* ꝑ Pipe, for	21	1	535	10	00
		To Profit and Loss gained by this Accompt	—	1	69	10	00
			21		605	00	00

The Dr. Side of this, and all Accompts *of* Goods, *shews what they cost, the Cr. Side what Returns they have made. In balancing these* Accompts, *what remains unsold, is carried to the Dr. Side of the* Accompt *of* Balance, *and the Gain upon what is sold to the Cr. Side of* Profit *and* Loss.

[3]

1752		Per Contra Cr.	Pipes	F.	l.	s.	d.
July	4	By Sundry Accompts, as ꝑ Journal, at 30 *l.* for	12	—	360	00	00
	19	By Muslin, received in Barter 2 Bales, for	1	7	32	00	00
	24	By *T. Freeman*, at 30*l.* ꝑ Pipe, for	2	7	60	00	00
		By Balance rem. at 25*l.* 10*s.* ꝑ Pipe	6	15	153	00	00
			21		605	00	00

Note that in addition to showing the two closing entries; namely

Cr: the calculated value of closing stock being carried forward, and

Dr: the balance then taken to the profit and loss account;

the account includes "inner columns" for quantities, which are also balanced.

In outline the common early journals for the periodic closing of goods inventory accounts, consistent with the incomplete descriptions of Pacioli, were:

On closing the accounts and reckoning profit at a period end.

Dr	The Balance account / Next period's Stock[14]	Value[15] of closing stock	
Cr	Goods inventory account		Value of closing stock

And (assuming a profit was made: reverse for loss)

Dr	Goods inventory account	The balance on the account (= profit made)	
Cr	Profit and loss account[16]		The same amount

Here, as in most texts, the profit and loss is taken as the "balancing item" on the goods inventory accounts, after closing stock has been explicitly valued. However other texts show a slight variation on this with the profit on sales being calculated and taken to the Profit & Loss account at the "period end" date (not the date of the sale), leaving the valuation of stock as the "balancing item"[17]. This is evident in Mellis (1588) (based on Oldcastle, 1543) within, for example, the account for Jewels[18]. These example accounts all show inner quantity columns[19] which are also balanced thereby aiding the determination of closing goods inventories.

Together with the journals described above these journals constitute the system that is referred to henceforth as the "early perpetual inventory records" system (**EPIR** system).

Having outlined the bookkeeping entries in Pacioli's method the following section outlines modern practice.

Modern bookkeeping for goods inventories.

This section briefly reviews the double entry accounting that is presented in modern bookkeeping and accounting texts and reflects on current practice. Though there are a wide range of ways in which the relevant bookkeeping entries are introduced (taught)[20], they tend to fit into two basic forms: based on either periodic inventory valuations or perpetual inventory records. The initial comments here are based primarily on Wood and Sangster (2008), the most recent edition of the Frank Wood book on bookkeeping and business accounting: a widely used text that has been in continuous publication since 1967.

Wood and Sangster introduce the possible bookkeeping entries by assuming that goods are sold at cost price (zero profit), resulting in:

On purchase of goods:

Dr	Goods inventory account	at cost	
Cr	Cash or creditors		at cost

On sale of goods:

Dr	Cash or debtors	at sales price	
Cr	Goods inventory account		at sales price

This is the same as Pacioli's instructions: only Pacioli doesn't assume sales at cost. The Wood & Sangster text then notes that the resulting balance on the stock account would be the cost of the remaining stock or inventory, but points out that any business would normally sell stock above cost price. It is at this point that they note that "Maintaining an inventory[21] account on this basis would … serve no useful purpose." (2008, p 29) and go on to describe (Chapters 5 & 9) the conventional bookkeeping practice; using purchases and sales accounts and period valuations of stock and cost of goods sold as follows:

On purchase of goods:

Dr	Purchases a/c	at cost	
Cr	Cash or creditors		at cost

On sale of goods

Dr	Cash or debtors	at sales price	
Cr	Sales a/c		at sales price

Followed by period end journals (or direct entries) to determine the cost of goods sold (and thereby gross/trading profit) and adjust for opening and closing stock:

Dr	Cost of goods sold[22]	the balance on the purchases account	
Cr	Purchases		ditto
To clear the account to zero (transferring all costs)			

Dr	Cost of goods sold	opening stock figure[23]	
Cr	Goods inventory account		ditto
To clear the period's opening stock value to cost of sales			

and

Dr	Goods inventory account	closing stock figure[24]	
Cr	Cost of goods sold		ditto
To carrying the cost of remaining stock over to the following period			

This completes the basic set of journals required for the "periodic inventory valuation" system (**PIV** system). This is the bookkeeping system that is introduced as the only or primary method in many introductory accounting and bookkeeping texts (for example Alexander & Nobes[25], 2007; Benedict & Elliott, 2008; Britton & Waterson, 2003; Jones, 2006; McLaney & Atrill, 2008). This is also true of the main sections of the BPP (EQL) *Interactive Bookkeeping Tutor*[26], which is very widely used in UK universities and colleges as well as in professional training. Even Gray, Laughlin & Bebbington (2001), which uses non-traditional approaches to teaching bookkeeping, effectively implements the same journals and ledger entries for the recording of goods inventory transactions.

An alternative system of entries based on a perpetual goods inventory model is covered in other texts, (for example Weetman, 2006; Harrison & Horngren, 2008; Edwards, Bell & Todd Johnson, 1979), either instead of or in addition to the periodic inventory valuation system[27]. Under these models the journals follow a variation of the basic form:

On purchase of goods

Dr	Goods inventory account	at cost	
Cr	Cash or creditors		at cost

On sale of goods

Dr	Cash or debtors	at sales price	
Cr	Sales account		at sales price

and, simultaneously,

Dr	Cost of goods sold	at the cost of the goods sold	
Cr	Goods inventory account		ditto

Followed by period end journals (or direct entries) to determine trading profit by taking the cost of goods sold (along with sales – not shown) to the trading or profit and loss account:

Dr	The profit and loss (or trading) account	the balance on the cost of goods sold account	
Cr	Cost of goods sold account		ditto
To clear the account to zero (transferring all COGS)			

This system of journals represents the "modern perpetual inventory records" system (**MPIR** system). It is, however, notable that the general tenet of these descriptions implies that the goods inventory accounts, at least those in the general ledger and therefore the focus of the initial expositions in the texts, are non-specific aggregated goods inventory accounts; unlike the descriptions of the **EPIR** systems of the 15th to 18th centuries.

A summary of the goods inventory bookkeeping methods described above (along with the acronyms used) is provided in Table 1, which also highlights the main differences in the systems with regards to the entries in the ledger account for inventory. For an example of the resulting goods inventory ledger accounts under each of the three systems described see Appendix 2.

------- Insert Table 1 about here --------

Having described the principal journals within the **EPIR** systems of Pacioli and those following his treatise and the main treatments found in modern texts (**PIV** and **MPIR**) the following section looks briefly at the genesis of the developments from the “old” to the “new”.

A review of the development and adoption of different goods inventory systems.

This section provides an outline of the transition from the early perpetual form of goods inventory accounting to the modern periodic valuation and cost-of-goods-sold based perpetual inventory systems as evidenced by the content of English language bookkeeping texts over the past 4-500 years, informed by relevant literature (much of which is primarily concerned with valuation issues[28], which are not a main concern to this paper).

EPIR systems persisted in use in Italy[29] from the 13th century through the 16th (Lane, 1945) and to at least the 17th century (Yamey, 1994b). During the early part of this period Pacioli’s system was improved and clarified, principally by Manzoni (1540) and Casanova (1558) (Peragallo, 1938). These improvements resulted, for example, in the standardisation of the use of “inner columns” to record, and balance, goods quantities within the ledger, rather than imbedding these numbers in the text (as described by Pacioli[30]); and the increased use and improved presentation of examples within instructional texts, aided by improvements in printing at the time. Peragallo further notes that in Italy “[b]ookkeping clung tenaciously to its antiquated forms” continuing “[i]t is not surprising therefore that accounting literature makes few notable advances from 1559 to 1795, and contents itself with the expounding of principles and rules laid down long ago …” (1938, p. 79).

Though not directly considering the detail of goods inventory records Edwards (2009) and Edwards *et al* (2009) look at developments in the coverage of double-entry bookkeeping in British texts over a similar period. Edwards (2009) provides the context of the schooling system in the UK during this period showing the linkages between the use of books, and many of the authors, to the non-classical academy schools of the time, which has parallels to Pacioli's role as an abaco master and the much earlier split between the Humanist and Abaco schools of the system in the Italian region that developed between the 13th and 15th centuries (Sangster, Stoner & McCarthy, 2008).

Edwards *et al* (2009) analyse details of 45 early English language double-entry bookkeeping treatises that were published after Pacioli's Summa until the end of the 18th century, many of which are from the later part of the 18th century. From this analysis it is clear that, as in Italy at the time, the texts, continued to use the **EPIR** system of goods inventory ledger accounts, including, *inter alia*, specific goods inventory accounts for different types or batches of merchandise, inner columns for quantities, and balancing to determine inventory quantities on hand and profits (or losses) made. This is illustrated by the extract from Webster (1759) reproduced in Figure 1 above. Though not providing direct evidence of accounting in practice, the content of the texts does imply (as argued more generally by Edwards *et al*, 2009) that these methods were used in practice. The use of **EPIR** in both texts and practice is further supported by Lee[31] (1975) in his discussion of accounting practice in the pre-industrial revolution period (until c.1760).

In addition, based largely on the work of Spraakman (1999) and Spraakman and Wilkie (2000) on the Hudson's Bay Company, Edwards *et al* (2009) report evidence of a change (in practice but not teaching) towards the modern use of **PIV** goods inventory accounting:

> "The pre-1810 ledger accounting system, with its made-beaver standard values, tracked every transaction for trade goods and supplies. It was replaced after 1810 with a system that recorded beginning inventory, amount added by the current outfit and ending inventory for each trade good and supply item. **The pre-1810 system was akin to a perpetual inventory system, while the post-1810 system was**

> **comparable to a periodic inventory system** (personal correspondence with Gary Spraakman)." (Edwards *et al*, 2009, p.567, emphasis added)

However, this change in practice does not appear to have been widespread or reflected in the bookkeeping and accounting texts of the time[32]. Lee (1975) reports that during the industrial revolution (c.1760 – 1830) manufactured inventory was largely not accounted for within the double-entry system, but within elaborate subsidiary records and separate cost estimates, observing that:

> "Under such conditions it was impracticable to operate the "perpetual inventory" of the merchant[33], by matching separately the revenue and costs of each class of goods dealt in. All that could be done was to prepare a "merchandise account," debited with total production costs for the period under various heads, and opening stock, and credited with sales, and closing stock, on lines similar to a modern trading account."(Lee, 1975, p.15)

In effect Lee is noting the move away from the use of **EPIR** systems towards **PIV** systems, as taught in many modern texts, including the use of aggregated inventory accounts (rather than specific goods inventory accounts) in the ledger. It is however significant that Lee does state that: "Raw material stocks **could** be dealt with, as before, on the perpetual inventory system and valued at cost" (1975, p 15, emphasis added), though he does not say whether or not they do. Lee adds that during this period there is no support from the literature or the then existing double entry teaching manuals to evidence the use of **PIV** systems: a situation (in both practice and the texts) that he reports continues into the next period, the Railway Age (c.1830-1870). Though he also observes that:

> "In merchanting businesses, indeed, separate goods accounts with their "perpetual inventory" columns gradually disappeared, owing to the greater variety of

> merchandise dealt in, and they were replaced by the modern unitary trading account, with opening stock brought forward from the previous year's account and closing stock inserted, as found by physical enumeration and priced on the basis of the latest purchases invoices." (Lee, 1975, p.19)

Therefore, suggesting the further replacement during the 19th century of **EPIR** systems with **PIV** systems of goods inventory accounting. In his discussion of the late Victorian period (c.1870-1900) Lee (1975) concentrates more on the effects of the rise of limited companies, costing indirect costs and management accounting more generally, rather than the more elementary issues that are relevant to this paper.

The evidence from text books and bookkeeping manuals published during the 19th century broadly reflect Lee's (1975) observations and discussions. Many of the texts even into the later part of the century (for example Turner, 1804; Dilworth, 1806; Preston, 1827; Ireland commissioners of national education, 1835; Harris, 1836; and Crittenden, 1861 – a text from the USA) deal only with **EPIR** systems, much as Pacioli and the early Italian writers did. Others, whilst concentrating on the **EPIR** system make mention or give brief examples of the use of subsidiary merchandise ledgers or warehouse or stock books, primarily outside of the double-entry system (for example, Lambert, 1812; Alger, 1823; Morrison, 1828). Foster (1866) provides an interesting example, in his 10th edition - published in the UK[34]. Though early in his text and examples he follows the **EPIR** system, and he explicitly states the need to record both price/value and quantities in merchandise accounts, he later comments on the practical (im)possibility of doing so in the Ledger in some circumstances, and recommends in these circumstances the use of a separate "stock-book or warehouse ledger":

> '" It may be objected," says Mr. Booth, "that the keeping of only one account for all kinds of merchandise is too concise a method for general practice; but every attempt beyond this, I know from experience, will prove fallacious, and so far from adding to

> that clearness and perspicuity which should ever be the principal objects of book-keeping, it will create unnecessary trouble and confusion. It is impossible for any person in extensive business, to keep distinct accounts in the ledger for every article he deals in. I am sensible that a merchant should be able to ascertain from his books the gain or loss upon particular commodities, as well as upon the whole of his transactions; but the ledger is not the proper place for details of this sort. It is owing to the introduction of so great a number of nominal accounts, and to journalizing the entries singly, that most treatises on book-keeping are rendered useless: - tradesmen being induced to reject all such fine-spun theories as are not reducible to practice, and to prefer the plain simple method of single entry".’(Foster, 1866, p. 110)

Foster does not go on to elaborate in any real detail how this stock-book should be kept, nor does he suggest that it be integrated with or be directly part of the double-entry system.

Even in the early 20th century Greeley (1920) introduces goods inventory accounting using what is effectively the **EPIR** system, in what he terms a “mixed account”. In later chapters he sets out the **PIV** system as the principal form of accounting for goods inventories, and makes a note on the possibility of perpetual goods inventory records outwith the double-entry system.

In summary it appears that, within the UK and North American context at least, the **EPIR** system remained in use largely unchanged, in both teaching and practice, throughout the 16th 17th and 18th centuries. It was only during the later part of the 19th century that widespread changes began to emerge, and these seem to have been led by practice and not widely or quickly reflected in the mainline teaching of bookkeeping and accounting. Within the 19th century bookkeeping texts were beginning to comment on the use of less (or non) specific goods inventory accounts in the ledger, mainly to save bookkeeping labour. In addition some texts began to introduce (limited) notes and instructions, and occasionally examples, on the use of subsidiary stock ledgers or warehouse books: in effect turning the goods account in the ledger into an aggregated inventory control account. Towards the end of the 19th and the beginning of the 20th centuries texts began to reflect the "modern" **PIV** system, with more detailed **MPIR** systems and costing related manufacturing inventory systems appearing within the double entry system only later[35].

Concluding remarks.

From the descriptions and history discussed we can see that the early perpetual inventory recording (**EPIR**) system of inventory bookkeeping persisted as the dominant form of inventory recording systems for most of the 400 to 500 years after the publication of Pacioli's treatise in 1494, at least in the English language teaching of accounting. This was so, even though from a modern perspective **EPIR** is seen by some as strange and the method is not promoted in the texts currently used with students. The fact that the **EPIR** system persisted in the teaching, and its seems practice, of bookkeeping for so long suggests that it was seen as relevant and useful at the time. One reason for this being that under **EPIR** each goods inventory ledger account contains, at least in summary form, all the purchase and sales transactions that the business has undertaken in those goods, which would provide potentially useful information to anyone who read those ledger accounts. This is in stark contrast to the ledger accounts produced by the **PIV** system that replaced **EPIR**, under which the inventory accounts show almost no information (especially during a period) and the relevant sales and purchasing information is split amongst several accounts, which are also quite likely to be kept in aggregate form.

The shift from the dominance of **EPIR** to the use of **PIV** clearly leads to the need to consider why the dominance of **EPIR** waned in the period towards the end of the 19th century and into the 20th century. This paper does not attempt to address this issue, which is clearly a topic for future research, though there are hints herein that provide a possible lead. The discussion above, and in Edwards *et al* (2009), relating to the changes within the Hudson's Bay Company records suggests that the move towards **PIV** may have been influenced by business practice and social conditions of the time. In addition it is possible that the move towards the teaching of the **PIV** system of goods inventory accounting was related to changes in the nature of accounting and financial reporting as well as the nature of the teaching of accounting towards the end of the 19th century. The detailed research in this paper therefore provides a basis for further research into important debates on the role of double entry bookkeeping and accounting within business and society[36] and may help to illuminate discussion on lessons that might be learnt from Pacioli's treatise in the contemporary teaching of accounting (Sangster, Stoner & McCarthy, 2007).

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Appendix 1: The books and records described in Pacioli's treatise.

Within the treatise Pacioli describes the proper system of records to consist of the inventory and 3 prime accounting books: the Memorandum, the Journal and the Ledgers.

The **inventory [*inventario*** in Italian**]** is a document, on paper or in a book (chapter 2), that details all a merchant's assets or belongings and debts at a point in time (chapter 3), from which the original memorandum, journals and ledgers are composed. The inventory is compiled at the commencement of the records, and may be repeated at later dates.

The **memorandum [*memoriale*]** is a detailed log of all transactions, however big or small, written as they occur (or as soon as possible thereafter). In more recent historical times (from 1613 to at least the 19th century) the memorandum was often referred to as the "waste-book"[38]. Though sometimes omitted from the formal books, for example in small businesses, Pacioli stresses the importance of such a detailed account of all transactions.

The **journal [*giornale*]** is the first part of the double entry system as such, and comprises the journal entries (in current terminology) that are necessary to post the items listed in the inventory and all transactions from the memorandum into the ledger accounts. All entries in the journal are to be detailed, including details of quantities and marks and a clear valuation standardised into the merchant's currency of accounting[39].

The **ledger [*quaderno*]** is the book containing all the double entry "T accounts" with the debits on the left and credits the right, all fully detailed, referenced to the journal (or inventory), cross-referenced and indexed.

Pacioli provides a detailed description of these books and of how they should be maintained within the context of good administrative and business practices, including the cross referencing between and within the account books and the marking (cancelling) of posted entries. Pacioli does not however provide comprehensive examples (see Sangster, Stoner and McCarthy, 2007).

Appendix 2:
Comparison of goods inventory ledger accounts

The following “T-accounts” illustrate the primary difference in the ledger from the operation of the different goods inventory recording systems in an example assuming one purchase and six sales transactions.

Example 1: goods inventory account under EPIR

Here **F** = Folio & **Q** = Quantity

Bulk ginger account

Date	Detail	F	Q	£	Date	Detail	F	Q	£
1/1	Opening balance b-fwd: 100 kilos of ginger at cost	X5	100	220	13/1	Cash – sale at market	1	30	120
3/2	Creditor – ginger bought from M Cristoph on credit	8	300	600	10/3	Debtor – sale of bulk ginger to B Danniel	16	80	360
	working total		*400*	*820*	5/4	Cash – sale at market	1	20	80
					12/6	Cash – sale at market	1	50	210
					18/7	Cash – sale at market	1	60	230
					11/11	Debtor – sale of bulk ginger to C Toppy	12	100	360
									1360
31/12	To P&L account for profit on sale of ginger (balance)	25		660	31/12	Balance of ginger on hand at estimated cost	Z5	60	120
			400	1480				400	1480

Example 2: goods inventory account under PIV

Bulk ginger account

Date	Detail	F	Q	£	Date	Detail	F	Q	£
1/1	Opening balance b-fwd: 100 kilos of ginger at cost	X5	n/a	220					
					31/12	To Trading account – opening inventory	19		220
31/12	To Trading account – closing inventory	19		120	31/12	Ginger on hand at estimated cost	Z5		120
				340					340

Under **PIV** quantities columns are not needed, nor would they provide much useful data if they did, especially as they are most frequently created for aggregate inventories of all (of a class of) goods: meaning the calculated average cost is not even meaningful.

Example 3: goods inventory account under MPIR

Bulk ginger account

Date	Detail	F	Q	£	Date	Detail	F	Q	£
1/1	Opening balance b-fwd: 100 kilos of ginger at cost	X5	100	220	13/1	COGS /ac for sale	18	30	66
3/2	Creditor – ginger bought from M Cristoph on credit	8	300	600	10/3	COGS /ac for sale	18	80	174
					5/4	COGS /ac for sale	18	20	40
					12/6	COGS /ac for sale	18	50	100
					18/7	COGS /ac for sale	18	60	120
					11/11	COGS /ac for sale	18	100	200
					31/12	Balance of ginger on hand at estimated cost	Z5	60	120
			400	820				400	820

It is notable that within the **PIV** system the goods inventory accounts are untouched throughout the accounting period, only being updated at period ends, and thereby (standing alone) are unable to provide any useful information on trade during the period or even total trading volumes, and that whilst the **MPIR** system does provide data on costs and movements of goods it provides no data on sales prices or profits, and therefore (standing alone) only provides limited information of use for trading decisions.

Tables

Table 1: Summary of goods inventory systems

Acronym	System / Name	Brief description of treatment *within goods inventory accounts*			Specificity of inventory account.[1]
		Purchases	**Sales**	**Period End** [2]	
EPIR	**Early Perpetual Inventory Records**	**Dr** goods account at **cost**	**Cr** goods account at **sales price**	Inventory valued and carried forward & Balance (= Profit) taken to capital account	Separate a/c for each item or batch of goods.
PIV	**Periodic Inventory Valuation**	No entries: Goods account only updated at period ends.		Inventory valued and carried forward Balance taken to Cost of Sales	Aggregate general account (by class of goods)
MPIR	**Modern Perpetual Inventory Records**	**Dr** goods account at **cost**	**Cr** goods account at **cost**	Balance is inventory value (subject to valuation & loss adjustments)	Aggregate general account (by class of goods)

Notes

1. Specificity relates to the degree to which, in general within texts, separate ledger accounts are kept for specific items or classes of inventories.
2. Subject to valuation & loss adjustments, that would be separately journaled as identified.

End Notes

[1] *Particularis de Computis et Scripturis*, the bookkeeping treatise contained within Pacioli's *Summa (Summa de Arithmetica, Geometria, Proportioni et Proportionalita (1494).*

[2] Note that this comment of Yamey (in note 12.19 of his commentary on the 1994 Gebsattel translation of the treatise; Gebsattel & Yamey, 1994) deals with strange practices in general in the bookkeeping entries for goods inventories, not just the valuation of merchandise in the Journal and Ledger, which is the subject of other commentary notes on this chapter. Commentary note 12.19 explicitly includes as an example of these strange practices the calculation of 'simple arithmetic balances' arising from debits in the account being made at different values to the credits, which is the issue that Wood & Sangster object to. Also similar criticisms have been raised within the Russian context (Kuter & Kuter, 2007)

[3] Inventory is first recorded in the Oxford English Dictionary as a noun specifically used to describe a quantity of specific goods or items as occurring in 1955 (http://www.oed.com/viewdictionaryentry/Entry/98981 definition 3b: accessed 1/12/2010) . Before that date the OED shows that inventory as a noun was primarily used to describe a list or catalogue of all types of items, much in the same way that Pacioli used the term *inventario.*

[4] An outline of the books and records described in Pacioli's treatise is provided in appendix 1.

[5] See appendix 1.

[6] Also later known as the waste book, see appendix 1, or in more formal forms as day books.

[7] The last three sections of the treatise are not given chapter numbers in the original. Several translations, however, number them chapters 37, 38, & 39, this numbering convention is followed here (some translations do not number the last – the sample or *Ricordanze* entries).

[8] Note that all the journals described in Pacioli's treatise are simple journals: each with a single debit and credit entry of the same amount.

[9] See note below.

[10] Much has been written on the interpretation of goods inventory values in Pacioli's treatise, and other earlier works, see for example Yamey (1984 and 1994). Save for the situation when goods are transferred to the business accounts (the specific situation being described in chapter 12, Nobes, 1995; p.381 elaborates), Pacioli appears to be clear that the "usual value"

is cost, not least because for the journals described to record purchases, the debited "usual value" must equal the cash outlaid and /or the creditors incurred.

[11] The description "inner columns" being used in several later texts, and by example even in earlier works including Manzoni (1540) and Mellis (1588)

[12] Or, possibly, the proprietor's stock (capital) account if profit is taken via a profit and loss account.

[13] In addition as separate goods inventory accounts were (generally) created for each significant type of merchandise, and as many goods would have been fairly highly specific due to the nature of trade, it is likely that goods inventory accounts would have been closed regularly, when the all the goods were sold.

[14] Though there are differences in the precise mechanisms described and accounts used the net effect is the carry-forward of merchandise to the next periods accounts, with the possibility of the extraction of a "balance sheet" of sorts in the process.

[15] There is disagreement amongst the early writers whether this ought to be at cost or at current or market value (see previous discusion). To a significant extent the discussion in this paper does not depend on which of these values is used, and is therefore not discussed in detail.

[16] Or, possibly, the proprietor's stock (capital) account (as above).

[17] This could provide an interesting dimension to the oft debated "valuation" of stock issue, but is beyond the scope of the current paper.

[18] Folio 5 in the ledger examples – this is an account with only a single sale, however similar wording appears in folios 7 and 10 where there are multiple sales and the wording indicates the same sequence.

[19] Here shown to the left of the date columns in the ledger, rather than the more normal later presentation to the left of the money columns.

[20] This section deals with the form of bookkeeping that is covered and does not address the texts that either do not deal with the bookkeeping entries at all or only use the double entry accounts to illustrate the overall affect of transactions on the business' assets and liabilities.

[21] The only change in recent editions being the use of "inventory", replacing "stock" (see Wood and Sangster, 2005)

[22] Alternatively directly to the trading account (if a separate COGS account is not held)

[23] Valued at cost, later adding or at NRV if lower.

[24] Again valued at cost, with quantities of goods on hand derived from an end of period stocktake.

[25] In appendix A, authored by Ullathorne, A.

[26] The BPP computer based and on-line package does mention other systems and provides an optional section that provides an example of the **MPIR** system, below.

[27] This method is mentioned, but not detailed, in Wood & Sangster (2005 and 2008).

[28] These valuation discussions are primarily concerned with two issues. Firstly relating to the meaning of normal or usual value, at which Pacioli instructs the goods' accounts should be debited, particularly in relation to initial entries (see Nobes, 1995). Secondly there is considerable disagreement between the early texts (in English and other languages) on whether end of period balances carried forward ought to be valued at cost, current or expected sales prices.

[29] Whilst it is recognised that Italy as a unified state did not exist at this time the name is used here to indicate the region that is now known as Italy.

[30] A development aided by the increasing adoption of Arabic numbers which, being based on the place value number system, are more amenable to columnar presentation.

[31] Lee (1975) is primarily concerned with the valuation of net assets, the determination of profit, and techniques of costing rather than stock records, but provides evidence and discussion of these issues.

[32] Interestingly it appears that moves away form EPIR towards "prototypes" of the PIV system were also emerging at a similar time, 1814, in Russia (Kuter & Kuter, 2007, who credit this change to I. M . Kline, p .6).

[33] The system in this paper referred to as the **EPIR** system.

[34] Some earlier editions, including that of 1937, being published in the US (Boston).

[35] Mattessich (2003) reports some academic discussion of the need for perpetual inventory systems in a French text of 1840, and in discussion by a Russian writer in the 19th century, but does not make clear whether this is akin to the **EPIR** or **MPIR**, or a different variant.

[36] For example the recently revived debate on the role of double entry bookkeeping in the rise of capitalism (Toms, 2010; Chiapello, 2007 and Bryer, 2000a, 2000b) which builds on the debate following Sombart (1902) including, *inter alia*, Yamey (1949 and 1964).

[37] NB copyright and preface dated 1920, title sheet dated 1921

[38] Defined in the Oxford English Dictionary as "A rough account-book (now little used in ordinary business) in which entries are made of all transactions (purchases, sales, receipts, payments, etc.) at the time of their occurrence, to be 'posted' afterwards into the more formal books of the set". used from 1613 to at least 1849. [http://www.oed.com/viewdictionaryentry/Entry/226030: accessed 1/6/2010]
The OED also notes for memorandum the definition (B1b) "A record of a financial transaction. Now rare or merged in sense…" as in use from 1583 (to at least 1711). [http://www.oed.com/viewdictionaryentry/Entry/116345: accessed 1/6/2010]

[39] At this time dealing with multiple currencies was common as the monies of each state, city or area, even within the area we now know as Italy, were individual and unstandardized. Geijsbeek (1914) notes (p.86) that Manzoni's text of 1532/1540 includes an explanation of the use of merchant's (conceptual) bookkeeping currency: the "*Lire de grossi*".