Equivalence methods: a little-known aspect of the history of costing.

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Abstract: The history of costing has been the subject of much research since the 19th century. Throughout the past two centuries, we have examples of use of equivalence methods. These however appear to have been somewhat neglected both by the specialist literature and by accounting historians and have never been the subject of a general study. Our research aims to fill this gap by examining the conditions under which these calculation techniques were able to develop, and the reasons why they were maintained in relative confidentiality. In addition to presenting them and understanding their advantages and drawbacks, their history sheds further light on the subsequent development of other calculation methods.
Our work reveals how these methods appeared in successive waves, at the crest of which we have the equivalence methods, corresponding to the points at which certain businesses felt a need to simplify the over-sophisticated costing methods that they had recently introduced further to theoretical advances. Although our considerations are made from a French standpoint, we felt it necessary to refer to developments made beyond our frontiers, essentially in the USA, which significantly influenced practices in France.
We have defined four periods that mark the progress of costing techniques: 1880-1910, the advent of industrial accounting; 1910-1930: influence of American methods in France; 1930-1950: the development of homogeneous sectors; 1950-1960, the advent of autonomous equivalence methods. We have thus observed a constant fluctuation between the increasing complexity of the methods and the need to simplify them based on the principle of equivalences.
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> "When a new science demands to be autonomous, it is always wise to question the conditions of its emergence, beginning with the interrogations behind them or knowledge making them possible."
> Gérard SIMON, 2008, *Sciences et histoire*, Gallimard, p. 99

Introduction

Since it was designed around twenty years ago, the ABC method has been the subject of various interpretations, countless applications and much criticism. It no longer appears as a modern concept, even if it is still regularly taught and is now considered as a classic method. Kaplan, who was at the origin of the method, qualifies it as the "traditional ABC method" (Kaplan and Anderson, 2004). Aware of the operational limits of the ABC method, he recently proposed a simplified version, the Time Driven ABC (TDABC). Several activities are combined in this method, time equations represent various operations that are measured by means of a single inductor: time. We can already perceive here the principle of equivalence methods.

What does this evolution from ABC to TDABC entail? If evolution is generally conceived as progress from the simple to the complex, why then do we observe a reverse trend in the case of this costing method? In order to clarify the question, it is interesting to take a look at the history of costing methods to try and pinpoint where equivalence methods come in. Are they always found after an innovation criticized for its complexity? Is their role to introduce operationality after theoretical developments deemed too complex to implement?

But first we have to agree on the definition of an equivalence method. As a first approach, we may consider that it is a *"method aiming to simplify calculations by fictively reducing, either partly or for the entire resource consumption process, units of consumption of resources or various products to a multiple of a unit of consumption or a standard product"*. Further analysis allows us to define three levels of equivalence according to the complexity of the method used:

- *"Level 1"* equivalence methods or simplistic methods. These seek to establish laws of variation of certain costs (labour, raw materials, energy, maintenance, amortizements, etc.) according to the physical characteristics of the products manufactured. An equivalence is established for each article, with the unit of reference (article, product, service, etc.) whose weighting allows the coefficient of global equivalence of the product concerned to be calculated.

- *"Level 2"* equivalence methods. These are complementary to other costing methods. They allow the charges for several centres of analysis to be grouped by means of equivalences connected with the intensity with which these grouped centres of analysis are used.

- *"Level 3"* equivalence methods. These are complex, autonomous methods for obtaining the cost of products and services resulting from complex processes, by calculating the equivalence ratios between the various production processes. These ratios of equivalence allow all the products manufactured to be reduced to a multiple of a base element and thus unify production.

As regards equivalence-based methods, the reliability of the calculations over time depends on the stability of the global homogeneity, assuming that the cost ratios between products or processes remain constant over a period of several years.

There were more works published on cost accounting from the early nineteenth century to the 1870's in France than anywhere else (Boyns, Edwards et Nikitin, 1997). It is therefore in this period that we sought the first uses of equivalence methods. We can of course see signs of these methods in the railways (Proudhon, 1855) and the mining industry. These were crude approaches, of the level 1 type. As regards our research, we go no further here than to say that they were in answer to a need for simplification with a view to conducting economic analyses. It is rather the following period, from 1880 onwards, with a focus on France, that concerns us.

Between 1880 and 1930, the science of accounting enjoyed great success in France. Literature on industrial accounting reveals a search for legitimacy by a profession that was in its early days. This preoccupation seems to take precedence over the relevance of the information given. Equivalence methods are not mentioned in the literature, nor are

innovations in costing (part 1). We felt it necessary to present the costing methods proposed by engineers in the USA at the same time: definition of a machine hour rate, normal level of activity, level 2 equivalence methods, standard cost (part 2). These methods were in fact widely used in France between 1910 and 1930 and had a certain influence on costing techniques. After 1930, these methods were developed in France, with the exception of standard costs, but the political events that marked these years, and up to the post-war period, gave them a more ideological character. This was the case for the method of homogeneous sections which, apart from the charging of indirect costs, is a level 2 equivalence method and was neglected for a long time (part 3). It was only in the 1950's that level 3 autonomous equivalence methods developed, which we will examine in the last part (part 4).

Our sources were numerous, including various private and public archives, professional literature and academic works[1] on the subject of costing.

1 . Accounting costs: 1880-1930

From the 1880's in France, accountants were keen to earn recognition for their profession and see their discipline acknowledged as a science. The method for calculating a true cost price was one of the items in the scheme they had to establish their respectability. But one of the consequences of formalizing accounting in abstractions and theory was that its logic, clarity and exactitude became altered and the resulting image was that of a mysterious and obscure language. In addition, the accounting method of calculating the cost price was seen to take on a hegemonic position that prevented other methods emerging in the USA at the dawn of the 20th century from being disseminated.

1.1 *The quest for recognition of accounting as a profession*

When the first congress of French accountants met in Paris in 1880, the profession then had no official recognition or prestige. It was only in 1945 that an Order of Chartered Accountants was set up under the auspices of a Republican government.

The arguments of the representatives of the accounting profession to uphold their demands were multiple. They mainly concerned the need for businesses to be able to provide

[1] We particularly used sources from the Ernest Stevelinck Foundation at the Nantes Library.

reliable information to their shareholders when distributing dividends, to third parties with regard to their financial stability and to the Government in order to appraise their profits (Company Tax was set up in France in 1916). In addition to all these reasons was the calculation of a true cost price.

To prove this point one only has to study the abundance of literature produced by accountants in which they explained how a cost price plays an essential role in the good health of a business and in guaranteeing the scientific aspect of accounting.

This is illustrated by this typical assertion: "it is essential for a company manager to know the cost price and establishing the cost price is one of the main services offered by accounting" (Julhiet, 1922, p.126). This quote taken from an accountant writing at that time is often mirrored by the phrases spouted from the pens of his contemporaries.

It is like a syllogism with the following premisses:

1. Accounting allows a cost price to be established
2. It is essential to know the cost price

Which logically implies that accounting is essential.

If the cost price was deemed to be essential to a company manager for the good running of his business, it was equally essential for accounting, according to its theoreticians, as the "law of permanence of inventory values at their cost price is the capital law of accounting science" (Guilbault et Leautey, 1889, p. 478) for, while striving to have accounting recognized as a science, the profession was seeking to strengthen its claim that the profession should only be accessible to members whose competence is certified by a national diploma issued further to a recognized period of training[2].

Therein however lay the risk that by claiming to be a science on the grounds of its internal logic alone, taking mathematics as a model, its usefulness for companies ensuing from the truths provided by double-entry accounting, theory and practice would become very far removed from each other.

[2] The Commission du titre d'ingénieur (CTI) was set up in 1934.

1.2 *An unkept promise*

Léautey et Guilbault, the patron saints of accounting between 1880 and 1930, are guilty of begging the question when they write in the preface to their *Science of accounting*: "*through the permanence of the cost price of inventory values, everything becomes clear in the mind of the person selling or producing. The entrepreneur follows his operations with mathematical precision, he knows exactly where he is going, he can move on or stop in time, he is master of his enterprise, he seeks the improvements shown to be necessary by his accountant"* (Guilbault et Leautey, 1889, p. X). We will see that their reasoning is based on taking as a truth the very thing they are trying to prove.

One account that is representative of the opinion of engineers in the inter-war period can help us to understand this: *"in general, for a production engineer or shop foreman, accounting represents a collection of papers and divers ledgers, showing what our customers owe to the company or setting down what the company owes to its suppliers, and determining our credit in the bank. The impression many technicians have is that accounting can only offer rough indications of how the business is going that are often fanciful and sometimes confused"* (Nottin, 1927, p 11). This is a far cry from the clarity and exactitude Guilbault and Léautey attributed to accounting (1889).

Whenever company archives provided us with further insight[3], we often found the same type of judgement. For example, the minutes of a working meeting at the car manufacturer Marius Berliet's, one of the pionneers of Taylorism in France, informed us that "most of the methods used for establishing cost prices were invented by accountants for the benefit of the banks [whilst] the main function of accounting [should be] to continuously inform the shop foreman whether he is manufacturing in the most economical way possible, which is not possible in 99% of ordinary bookkeeping where the information arrives too late, if at all, to be of any real use" (FAMB, 1917); this echos the opinions of American efficiency experts working on costing innovations (Gantt, 1915).

We have mentioned the interest of accountants for cost prices. We have just seen that in fact accounting was a long shot from meeting the expectations of industrialists. It remains

[3] See Zimnovitch (2001).

for us to examine if the accounting method of calculating costs did not hinder the dissemination of other methods we know to have been invented in the early 20th century.

1.3 *A hegemonic discourse*

While no other method of accounting overshadowed the double-entry technique during the period from 1880 to 1930, the same can not be said of the non-accounting process used for drawing up estimates in particular. The reaction of accountants to this was somewhat hostile, as shown by the following quotation: *"one of the causes of failure of many businesses is the lack of determining the cost prices. A cost price resulting from good accounting is accurate, while a cost price established through an estimate will only be accurate by change. In the first case, we attain the truth […]. In the second case, we have simply calculated the probability and arrived at an approximation that is frequency found to be wrong."* (Guilbault et Leautey, 1889, p. 13). We have again here our syllogism that preaches cost prices in favour of double-entry accounting, but beyond this we have a criticism of anything calculated outside the accounting process.

The importance of obtaining an accurate cost price implies that all the charges are integrated into the cost price calculation. The notion of integrating costs in a theoretical, predictive manner, as is the case with standards, was not entertained in the accounting cost price. While accountants had long been familiar with the notion of a technical or "conventional" price which enabled book entries to be made without having first to know the exact price paid for every charge involved in the production process, the general feeling was that : *"this method was a contradiction with the fundamental principle of Accounting, which is the permanence of inventory values at their cost price, and leads to empiricism and arbitrariness"* (Bournisien, 1909, p. 134).

We are justified in thinking that this attitude at least had the effect of inhibiting any attempt to innovate towards standard costs. The comment made in April 1919 by the accounting manager of Renault, Meurisse, is significant here: while the manager of the cost price department was toying with an idea close to that of the pre-established cost, Meurisse challenged the ability to predict it sufficiently accurately owing to the bungled parts and other variations encountered each day in the production process; he thus wrote to the management: *"I will probably be told that the cost price department takes these considerations into account*

when drawing up the prices. It is not however possible to do this rationally, since, […] if he takes these unknown factors into account, he will be forced to do it in a theorietical or empirical way and will not under any circumstances be able to prove the results obtained". (Renault, 91 AQ)

This rejection of approximation and empiricism, and attachment to exactitude did not favour the development of equivalence methods even though the concept was emerging in Great Britain and in the USA in particular during the same period. We have found a trace of this in francophone literature, in the writings of the Belgian author Joseph Trossen (1935, p. 79), but only a brief reference nonetheless.

2. The impact of American methods in France 1910-1930

2.1 *The problem of charging overheads in the late 19th century*

When one begins to calculate the cost of an item, the problem soon arises of identifying certain charges comprised in it, starting with those we used for various items without knowing exactly to which they need to be linked. Writing off machines used in processing several products, the wages of the engineers and technicians required for operating the machines, the wages of the managerial staff of the organization are just some examples of this. As industrial processes became more complex with the development of techniques, managers and accountants observed the increasing amount of overheads involved in their total charges, including in the production costs. New problems were also being posed: what should be included in overheads (amortizements and interest on the capital used are examples of these), should they be included in the costs, should only the production costs be calculated or should other charges be incorporated, and how then should overheads be distributed? (see Zimnovitch, 1997, pp. 94-103).

Different methods of distributing overheads were used in the late nineteenth century : a percentrage of the direct labour costs, a percentage of the direct labour costs combined with a percentage of the raw materials costs… None of these methods were really satisfactory.

Mass production and Taylorism put costing into the hands of the engineers from the mid nineteenth century in the USA.[4]

While we may perceive a form of determinism in the logic of allocating direct charges owing to the rise in overheads and to competition, we must not however neglect the importance of certain individuals in the progress achieved. This was true in the case of American engineers.

2.2 *Invention of the "Machine hour rate" by American engineers*

Owing to the increasing importance of overheads due to the industrial revolution in the second half of the nineteenth century, the problem arose as to how these should be assigned to the products[5]. In 1885, Captain H Metcalfe, an American Army Ordnance Officer, published one of the first industrial accounting books in the USA[6]. This work, entitled "Cost of Manufactures" (Metcalfe, 1885) was followed in 1886 by a paper presented to the American Society of Mecanical Engineers (Metcalfe, 1886) in which he described a system for allocating indirect charges by breaking the company down into departments. He distributed the indirect charges among the departments and then divided the total charges of each department by the number of working days of the previous year. It is this daily rate that allows the work performed by each department to be costed. Later on, another engineer Alexander H Church (1866-1936), English born but who settled in the USA in 1910 as a consultant engineer (Scorgie, 1993), perfected this method and disseminated it widely. From 1901, in a series of articles published in "The engineering Magazine" (Church, 1901, 1902, 1909) Church proposed a 3-stage method of calculating the hourly machine costs by means of a "scientific production centre". The company was first divided into "production centres" which may be a machine, type of machine or workstation (grouped in order to ensure the

[4] An American article dated 1921 ennumerates 350 industrial accounting books in the USA: A bibliography of cost books, NACA Bulletin, vol 2, no 10, April.

[5] Other problems also appeared at this time in the modelling of costing systems, such as how to distinguish between "production" cost centres working directly for production and "service provider" cost centres working for other centres, making it necessary to cascade the distribution of the charges related to these cost centres. Garner (1954) refers to Nicholson (1913) as well as to Webner (1917) and Taylor for how this problem was tackled.

[6] It is important to note that in parallel, in France, there was a school of thought that advocated breaking companies down into sections. We may cite: Degrange (1824), numerous manuals devoted to agriculture (Lemarchand, 1998), the works of Toussaint in the company Schneider in Le Creusot (Toussaint, 1900) and studies conducted in arsenals and the ship building industry (Lemarchand, 1998).

homogeneity of the method[7]). The indirect production charges were then distributed between these production centres according to distribution keys: area occupied, consumption, etc. The total charges of the production centres were then distributed by allocating them to the product costs according to the hourly rates. These hourly rates are obtained by dividing the total charges of the production centres by the number of machine hours considered normal for the reference period.

The increasing complexity of industrial processes resulted in the multiplication of these production centres, which made the method of the "Machine hour rate" difficult to implement. One solution would be to use the equivalence method.

2.3.Use of equivalence methods

Taylor who had set up numerous industrial accounting systems in the USA (Chandler, 1977, p. 412; Aitken, 1960) was reputed to have adapted Church's "production centre" method to make it simpler to use (Garner, 1954, p. 196) by means of an equivalence method. This method, known as the "cost numbers method" designed while he was working for Bethlehem Steel (Epstein, 1978) is described by Atkins in particular in the Industrial Management magazine (Atkins,1923a). This article is found in Appendix A of his work "Industrial Cost Accounting for executives" (Atkins,1923b). This method is also presented by Keely in a paper presented at the Philadelphia meeting of the American Society of Mechanical Engineers on February 8, 1913 and published in two specialist magazines (Keely, 1913a,b). According to him, the charges are first distributed among departments, some of which are auxiliary departments, that is: "*which aid indirectly in the manufacture of the product, but do not work upon the material going into it in the sense of changing its form*" and which are then allotted to main centres. The charges are allocated to the various products in each department. For each department, the unit of charges is the machine hour. It is however necessary to consider a) that the breakdown is into departments and not into machines or group of machines and b) that we have to observe what can be assimilated to the principle of homogeneity of the method. He counts all the indirect charges ascribed to each

[7] A cost centre grouping overheads or indirect charges in a costing system must be set up so that all the charges concerned can be reduced to a single unit enabling the proportion of these charges ascribable to each product manufactured to be measured and allocated to it. This ensures the homogeneity of the costing system. It is based on the principle of equiproportionality, which means that all resources must be used in the same proporitions for all activities in order to avoid the aggregation errors that occur when the cost aggregates resources that are consumed by cost objects in different proportions (Datar and Gupta, 1994, p568).

machine (amortization, insurance, tax, etc.) in a workshop and calculates the weight of these charges for each machine in the workshop in relation to the total charges of the same type for the other machines in the department. This is what he calls a "cost-number". In the next stage of the costing process, the time considered is the actual machine time multiplied by the cost number, which gives us a "cost number charge". It is the total "cost number charges" of each department that will serve as a basis for distributing the overheads. In this method, "production centres" related to machines are grouped together, which simplifies the calculation of overhead distribution. On the other hand, for calculating the machine hour rates, the machine utilization time in the same cost centre are weighted by the respective costs of machine utilization and maintenance. It is this device that ensures the homogeneity of the method.

Another author, Webner (1917, 1924), proposes a method he calls the "Point Method". In this method, he breaks down the overheads of a cost centre according to a rate of equivalence between products, itself linked to their consumption of direct man hours. It was called the point method as the various products are expressed as points according to the direct man hours consumed, with reference to a master product which is that which requires the most direct man hours.

2.4 Dissemination of American costing methods in France

It was only during the First World War that the costing methods developed by American engineers, and particularly the machine hour rate method, began to become known in France. At least as an ideology, French literature on costing shows signs of these developments in the writings of Charpentier (1919) and Blandin (1928). We can also find the ideas of American engineers in such professional magazines as the Revue de la Métallurgie[8] which had served to disseminate Taylorian thinking in France since 1915. We may also postulate that practices followed the same trend. This is upheld by several observations. First of all, some American engineers came to France in answer to the call made in 1917 by Louis Loucheur, Secretary of State in Clemenceau's government, to contribute their ideas to the war effort. Some even set up consulting businesses in France (Moutet, 1992, 1997). We may cite Clarence Bertrand Thompson (1882-1969), lecturer at Harvard from 1911 to 1917. On his arrival in France,

[8] For example, the translation of Gantt's article by Nusbaumer: "Des relations entre la production et les dépenses d'une usine". Revue de la Métallurgie, 1915, pp. 1066-1068.

where he stayed until 1930, he set up the first organizer-consultancy bureau and published three editions of a work devoted to American costing methods (Thompson, 1920, 1924 and 1928). Likewise, Paul Atkins, married to a French woman, lived in France in 1924-1925 and lectured on costing methods at HEC-JF[9]. He published a work in French on the teaching of costing methods (Atkins, 1925) based on his PhD thesis defended in France at the Univeristy of Paris. Apart from those actually living in France, works on costing by American engineers were at least distributed in France and even translated (Lemarchand, 1998). Apart from the works of Atkins and the three editions of Thompson's work mentioned above, those of Charles Buxton Going and Gantt were translated in the 1920's by André Blandin, civil engineer from the Ecole des Mines, and published by Payot as part of a collection dedicated to company management problems « La bibliothèque de l'entreprise ».

All these ideas on costing were also widely disseminated through the sharing of experiences and ideas during the setting up of a huge military-industrial complex after the First World War (Lemarchand, 2002).

3. The uniform cost price: 1930-1950

3.1 *France and machine hour rate methods*

As we have already said, it was only in 1945 in France that the status of accountants became fully recognized by the State. That means that between 1930 and 1945, the accounting method of calculating costs did not disappear – it still today occupies a place, however small, in management accounting – but it ceased to be hegemonic and even took second place to the uniform costing method which generated wide interest in France.

At the basis of the uniform cost, we have the same problem of allocating indirect charges as has been mentioned for the USA. It is true that economic development in France between 1896 and 1930 did not reach the same levels as that observed on the other side of the Atlantic. Nevertheless industrial production was seen to double at that time (Ambrosi 1969, p. 511) which hence became known by economic historians as the "Golden Age of industry".

[9] These conferences must have made an impact as Jean Milhaud mentions them in his work « Chemins faisant » (Milhaud, 1956, p. 122) and claims that they have remained famous.

In this context, it is logical to note that French companies, as well as military establishments (arsenals, etc.) began at that time to explore the allocation of indirect charges. From 1917, the Maison Renault was thus at the centre of thinking on the question. This would lead others – particularly in the same industry – to join in this process of reflexion and reach the conclusions that: "With modern machines, overheads may account for as much as eight times the labour costs. It is therefore dangerous to use labour costs as a costing basis, […] it is necessary to determine for each workshop or large set of similar machines all the following hourly expenses […] » (Berliet, 1921).

Marius Berliet appointed in 1915 an English efficiency engineer, Eggerton Banks, who was well versed in Taylor's ideas (FAMB) and, as we have already said, several engineers from the USA published works that were disseminated from 1918. In these works, the question of cost is tackled, particularly using the hourly rate method. The notion of *cost centre* is not specifically referred to, but the idea is definitely present in the words of Going-Buxton: " we often group machines into classes and calculate the hourly rates of each class instead of taking each machine individually (Going-Buxton, 1922, p. 136).

3.2. *The homogeneous sections method*

We have just seen that at the dawn of the 20th century in France there was a demand in certain companies for a change to the concept of accounting cost, in order to include more realistically the burden of overheads. In parallel, Taylorian engineers had developed methods that could meet this demand. In order to reduce the number of centres necessary to break production down to machine or even workbench level, equivalence mechanisms were sometimes proposed in the logic of Taylor's *cost numbers*. Similar systems in place in Germany indicate that this was not strictly an American invention (Trossen, 1935, pp. 79-86 and pp. 188-190). We may even question whether the term invention is appropriate for what seems more like the logical result of economic evolution related to the increasing mechanisation of industry.

These remarks are just as valid for the homogeneous section method, so much so that Emile Rimailho (1864-1954), a polytechnique-educated army officer and company manager[10],

[10] Mainly the CGCEM, a company manufacturing and repairing railway equipment. For a bibliography of Rimailho, see: Lemarchand, 1998.

designed in 1927, on the initiative of the CGOST or *Commission Générale d'Organisation Scientifique du Travail* (later renamed the CEGOS in 1936[11]), an offshoot of the *Confédération Générale de la Production Française* (CGPF). The aim was to have a better appraisal of costs. All he did was to use the conventional breakdown of a company into charge groups in order to make more logical correlations between monetary resources and products manufactured[12]. The method proposed was the one he had put in place at the CGCEM based on his observations in French military arsenals. He draw up an initial report in 1927 (Rimailho, 1927) which was published in 1928 by the CGPF (Rimailho, 1928). Like other models devised at that time, the method of allocating overheads on the basis of normal business activity was known as "technical cost" in 1927, then as "rational charging" in 1928, different to the "accounting cost" which he felt was consistent with financial accounting.

What is different about Rimailho's method lies particularly in the logic of homogeneity in his definition of what he calls sections[13], "workshop sections" in 1927 then "homogeneous sections" in 1928. He defines a workshop section differently to a group of identical machines and operators all performing identical tasks. These are not Taylorian workshops, but "the joining of interrelated resources, not because they are identical, but because they are interrelated" (Bouquin, 1997, p 71). *"For a section to be homogeneous, its composition will be such that the various professional specialities making it up are in principle employed in the same proportion for all the work performed by the section and items of varying value, including the equipment, found in each speciality are themselves used in the same proportion for all the work. A section may for example contain millers, planers and drillers, if the relative value of the milling, planing and drilling work is in general the same for all the work entrusted to the section"* (Rimailho, 1928, p. 66). All charges excluding the raw materials are grouped into sections. Some are said to be "productive" and are directly distributed among the products and others said to be "auxiliary" will are distributed among the former. Another concept specific to Rimailho is the unit of work which is derived from the homogeneous section. The common unit of measurement which will allow the charges collected in a homogeneous section to be allocated to the products is time: "the definition of homogeneous sections itself enables all the work entrusted to a section to be considered as

[11] For a history of the Cegos, see: Dard, 1999.
[12] While Rimailho can be classed among Taylorian engineers (Moutet, 1997) he claimed that Taylor had simply borrowed the methods implemented in French arms factories.
[13] For Rimailho there was more to his method than simply the accounting aspect. A section is also a team, a base unit of an organization, "interrelated teams managed autonomously". Rimailho was aware of the experiences of the Bat'a factories and the writings of Hyacinthe Dubreuil with whom he published under the names Dubreuil and Rimailho. He also published his ideas on this topic: Rimaiho, 1936, 1947.

generating expenses whose unequality only depends on the unequality of the time devoted to performing it" (Rimailho, 1928, p. 69). The "hourly rate" or "selection hour" is calculated by dividing the total charges of the sections by the number of direct man hours performed in the sections[14]. It is homogeneity that allows it to be used in this way "If the assembly section cost 15000 Francs and performed 1000 hours of work, each fitter hour has cost 15 Francs. The more homogeneous the section, the more legitimate application of this mean cost will be (Rimailho, 1947, p.36).

The homogeneity resulting from construction into homogeneous sections thus makes it possible to reduce the number of cost centres and thus avoid the criticism encountered for example by Church's method, considered excellent in principle but too difficult to implement. Underlying this is the concept of equivalence.

Further research was begun in the early 1930's as part of a CEGOS research committee. This culminated in the publication by CEGOS in 1937 of a brochure entitled "A uniform method of costing. How and Why?" (CEGOS, 1937) presenting a costing model inspired by Rimailho's work and which was to become the reference for French cost accounting until the 1990's. He made some technical changes to the Rimailho method. For example, he defined the homogeneous section as "a group of production means such as the operations performed have a common measure to which its costs can be related" (CEGOS, 1937, p. 78). Rimailho criticized this deformation of his original idea: In the book "A uniform method of costing", CEGOS defines the homogeneity of a section by the common measurment of its work unit. This condition is inadequate: a section of a rolling mill will not have the same homogeneity and hence the same unit of work depending on whether it is manufacturing an order requiring several passes, or just one... The section is the same, but it ceases to be homogeneous if it is used for either roles indifferently" (Rimailho, 1947, p. 216). We can but agree. Defining homogeneity by the existence of work unit is tantamount to confusing cause with effect (Bouquin, 1995, p. 65).

[14] It nevertheless mentions other distribution factors such as : kilos, a number of parts, a percentage of turnover, etc. He then speaks of a "task unit".

Rimailho made an important contribution to costing by being one of the first people to clearly pose the problem of the conditions of homogeneity[15]. It was not however this aspect of his method that caught on, but the interpretation that he and others gave it in developing a uniform cost, the touchstone of an ideology that, for a certain elite that we may call technocrats, would help to overcome the crises that shook the country between 1930 and 1945. If in 1928 the aim was to perfect costing methods, in 1937, the aim of CEGOS in presenting a uniform costing method was quite different, even if the authors were greatly inspired by the ideas of Rimailho. *"It is absolutely impossible to seriously calculate a unit cost"*, declared A Detoeuf[16] (Detoeuf, 1937, p. 11)

3.3 *A technocratic function*

What the technocratic function of the uniform cost reveals is the faith in a method served by a body of technicians capable of giving "the right answer", the one that will reconcile diverging interests particularly between capital and work. In the same way as the accounting cost is overdetermined by the will of accountants to justify the status of their profession, we can perceive behind the uniform cost the desire of certain engineers not only to attain the position of an arbitrator between the company owner and the workers, an idea already found in Taylor's ideas, but more importantly, to erect themselves as the safekeeper of public affairs. This was expressed by Coutrot, a polytechnique-educated industrialist and organizer, and like Rimailho, a costing theoretician, when he wrote: "it is up to engineers to construct better societies as it is them, and not lawyers or politicians, who have the required methods" (Dard, 1993, p. 56).

It is not irrelevant here to note that one thing Rimailho and Coutrot had in common was their membership of CEGOS. After the First World War, the first national employer's federation, the CGPF, the forerunner of the present Medef, was set up and founded in 1926 a commission on scientific organization, the CEGOS, which in particular explored the question of costing. This produced in 1928 the Rimailho report: *Establishing costs*, which was only

[15] He also evoked the problem that would be raised later on in equivalence methods: the stabilty of this homogeneity, that is the conditions under which these methods must be maintained: "we set up a homogeneous team which will be more or less stable, and may vary from one order to another" Rimailho, 1939, p139.

[16] A Detoeuf, educated at the Polytechnique school, was the first chairman of Alsthom from 1928 to 1940. He was also chairman of CEGOS and wrote the preface to the report *A uniform costing method. How and Why?* Published in 1937 (cf infra).

distributed to a selected audience. But his ideas were reiterated in a document published by CEGOS in 1937 (cf supra) and which was read by a wider audience.

It was the political and social events of 1936 that gave the homogeneous sections method an opportunity to be presented to a broad section of company managers. Disoriented by the increasing labour costs resulting from the Matignon Agreements, company owners turned to their federation for help in facing up to this situation. The CGPF, via the CEGOS, proposed in its brochure *A uniform costing method. How and Why?* simple rules inspired by the homogeneous sections method which, it was said, "were a precious guide avoiding a costly trial and error approach, made competition healthier by eliminating costing errors, made comparisons possible, facilitated the justification of price variations to clients and the public authorities" (CEGOS, 1937, pp. 37-39). A new function was assigned to costing: that of an argument to be used in discussions with the various stakeholders of the company, that is its clients, the unions or the government.

As regards the governing, the new minister of the Economy, Charles Spinasse, encouraged this approach, by setting up the COST (Centre national d'organisation scientifique du travail - National centre for the scientific organization of work) to which he appointed Jean Coutrot as its director. But it was only at the time of the Vichy government, in which Spinasse had a position as minister for a time, that a new impetus was given to the technocratic function of costing with the production charter.

3.4 *L'opérationnalité par les équivalences*

An further step in the development of the Homeogeneous Sections or CEGOS method (Lemarchand et Leroy, 2000), was taken with the publication of the French accounting plans in 1942 and especially 1945, whose use was recommended to companies. But there's many a slip 'twixt the cup and the lip, and in reality applications remained limited.

Firstly, technocratic ambitions were only realized in some rare economic sectors, such as steelmaking (Meyssonnier, 2001). On the other hand, several trade unions took the initiative of offering their members a uniform costing method as devised by CEGOS, at least

along the lines of homogeneous sections method (Lauzel, 1959). There was however criticism that it was difficult to implement while achieving the required homogeneity.

> "Now the 1942 method, like that of *CEGOS, in order to achieve satisfactory costs, requires a minimum number of sections in proportion with the degree of complexity of the company* (Martin, 1952, p. 76).

It was therefore proposed to combine it with equivalence methods in order to simplify the calculations by reducing the number of sections. This was indeed the main utilization of these methods as proposed by CEGOS in one of its training brochures in the 1950's:

> *"Indexible methods (based on equivalences) are, above all, convenient ways of distributing types of expenses among articles or distribution sections. It is only in some extreme cases that they can be truly qualified as autonomous management systems and even then they are limited to highly global systems"* (CEGOS).

Thorens (1954) and Bourquin (1954), proposed calculating the probable cost ratios between products outside the accounting process. Bloch (1962), used as the work unit the time required for the operations on a typical article with, for the other articles, a scale giving the equivalences in type-units that were multiplied by the month's production. Audoye (1955) proposed the "characteristic number" method. This referred to an equivalence work unit that was valid for all the activities of a company and which, in the homogeneous section method, attributed to each item produced a comparable normative value characterizing the technical and financial structure of its cost (Audoye, 1955, p. 35).

These types of method were thus proposed by the trade unions up to the 1970's: the National confectioner's union (1960), the International association of textile dyers (1967) and the National syndicate of rubber and plastics and associated industries (1972).

In parallel, we can still find references to level 1 equivalence methods in academic literature during this period (see for example: Martin, 1948).

4. Autonomous equivalence methods after 1950

4.1. *Conditions for their emergence*

Once the notion of autonomy of equivalence methods is put forward, the quotation by Simon (2008, p. 99), a science historian, which we have placed at the beginning of this paper, invites us to "question the conditions of [their] emergence, beginning with the interrogations behind them or knowledge making them possible."» (Simon, 2008, p. 99). This does not mean that the role of their inventors does not merit consideration, but that we also have to examine other factors, because "the *conditions* for innovation do not only depend on the innovation itself" (Simon, 2008, p. 111).

As regards the simplified equivalence methods we have already encountered, and which we continue to see after 1950 such as in this document by the *Conseil National du Patronat Français* (National Council of French Employers) in 1957 (CNPF, 1957), there is no precise reference to an "inventor" as such. As regards the two autonomous methods based on equivalences that appeared beween 1950 and 1960, one of these, the points method, has no recognized originator, while the other, the GP method, is signed by the initials of its inventor: Georges Perrin.

Apart from the impetus of individuals, the early 1950's provided the right conditions for costing innovations to improve on previous methods, owing to the wave of modernizations which aimed to bring France into the era of management, productivity missions on accounting methods in 1951 played a significant role (Boulat, 2006). It was these missions that popularized standard cost techniques. It is of note that the rate of inflation at that time in France was soaring! After the Korean war, the price of imported raw materials in 1951 had multiplied by 2.5 and that of industrial products increased by over 70%! (Ambrosi, 1969, p. 212). In such economic conditions, the analysis of differences in price in relation to a standard became quite irrelevant.

The early 1950's in France were marked by high industrial growth and the need for organization and rational management. It is the ardent obligation of the Plan. Cost accounting was the subject of several articles and works. These presented the now classic homogeneous sections method and the standard costs method from the USA. Both of these however came

under criticism. The first for its costliness and complexity, and the second for its inappropriateness at a time when prices were soaring. The conditions were right for a compromise, a combined method:

The problems with the classic method, which is admittedly quite costly to implement, and the dangers of the standard method in our poor country whose currency is like a will o'the wisp, made practicians to seek a compromise. This compromise is the mixed method, or methods to be more precise, as they are uncountable." (Thibert, 1952).

This mixed method is the autonomous equivalence method, of which the points method offers an example.

4.2 *The points method*

This was presented during a series of conferences given as part of a training program, in 1951 and then in 1952, at the Paris CNAM by Messrs. Thibert and Martin (1951, 1952). We also find a presentation of the method in a publication by Laugier dated 1957[17].

This method is based on constant ratios and an analysis of the workstations. The point is presented as a unit of measurement of identical technical factors and serves to rank unit costs (or each of the elementary factors making up a set of identical factors). A number of points is given to the elementary cost (100 for example) and all the other unit costs of coefficients calculated from this base are allotted. For raw materials, either everything is related to a reference value (kilo of materials of a given product, etc.) or a conversion coefficient is used, such as a nomenclature with the actual costs or standard costs if the materials entering into the same order do not belong to the same technical family. When the precise production time is known, it may be used as a calculation base, with the hour of production assimilated to one point. The cost of the point is calculated by dividing the total costs by the total number of points. As we know the number of points allotted to a given production, the cost of this production is therefore equal to the cost of the point multiplied by the number of points consumed by this production.

[17] Quoted by Lauzel (1973, p.133).

The division used here is finer than the section. It is the production workstation to which the cost of the point is related: the work unit being the hour of production. To be added to the production cost thus determined are the general overheads budgeted, which are reduced to a budgeted hourly cost.

The stability of this method is based on the principle of the stability of constant ratios:

"If we take the cost of the hour of work of a section as a reference for comparison, the ratios of the hourly costs of other sections compared to this basis will remain invariable constants so long as the industrial processes and plant of the factory are not replaced or greatly modified. The whole system is based on the constancy of the ranking of these ratios, but this constancy remains even in the case of monetary variations…. There results a ranking of ratios between the various products which will only change if the production methods are changed". (Thibert, 1952, p. 20).

4.3 The GP method

The GP method was invented by Georges Perrin[18]. Instead of seeking the best possible breakdown and considering that only the total costs of a company can be calculated without any ambiguity, he changed the angle on the problem by modelling it as a company producing only a single product.

This unificaction was achieved by determining the *"production effort"* that represents all direct and indirect production efforts necessary to manufacture the product. Irrespective of the products manufactured or method used to manufacture them, this concept is homogeneous in that the unit chosen to measure the production effort is the GP. Its choice is arbitrary and conventional, as it has no impact on costing. It could represent a paticular machine or given part which will be designated the "base article". The method determines how much resources each workstation consumes under the usual operating conditions (aiming at a standard cost), while the workstation is defined as "a set of material and human resources necessary for realizing an operation".

Overheads (consumption of direct resources) are thus attributed to each workstation per unit of work, that is a direct unit cost excluding purchases incorporated into the products and expenses specific to a customer, which the authors of this paper still call a "post rate".

[18] Born 6 November 1891. Educated at the école Centrale. During World War II, he withdrew to his property, the château de Chéronvilliers, in the Eure department. Georges Perrin took advantage of this period to formalize his method for determining industrial costs, the "GP method". For a more detailed biography, see: Levant et de la Villarmois, 2004).

The workstation costs are then expressed in GPs. A post index is calculated for each workstation, representing the ratio of its consumption of resources to that of the base process (of the unit of value added). The post index is therefore equal to the post rate divided by the "base rate".

The cost of the various processes is also estimated then expressed in GP, a process being a specific utilization of the various workstations (operating route). The various products and processes are then themselves calculated in terms of GP, according to their consumption of the processes. All the activities of the company are thus measured in GPs[19].

The "value added cost" of any product can therefore be calculated at any time. It is equal to the GP cost multiplied by the number of production GP of the process, expressed in GP equivalents. The cost of an article is calculated by the sum of the materials incorporated into the products sold, the expenses specific to a customer and the value added costs concerning the article.

The GP method was first disseminated by the practice set up by G Perrin in 1945, and after 1975, by the LIA practice, firstly under the name UP method and since 1995, under the name of the UVA method. Numerous articles about the method were published in specialist magazines by G. Perrin up until his death in 1958, then by his wife S Perrin who, with the publisher Dunod, took care of putting out the posthumous work by Georges Perrin entitled "costing and control using the GP method " (Perrin, 1962). The GP method enjoyed limited success however. Around 150 to 200 "GP" applications were put in place [in France], 60 of which were during G. Perrin's lifetime. Other applications were recorded outside of France, in Great Britain, Belgium, Brazil, Italy, Morocco, West Germany, Switzerland and the USA.

Again during this period, we find references to level 1 equivalence methods in specialist literature (see for example: CNPF, 1957 ; CEGOS, undated) and academic works (see for example: Martin, 1952 and Thibert ,1951-1952).

[19] The UVA cost is established for each period. This is determined from all the charges entered into the accounts for the period. If C is the amount of charges in the accounts, A the amount of purchases incorporated into the products, D the amount of customer-specific expenses and Q_{uva} the production of UVA in the period, we obtain: *UVA cost* = $\frac{C-(A+D)}{Q_{UVA}}$.

Conclusion

First of all a method based on simple common sense in the 19th century when it was necessary to reduce a diversity of products to a single reference for the sake of economic reasoning, equivalence methods developed in the early 20th century to attain a second level which reduced the number of centres of analysis, or *cost centres*, and simplified the job of accounting. It was only after the 1950's that autonomous methods appeared, with limited success however (Levant and de la Villarmois, 2007).

Although some traces remain of simplified methods, a parallel may be drawn between the increasing complexity of the equivalence methods and the development of costing methods as observed by us. The main trend is unquestionably that of increasing complexity, but it is punctuated by periods during which variants were proposed, methods of equivalence aiming to simplify the recent innovations. In reality, this pattern corresponds to the changes dictated by economic needs. We have seen that other causes were instrumental in these changes. We thus revealed the respective impacts of a corporate factor and then of an ideological factor.

Does this pattern also remain valid for other countries? It would be interesting to explore this question for the USA in particular, especially that level two equivalence methods appeared there in the early 20th century, when hourly rate methods were being developed, which we have seen to be making a come-back with the TD ABC further to the dissemination of the ABC method in the 1990's. A possible area of research would be to seek the parallels that may have existed between the standard cost methods that appeared in the USA beween 1900 and 1920 and the *cost number* method proposed by Taylor, or the method of equivalence developed by Webner.

Finally, for France, we need to explore further the development during the inter-war period of the concept of homogeneous sections, and its relation to equivalence methods.

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