Implementing the Gantt chart in Europe and Britain: the contributions of Wallace Clark

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Abstract

Purpose – The purpose of this paper is to trace the European and British activities of Wallace Clark and his consulting firm with public sector agencies and private firms implement Henry L. Gantt's chart concept.

Design/methodology/approach – Archival records and secondary sources in English and French.

Findings – Developed to meet the shipbuilding and use needs for the Great War (World War I), the Gantt chart was disseminated through the work of Wallace Clark during the 1930s in numerous public sector and private organizations in 12 nations. The Gantt concept was applied in a variety of industries and firms using batch, continuous processing and/or sub-assembly lines in mass production. Traditional scientific management techniques were expanded for general management, such as financial requirement through budgetary control. Clark and his consulting firm were responsible for implementing a managerial tool, the Gantt chart, in an international setting.

Research limitations/implications – Some firms with which Clark consulted could not be identified because the original records of the Wallace Clark Company were disposed of by New York University archival authorities. Industries were identified from the writings of Pearl Clark and Wallace Clark, and some private or public organizations were discerned from archival work and the research of French and British scholars.

Originality/value – This is the first study of the diffusion of a managerial tool, developed in America by Henry L. Gantt, into Europe and Britain through the contributions of Wallace Clark.

Keywords Scientific management, Management consulting, Budgetary control, Gantt chart, Henry L. Gantt, Wallace Clark

Paper type Research paper

Whereas the transfer of technology across national boundaries can be traced through licensing agreements, patent records and other means, documentation of the diffusion of ideas is more problematic. Publications through books and journals, professional conferences and international scholarly associations are familiar means of transferring and exchanging ideas. The role of consultants in the spread of management concepts and techniques, however, is typically neglected in management history and provide another way to examine how ideas are adopted, refined and/or implemented in management practice in an international environment. My purpose is to examine how

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one managerial tool, the Gantt chart, influenced the practice of management in Britain and Europe through the work of Wallace Clark.

Management consulting, in current parlance, grew out of industrial engineering rather than traditional business disciplines. Henry Towne's seminal presentation before the American Society of Mechanical Engineers (ASMEs) called for engineers to be "economists" in the utilization of human and physical resources (Towne, 1886). For Towne, shop management and accounting were neglected but as important as engineering subjects for study. Frederick Taylor was one who responded to Towne's message and his *shop management* asked engineers to improve manufacturing shop practices through time and motion studies, setting performance standards, incentive plans, employee selection and finding standard costs (Taylor, 1903). Taylor's work was later called "scientific management" and a band of followers gathered, among them was Henry L. Gantt.

Henry Laurence Gantt

Henry L. Gantt received his bachelor's degree from Johns Hopkins University and taught at a preparatory school, McDonogh, before attending the Stevens Institute of Technology, Taylor's *alma mater*, for his mechanical engineering degree. Employed at Midvale Steel, Gantt met Frederick Taylor and worked closely with him at Midvale, Simonds Rolling Machine Company and Bethlehem Steel. Gantt was one of "Taylor's strongest supporters in the scientific management movement" (Petersen, 1991, p. 134).

In 1901, Gantt opened his office as a consulting industrial engineer and installed scientific management in numerous firms in the 1900s and 1910s. Nelson identified 29 firms that employed Gantt and other consultants considered "Taylor's closest followers" to implement scientific management and found "individual specialization within an overall conformity to Taylor's ideas" (Nelson, 1974, p. 500). Each consultant had a special interest he emphasized in his work – for example, Carl Barth stressed improved machine methods, Frank Gilbreth worker motions and materials movement and Gantt his task and bonus incentive system. Taylor's functional foreman idea, with its specialization of oversight duties and not coordination, was not an idea that was implemented, but, with individual exceptions, there was a general adherence to Taylor's ideas.

Fundamental to task and scientific management is setting a performance standard. Gantt's task and bonus system required him to define a task so as to determine if a bonus was appropriate. As a former educator, Gantt knew the importance of illustrations and began using horizontal bars to portray the progress of workers toward performance standards with respect to earning a bonus. Records were kept whether a worker's production merited a bonus, shown by a black horizontal bar, or did not, a bar drawn in red. This provided performance feedback to supervisors and workers about how well they were doing and what remedial action, such as further training, might be appropriate.

Without the psychological trimmings, Gantt was on the cusp of what became the "goal-setting theory" of motivation (Locke and Latham, 1990). Performance standards were the targets or goals for purposefully directed action in task accomplishment; checkpoints provided the means of measuring progress toward goals, enabling supervisors and workers to gauge results, and this information could suggest corrective action for employees or managers. Gantt's bonus for successfully meeting performance

standards was the incentive for accomplishing the task. For his time, Gantt's insights into human behavior and motivation were remarkably prescient.

Gantt's ideas for progress and performance charts expanded to include planning and measuring daily machine output, idle machine costs, production costs and other areas important to productive performance (Petersen, 1991, pp. 134-142). His ideas about shop level management, setting standards and depicting progress and performance would be challenged in his consulting assignment for the US Army and the Emergency Fleet Corporation.

H.L. Gantt and the Great War

The Great War began in 1914, but the USA did not become a combatant until 1917, and lagging munitions production created an opportunity for Gantt to become a consultant to the US Army. Working with General John T. Thompson at the Frankford Arsenal, Gantt developed a means of scheduling and coordinating munitions production and supply between private contactors and federal arsenals. Gantt began to realize *time* as a more important factor for the arsenal, suppliers and Army than dollars or units of production. He proclaimed to his friend Professor Joseph Roe "We have been wrong scheduling on the basis of *quantities*. The essential element in the situation is *time*, and this should be the basis in laying out any program" (Alford, 1934, p. 207). Success with his work in the federal arsenals led to an opportunity to be a consultant to the newly created Emergency Fleet Corporation.

In 1917, German submarines were sinking or damaging two and one-half times the number of ships the USA and Great Britain were building. The Emergency Fleet Corporation's goal was to increase shipbuilding to overcome this shortfall, and it asked Gantt to assist in planning and coordinating the efforts of the various shipbuilding yards. Gantt found the number of "rivets driven" to be a common denominator to measure and compare performance in different shipyards; rivets driven as a standard could be applied to any vessel being constructed regardless of size or purpose. Working with fellow consultants Harrington Emerson and Walter Polakov, Gantt's charting of shipbuilding led to an outpouring of 1,284 launchings of newly built ships from 341 shipyards and the work of 3,50,000 shipyard workers (Alford, 1934, p. 199). This expansion of the fleet and its capacity to move more materiel and personnel was a boon to the allied war effort.

Charting the ocean: the USA shipping board

Once built, these ships had to become operational to deliver equipment, personnel and supplies, and this became the assignment of the US Shipping Board. As newly constructed vessels became available, previous methods for scheduling ports and destinations were unsuccessful. Alford recalled:

> The handling of this large and ever-growing fleet was a stupendous task – probably the most difficult problem which had ever arisen in the shipping world […]. The old plan of tracking ships by sticking pins and flags on large maps was tried […] but it was so cumbersome that it was impossible to follow the movements of even coastwise vessels. The most serious limitation of this (pins and flags) system was that it did not take any account of time (Alford, 1934, p. 200).

Gantt selected a member of his consulting firm, Wallace Clark, to address this "stupendous task". Clark had capably assisted General Thompson at the Frankford

Arsenal, and Gantt designated him as Director of the Scheduling Section of the US Shipping Board. Clark told an ASME audience of his task:

> The problem was to get troops to France and to bring to the USA food and raw materials. The US Army did the former and the Shipping Board accomplished the latter. This board had first ascertained what was needed at given times. Then it had listed its ships which aggregated about 12,000, and it was here the [Gantt] efficiency chart was of such service, inasmuch as it afforded a graphical record showing in all required detail the daily movement of every ship, and made it possible to estimate beforehand the available carrying capacity in any direction for several months ahead (Clark, 1918, p. 803).

Clark's referral to Gantt's graphical method as an "efficiency chart" reflects Gantt's "modesty" and never referring to his contribution as a Gantt chart (Petersen, 1991, p. 140).

Accounting for time posed a problem for a shipping fleet of diverse capacities, purpose and costs per hour of operation. Gantt set "ship hour" as a standard to study ship activity/inactivity. Results of this study led to improved port procedures for loading and unloading, for re-coaling and maintenance and repair. These improvements reduced inactive ship hours from four to two weeks (Alford, 1934, p. 201). With increased time at sea, more efficient scheduling was needed. Henry van Riper Scheel, a member of Clark's scheduling section, recalled:

> Wallace Clark effected tremendous savings by the application of graphical planning and scheduling procedures to the operation of ships and a graphics chart system which I [Scheel] devised, installed, and for months supervised [and] was soon reporting at daily or weekly intervals what every hatch of every ship in every world port was doing every hour of the day or night (Scheel, 1961, p. 221).

Gantt's development of a method of determining and displaying progress toward a goal was a contribution to the managerial tool-kit that went far beyond an application to shop-level practice. Introducing time as critical in improving scheduling and coordinating efforts during the Great War opened a new technique for managerial planning and controlling. Henry L. Gantt's death in 1919 precluded his further work – that would be the contribution of Wallace Clark.

Wallace Clark

Clark's (1922) *The Gantt Chart: A Working Tool of Management* and subsequent translations earned him recognition as a management pioneer. He was born as Henry Wallace Clark on July 27, 1880 in Cincinnati, Ohio, the son of William Allen Clark and Mary Rankin Clark, and graduated from the University of Cincinnati in 1902 with an AB in economics and sociology (Clark, 1957, p. 2). He was employed by the Remington Typewriter Company in its Manila and Hong Kong offices, resigned for a position at the export–import company of H. W. Peabody, then returned to the USA to work for Cincinnati's Lodge and Shipley Machine Tool Company (Thompson, 1926, preface). In 1907, Clark rejoined Remington Typewriter in its New York City headquarters as head of the central office staff and assistant to the president.

In 1910, Remington asked Henry L. Gantt to streamline work in its five factories and later its central office in New York. Improving the central office created the opportunity for Gantt and Clark to work together and, subsequently, for Gantt to ask Clark to become a member of his consulting practice in 1917. Clark had been attending night classes in

industrial management at New York University and recalled what it was like to be a member of Gantt's team:

> Gantt was an ideal teacher and was able to bring out the best in his men. He was never completely satisfied with anything we did, always making feel that we could have done better […]. None of his criticisms was personal, but always grew out of the work which needed to be done […]. If we did not finish at the office he would ask us to go out to Montclair [Gantt's home in New Jersey] for the evening or for over Sunday, we would continue the discussion there until everyone but Gantt was exhausted (quoted in Alford, 1934, pp. 156-157).

Gantt's confidence in Clark's work led to increasing responsibilities, including his assignment to work with General Thompson at the Frankford Arsenal and placing Clark in charge of scheduling for the US Shipping Board.

After the Great War

An armistice November 11, 1918 ended the war, and Gantt returned to his consulting practice. Clark continued with the firm until Gantt's death on November 23, 1919. Clark wrote frequently about the Gantt technique, its installation, benefits, etc., soon establishing himself as a leading spokesperson for Gantt's work (Clark, 1920; Clark, 1921a, 1921b). His recognition as a Gantt proponent and experience during the war with Gantt's bar charts for planning and controlling and office management led to the formation of Wallace Clark and Company, "consulting management engineers", in 1920 in New York City. Herbert Hoover, then Secretary of Commerce, employed Clark's firm to investigate the operation of the US Patent Office; then, Clark was appointed to a commission to organize a proposed Federal Department of Public Works (Clark, 1931, p. 1).

Leon P. Alford, editor of prominent management engineering journals and Gantt's friend, asked Clark to publish a book about Gantt's work and its benefits. *The Gantt Chart: A Working Tool for Management* (Clark, 1922) was a positive breakthrough in management's ability to plan and control:

> The Gantt Chart, because of its presentation of facts in relation to time, is the most valuable contribution to the art of management in this generation […] [It] makes it necessary to have a plan […] compares what was done with what was planned […] emphasizes the reason why performance falls short of the plan and thus fixes responsibility for the success or failure of the plan […] visualizes the passing of time and helps reduce idleness and waste of time […] [and] presents facts in their relation to time and is, therefore, dynamic (Clark, 1922, pp. 3-5).

He emphasized that "the principles of the Gantt chart can be applied to any human activity, but up to the present […] most extensively to industrial production". There were three general categories of charts and their purpose as follows:

- Man and machine charts for comparing what could be done for comparing with what was accomplished.
- Layout and load charts to establish priorities for activities and to visualize the work ahead.
- Progress charts to compare planned with actual performance by products, budgets, expenses, sales, etc. (Clark, 1922, p. 17).

The book was a primer in how to draw a chart and how it could be used, including a chapter by a practicing manager how his organization applied it in tracking sales performance.

It became a world-wide success, created an international awareness of Gantt's contribution and the Russian government reportedly published 1,00,000 copies for its managers (Wren, 1980, p. 2). *The Gantt Chart* reached an audience beyond traditional scientific management's objectives. It marked a new era in management techniques useful to different forms of organization and adaptations to different needs. Henry Gantt never referred to his product as a Gantt chart, but that phrase would bring him international acclaim.

The Kemmerer Commission

Professor Edwin W. Kemmerer, an expert in international finance, headed a 1926 mission to study the Polish economy when it gained its post-war independence. Among the tax, banking, accounting and economic experts on the commission was Wallace Clark, a "management engineer" (Clark, 1927a, 1927b, p. 309). Clark's task was to assess the operation of state-owned monopolies in salt, alcohol and tobacco, significant sources of national revenue. Alcohol production was closed, awaiting the potato harvest, so it could not be studied. He reported salt mining and processing had unused capacity with three mines and six processing facilities. Records of production and costs were not maintained, so management received no performance results. Clark noted that a state monopoly had no incentive to perform efficiently or to keep records, but the government must recognize the scale of production exceeded the scope of the market in a nation the size of New England, New York and Pennsylvania combined. He recommended Polish authorities restrict production or expand sales to other nations – but salt was a cheap commodity. His comments about the tobacco monopoly were similar about record keeping, lack of managerial control and excess capacity.

Clark was asked to visit other Polish firms in a variety of industries – coal, cotton, nitrates, steel, etc. He reported that the main issues were inadequate working capital, lack of modern equipment and the need for improved information and control. Five plants were using Gantt charts "to good advantage", education for scientific management was advancing and:

> Management engineers have turned their attention to the more difficult task of simplifying the methods of plants which manufacture to order or produce a variety of goods in small quantities. It is these methods which are most applicable to Polish plants (Clark, 1927a, p. 311).

The Kemmerer Commission returned to the USA in February 1927, and Clark returned to his practice, but not for long.

Karol Adamiecki's "Harmonograph" and work in Poland

Clark's opportunity to implement his recommendations came when Poland's Minister of Finance, Zeslaw Klarner, invited him to return in 1927 to "Americanize" the state monopolies and industry. Poland had made advances in scientific management because of the work of Karol Adamiecki, "Poland's Taylor". Adamiecki pioneered scientific management education in Poland and his Institute for Scientific Management translated and published Clark's *The Gantt Chart* in 1925. Clark and Adamiecki met in 1926 during Clark's work for the Kemmerer Commission, and they found shared interests in the similarities between Gantt's graphics and earlier work by Adamiecki.

Adamiecki developed a graphical method of planning and coordinating work in 1896 called a "harmonograph". His paper "Harmonization as One of the Chief Cornerstones of Scientific Management" was presented at the First International Congress on Scientific

Management held in Prague in 1924 (Mihalasky, 1996, pp. 150-151). The harmonograph used strips of paper to identify operations necessary for the planning and harmonization of workers in a group effort. It had elements of Gantt's method, but depicted them differently. For instance, the harmonograph put operations on the horizontal axis and time on the vertical one, the reverse of a Gantt chart. Mee reported the harmonograph more closely resembled a program evaluation and review technique network (Mee, 1962, pp. 28-29).

Remaining Clark correspondence at New York University is not about Gantt's graphical technique but Gantt's position that banks should loan money based on firm's efficiency, not assets (Adamiecki to Clark, March 23, 1927; Clark to Adamiecki May 17, 1927). Adamiecki died in 1933 and his work was not translated into English until 1948 by one of his followers, Zygmunt Zbichorski. Zbichorski corresponded with Wallace Clark until Clark's death in 1948 (Mihalasky, 1996, p. 152).

Adamiecki may have furthered Clark's professional visibility by encouraging his participation in groups promoting scientific management in Europe. In 1927, Clark was appointed scientific management advisor to the International Labor Office, (Adamiecki was a member), named Scientific Management Representative to the International Management Institute (IMI) when Adamiecki was on its Board of Directors and joined the *Comité Internationale de l'Organisation Scientifique* (CIOS), frequently attended by Adamiecki, a CIOS Vice President. Adamiecki, then Zbichorski, worked with Clark to further Gantt's charts and scientific management in Poland and Central Europe.

Wallace Clark et Compagnie: organisation-conseilleurs

When Wallace Clark opened his consulting office in 1927 at Rue de Jean Goujon No. 8 in Paris' eighth arrondissement, he was not the first American to see opportunities for using his knowledge to improve productivity in European industries. C. Bertrand Thompson, former Harvard Professor who had received a consulting assignment from Taylor, opened a consulting practice in Paris after the Great War. He had consulted with the French munitions industry during the war and continued his work afterward. Thompson had a successful practice with his "Taylor-Thompson" adaptation of scientific management to meet the needs of industry in France and other countries (Wren *et al.*, 2015).

Thompson and Clark had separate offices in Paris but apparently knew each other well enough for Thompson to write a biographical sketch of Clark for the preface of the French translation of *The Gantt Chart*. Both were products of two scientific management luminaries, Taylor and Gantt, but offered different advice to their clients. Thompson's work followed more closely Taylor's shop management approach with cultural and economic modifications, whereas Clark offered Gantt's methods that were applicable to and beyond the production floor. Clark and Thompson were the only individuals from mainstream scientific management to maintain management consulting offices and professional staffs in Europe and Great Britain during this period of time[1].

In 1927 and 1928, Clark applied Gantt's charts to Poland's salt monopoly to improve drilling, storage and transportation; to the tobacco monopoly to track sales against sales quotas and balance purchases with sales; in Warsaw's Municipal Tramway Company's repair shop; in a copper rolling mill; and for a manufacturer of railway passenger and freight cars. Further assignments developed in Polish and German "industries

producing cellulose pulp, paper, textiles, lumber, industrial machinery, steel, and iron" (Clark, 1930a, 1930b, p. 189). As his practice expanded, he hired English-speaking engineers who were native to the country in which they were working and familiar with the customs, laws and work practices of their country. They learned the Gantt chart technique and were interpreters for on site workers or managers. When asked if he did not speak Polish or the language of any country in which he was working, he responded: "On the contrary, I find that when things have to be translated, only the essential things are said. This eliminates a great waste of talk and time" (Clark, 1930a, 1930b, p. 190). "Waste", the bane of efficiency engineers, could also be found in words and conferences.

Budgetary control developments

America's stock market crash in October 1929 led to a world-wide economic crisis calling for firms to improve efficiency and overall performance with means beyond shop management solutions. Cost accounting, part of Taylor's repertoire and a frequent subject in the scientific management literature, did not provide for broader financial and capital accounting for firms such as what could be achieved through budgetary methods. Economic hard times called for an understanding and practice of financial planning and control beyond costs. In response, Lyndall Urwick, Director of The IMI, organized a conference on budgetary control in Geneva in July 1930 (IIOST, 1930). The conference attracted an international audience of academics, governmental officials, business practitioners and management consultants. McKinsey (1922), founder of the eponymous consulting firm and author of a pioneering book on budgetary control, was unable to attend, but Lyndall Urwick read his paper on budgeting as an aid to determining policy. Harold Vinton Coes, former ASME President and partner in Ford, Bacon and Davis Consultants, was unable to attend, but Wallace Clark read his paper regarding overcoming opposition when introducing budgetary control. Other papers treated various facets of budgeting, forecasting, responsibility for budgetary control and concluded with sessions for industry groups to form for future exchanges of ideas. Berland observed that the Geneva conference was "when budgetary control took off in France, even if the technique was not totally unheard of, and had its origins, in the 1920s" (Berland, 1998a, 1998b, p. 305).

Budgets have a long history and are statements of financial plans allocating financial resources to departments and activities. A budget is often the authority to spend and may or may not have any consequences for accountability. Budgetary control extends budgets by financial planning through periodic checks on performance to compare actual with planned progress and determining where, when and if corrective actions are necessary. Budgetary control enables locating accountability for the use or misuse of a firm's financial resources. Henry L. Gantt's graphical approach to displaying plans, checking progress through the performance period and making corrections if and as needed was as amenable to financial matters, as it was to manufacturing and selling (Clark, 1924, 1925).

Budgetary control was practiced in America; for example, Alfred Sloan emphasized General Motors' multidivisional organization would not have been possible without control through financial measures of performance (Sloan, 1964, Chapter. 8). McKinsey's (1922) seminal book on budgetary control was another landmark. "In France, before 1930 (however), budgetary control was the object of only a few scattered studies" (Satet, 1936, p. 4). French scholars credit Wallace Clark with introducing planning and

budgetary control in France as a proposed means to improve profitability during the depression (Moutet, 1997, pp. 261-264; Berland, 1997, p. 6).

This research has extended Clark's work to other nations indicating a much broader international influence for the work of Henry L. Gantt (Table I). Gantt's progress and performance charts provided graphics for planning, monitoring and controlling production, sales, materials inventory, staffing and financial budgets. Shop management tools such as cost accounting were inadequate for the vagaries of the market in forecasting sales, adjusting inventories, planning production and other decisions that required integration and coordination throughout the firm in dire economic times such as the 1930s.

Clark's firm in France

Clark's firm had notable clients in France, and results of its work are apparent in some instances (Table I). AFC-Pechiney was a major non-ferrous metals, primarily aluminum and chemical producer in France. A decline in aluminum prices began in 1929, before the

Austria
Automobile manufacturing

Belgium
Merger of chemical firms

Britain
Chocolate
(Rowntree?)
Foundries
Machine tools
Steel castings and alloys
(Hadfields Ltd.)

Denmark
Textile spinning

France
Agricultural machinery
(Société de Gouvy)
Aircraft engines
(Renault)
Aluminum
(AFC-Pechiney)
Automobile manufacturing
(Renault)

France (continued)
Coal mining
(Compagnie des mines de Vicoignes-Noeux-Drocourt)
Iron and steel
(Aciéres de Pompey)
(Aciéres d'Ugines)
Machine tools
(Emidecau)
Photographic film & equipment
(Kodak-Pathé de Chatou)
Printing and publishing
Shipyards
(Saint-Nazaire-Penhoët)
Textiles
(Schlumberger de Mulhouse)
(Kiener de Colmar)

Germany
Iron and steel
Lumber
Textiles

Italy
Rubber
Textiles

Poland
Copper and brass rolling mill
Iron mine
Paper, pulp and cellulose
Rail equipment
(Lilpop, Rau and Lowenstein)
Salt and tobacco
(State-owned)
Tramways maintenance shop

Roumania
Salt and tobacco
(State-owned)

Scotland
Machine tools

Switzerland
Aluminum foil
Alarm clocks
Knitting machines

Turkey
Matches, salt, spirits and tobacco (State-owned)

Notes: [a] A New York University archivist "disposed of" the 108 client files of Wallace Clark's consulting firm in 1986 (Alison Lotto, New York University, to author February 8, 2013). Consequently, it became necessary to reconstruct a partial list for Europe and Great Britain from the writing of Pearl Clark and Wallace Clark, personal investigation and the findings of the following scholars: Berland (1998b, p. 312), Berland (1997, p. 7), Cailluet (1998, p. 195), Champsaur and Cailluet (2010), Clark (1957, pp. 101-102), Clark (1930a, 1930b, p. 189), Clark (1931, p. 3, p. 53), Lewis *et al.* (2011, pp. 89-92), Moutet (1987, p. 1064, p. 1068), Moutet (1997, pp. 212-214, pp. 262-268, p. 288) and Satet (1936), appendices B & C.

Table I. Consulting assignments of Wallace Clark's firm in Europe and Great Britain, 1927-1939: states, products and firms (if known)[a]

Depression, and Pechiney responded by closing smaller, less efficient and obsolete plants. Needing further efficiencies, Clark's firm was employed to begin improving the maintenance shops at L'Argentière aluminum plant in the French Alps. The electrochemical processes used in manufacturing often caused machine failure, creating unexpected delays and the retention of large inventories of "just-in-case" replacement parts. Working with Jean Benoit, Managing Director of the plant and an advocate of scientific management, Clark and his associates established a preventive maintenance program "reducing considerably the volume of replacement parts and their heterogeneity" (Cailluet, 2012, p. 85). Clark's firm continued working with Pechiney until 1933 and established production cost controls, budgetary controls and inventory management procedures that "were extended between 1930 and 1934 to all electro-metallurgy plants […] with spectacular results "(Champsaur and Cailluet, 2010, p. 11)[2].

Ford Motor's development of the automobile assembly line became a competitive threat to the French auto industry. Ford built a manufacturing plant in Manchester, England, in 1911, and products from its assembly plants in Bordeaux (1913) and later at Asnières France were selling and gaining market share despite the passage of a protective tariff and taxes by the French Government. French automobile manufacturers were small-scale producers that relied on craft workers to produce components to be conveyed to work stations for assembly, a slow and costly process. For example, the Peugeot factory at Lille France made two cars per day using batch production (Laux, 1992, p. 80). Batch production was also used at Hotchkiss Motors, using Gantt progress charts for planning and monitoring ordering and receipt of "rough castings and forgings" to be machined for automobile parts and layout charts to schedule and monitor the machine work (Héranger, 1924, p. 308).

French firms saw Ford's competitive advantage and responded with assembly lines at Citroën (1919), Berliet (1920), Renault (1922), Peugeot (1923), Hotchkiss (1924-1925), Delage (1926) and Chenard and Walker (1927) (Kogut and Parkinson, 1993, pp. 179-202; Moutet, 1997, p. 112). By 1925, only Berliet and the Ford-France plant at Asnières had installed assembly lines to control the flow of components to final assembly (Moutet, 1997, p. 112).

In 1930, Renault employed Clark's firm to improve its assembly line at its Billancourt factory. Renault, "the largest automobile firm in France", according to Clark, was also a widely diversified firm manufacturing tanks, aircraft engines, tractors and railroad cars. Earlier, Clark had published articles explaining how Gantt charting could be used on "feeder lines", the sub-assembly lines of components to be added to the chassis when the flow of the main line arrived (Clark, 1927a, 1927b). Each component had to be planned to insure it arrived at the right place at the right time. At Renault, Clark found a unique application of Gantt charts in planning work on the sub-assembly line, monitoring its progress and controlling it as the component was added to the chassis. This enabled parts to arrive just in time and not constrain the flow of the main assembly.

Clark's firm introduced Gantt charting to Renault's automobile and aircraft engine assembly lines and Moutet found Renault used "graphs to report to production chiefs to check their respective areas of responsibility" (Moutet, 1997, p. 285). Renault was an exception, perhaps due to Clark's work, but Moutet studied twelve firms, automobile and others that attempted assembly line manufacturing for which "an adequate description of the methods used were available" and concluded planning as Gantt

charting required was "rarely used" (Moutet, 1997, p. 285). Renault was a notable exception in its industry in coupling a new technology, the assembly line, with an effective managerial tool, the Gantt chart, to gain a competitive advantage.

Aimée Moutet credits Wallace Clark with pioneering the planning concept for industries producing in shorter series, batches, of similar but varying types, such as textiles. Clark wrote of using Gantt charting as a means of improved performance in textile firms when an assembly line was inappropriate (Clark, 1930a, 1930b). In 1932-1933, the textile firm of Schlumberger and Company of Mulhouse France engaged Clark's firm to install a system of planning to prepare machines, materials and employees in advance of beginning a production run. Planning at Schlumberger enabled a reduction in inventory by having the right quantity and quality of cotton at the appropriate time, less idle time through production planning and preventive maintenance of the looms, and "possibilities for profit from these presented advantages, especially in time of crisis (i.e. the depression), for continuity and flexibility of fabrication" (Moutet, 1997, p. 288).

Other consulting assignments in France were numerous. Pearl Clark wrote that her husband's firm consulted in the Saint-Nazaire-Penhoët shipyard that built the cruise liner, Normandie, at that time the world's largest and fastest ship. Monsieur Coqueret described Clark's work as step-by-step graphics for planning, progress reports and measures taken to "éviter les retards" avoid delays (Satet, 1936, Table I, p. Chapter 2). A budgetary control system was introduced at Kodak-Pathé's film and photographic equipment manufacturing plant of Chatou France (Moutet, 1997, p. 261). Adam Kiener's woolen products firm of Colmar France was able to avoid bank foreclosure by finding economies through budgetary control (Moutet, 1997, p. 262).

Monsieur Jean Soulé described Clark's work at the Mining Company of Vicoignes, Noeux and Drocourt at Noeux-les-Mines in Nord-Pas-de-Calais as cost determination, reduced overtime hours, inventory control of supplies, real time control of performance and providing a basis for long range planning (Satet, 1936, Table I, p. C-1). The Workshops, Forges and Steelworks d'Ugine were also clients (Berland, 1998a, 1998b, p. 312). Clark's work in France was substantial and a colleague and translator of his works, Thérése Leroy, considered Clark's application of Gantt's charts in France "the most outstanding contribution to the art of organization made by the previous generation" (Leroy, 1948, p. 42).

In Britain

Wallace Clark and Company had an office in London, but relatively little is known about its clientele, particularly in comparison with our knowledge of its work in France. Table I lists "chocolate" among the industries Clark cites for his work in Britain, and it is likely that it was Rowntree and Company, not Cadbury, because Seebohm Rowntree and Lyndall Urwick were "actively engaged" in promoting budgetary control in Great Britain (Berland and Boyns, 2002, p. 335, p. 345). Clark attended a conference organized by Urwick and Rowntree, perhaps one of the Oxford Management Conferences (Briggs, 1961, p. 183). Our understanding of Clark's work in Britain is limited and calls for further research.

A in-depth case study by the British scholars Lewis, Lloyd-Jones, Maltby and Matthews reveals Clark's work with Hadfields, a Sheffield manufacturer of steel castings, alloys, industrial machinery and armaments. Hadfields was under the

personal control of Robert A. Hadfield, son of the founder. In 1934, the firm was losing contracts steadily, and A. Roebuck, a director of Hadfields, proposed an outside consultant for advice: "Nothing but good and improvement would arise from a thorough overhaul of our present methods" (Lewis *et al.*, 2011, p. 90). The board hesitated and Roebuck took matters in hand and traveled to France, seeking recommendations. He visited two firms and found positive reports of Clark's firm and its successes that enabled a turnaround of the firms' performance. Roebuck reported to the board he was convinced Clark's methods represented the "best practices" of management.

Hadfields's problems were outlined for Clark as a lack of cost control, low product quality, a congested factory workspace, idle machinery, absence of accounting for overhead expenses and inadequate production records. Clark's firm spent one year studying Hadfields's operations and recommended "new management methods" for planning, measuring progress, maintaining production records, inventory control, cost keeping, budgetary control and executive direction (Lewis *et al.*, 2011, p. 90). Hadfields was charged £10,500 for this year of work.

Subsequently, the Hadfields's board notified Clark that implementing his ideas would "seriously affect production during the period of installation […] [and] the directors were unable at present to undertake any risk" of changes in production (Lewis *et al.*, 2011, p. 91). Rejecting the services of Clark's firm seemed the right thing to do as orders for steel products and armaments increased in the late 1930s as the threat of war in Europe increased. The firm's success was short lived and Hadfields's inefficiencies reappeared, and the management consulting firm of Urwick, Orr and Partners was employed in 1944. Urwick, Orr and Partners' report disclosed the same inadequate management, poor organization and over-burdened senior executives whose span of control was too wide. This report was also ignored, and after World War II, Hadfields was nationalized under Britain's Iron and Steel Act of 1951.

Lewis and his colleagues point to Hadfields as supporting evidence for Alfred D. Chandler's conclusion that British industry was "personal capitalism" because of its failure to build organizational capabilities in manufacturing and marketing, the late emergence of managerial hierarchies and the slow separation of management and control (Chandler, 1990, p. 12, p. 240, p. 392). From his experience, Wallace Clark would have concurred regarding personal control from the top and a culture that resisted change as his lessons learned from Hadfields. Whether this British style of personal capitalism dampened enthusiasm for employing Clark's firm in Britain is a matter for further study.

In Poland

Clark's participation in the Kemmerer Commission provided entrée to Polish industry and his subsequent return to Europe. Table I indicates his further study of the state monopolies in salt and tobacco, metals and pulp and paper. His work with the Warsaw Tram service involved scheduling and controlling the maintenance of all equipment, and Lilpop, Rau and Löwenstein applied graphical methods to manufacture freight and passenger cars for railroads. Discussed earlier, Clark's relationship with Karol Adamiecki, a Polish pioneer in scientific management, was established during these years and maintained through Adamiecki's follower, Zbichorski. Thompson reported "Mr Wallace Clark installed the Gantt charts in

many Polish concerns" (Thompson, 1940, p. 174). Locating these efforts indicates the need to understand more deeply the role of scientific management in Poland.

In Germany

The Germans took a nationalistic approach to scientific management by creating the *Reichskuratorium für Wirtschaftlichkeit* (RKW) in 1921 (Shearer, 1997). Through the efforts of steel manufacturer Carl Friedrich von Siemens and his colleague, Carl Köttgen, the state-funded RKW, was a clearinghouse for German academic or industry specialists to study and promote industrial economy and efficiency during the interwar years of the Weimar Republic. American ideas from Henry Ford and Frederick W. Taylor were to be emphasized, although Thompson found Frank B. Gilbreth achieved greater recognition and "the [Taylor] System generally identified with time and motion studies" (Thompson, 1940, p. 172).

Bertrand Thompson refused a consulting assignment at the *Allgemeine Elektrizitäts Gesellschaft* (General Electric Company) because German labor law prohibited premium pay for performance (Thompson, 1940, p. 171). Skroch (1934) reported Gantt methods were used as performance monitoring devices in plants using the Siemens–Martin process for producing steel. This open-hearth process made steel in batches, ideal for applying Gantt's methods, but the identity of the firm in the iron and steel industry cited by Clark (Table I) remains elusive. When Adolf Hitler's National Socialist Party came to power in 1933, the RKW became a means for Nazi control of industrial practices.

In Russia

Application of Gantt charts in Russia was the work of Walter Polakov, a native born and educated Russian and one-time member of Gantt's consulting firm. Polakov translated Clark's book *The Gantt Chart* into Russian and worked with Clark on the US Shipping Board. From December 1929 to May 1931, Polakov applied Gantt's methods to a machine tool plant as well as other assignments by the Russian Supreme Council of the National Economy, and his work was "warmly recommended" for all Soviet enterprises (Wren, 1980, p. 7). The Russian five-year plans were considered "impressive achievements" despite assorted shortfalls and charting for planning and controlling was a part of this success (Polakov, 1931).

In 1934, Wallace Clark was invited to follow up on Polakov's work in the U.S.S.R., spent a week studying the situation and refused a contract because:

> You can't talk to people who make basic decisions. These are made chiefly from a political point of view. The success of any planning would be at the mercy of political changes and would not depend on thorough and conscientious work. In any organization that is political, the worker's attention is diverted from doing a good job to standing in with those who have the power to remove them (Clark, 1957, p. 110).

Clark's decision left Polakov as the only Western consultant employed by the U.S.S.R., and there is no evidence Gantt's methods had any further impact in that nation.

The wallace clark international management center

Wallace Clark and his wife Pearl returned to New York City in 1939, as World War II was beginning to engulf Europe. During the war, Clark was an advisor to the US Army Signal Corps and the Office of Scientific Research and Development. He reopened his New York City consulting practice when the war ended, but when AFC-Pechiney

requested his services in 1947, he assigned Kenneth B. White, former head of his Paris office, to assist Pechiney, as it reorganized after the war (Berland, 1997, pp. 10-12). Another known arrangement was per diem contracts with Joseph Juran, formerly a statistical quality control engineer for Western Electric Company. After leaving Western Electric, Juran became a member of New York University's Department of Administrative Engineering. According to his biographer, Juran "struck a deal with the well-known management consultant", Wallace Clark, who became a major source of Juran's consulting assignments (Butman, 1997, p. 75, p. 82). Following Clark's death in 1948, Juran offered to buy the Clark firm, but Pearl Clark refused, and Juran opened his own practice (Butman, 1997, p. 82). Further inquiry is suggested to examine any possible influence of Clark and Gantt on Juran's "trilogy" of quality improvement and the world's quality control movement.

Clark's last professional appearance was the 8th International Management Conference (CIOS) in Stockholm in July 1947. He died in New York City, July 4, 1948, and a long-time colleague praised his strong and enduring leadership that "assured his everlasting place in the history of the scientific management movement" (Leroy, 1948, p. 42). A fellow in numerous professional associations, Clark received awards from the Polish and Turkish governments, was granted an honorary doctorate by the Stevens Institute of Technology and received the Henry L. Gantt Gold Medal in 1934.

In 1952, Pearl Clark established the Wallace Clark International Management Center in New York University's School of Commerce, today's Stern School of Business. The center was housed in its own facilities, contained "the nucleus of a management library, foreign reports, records, papers, pictures, and the desk of Wallace Clark" (Gilbreth, 1952, p. 181). In recognition of his contributions to international management, the International Committee of Scientific Management (CIOS), the ASME and the Association of Consulting Management Engineers established and jointly sponsored the Wallace Clark Award for others who made substantial contributions to the advancement of international management.

Clark's "everlasting place in the history of scientific management" was, however, fleeting. New York University dismantled the Wallace Clark Center for International Management in 1962, and the records of Wallace Clark and Company were disposed of in 1986 (Lotto, 2013). The fate of the Wallace Clark Award is being sought – known recipients are Hugo de Haan (1949), Theodore Limperg (1950), Erwin H. Schell (1953), Lyndall Urwick (1955), Harold Smiddy (1958), Peter Drucker (1963) (Drucker archives) and Joseph M. Juran (1967).

Discussion and conclusions

This is the first study of the diffusion of a managerial tool, developed by Henry L. Gantt, into Europe and Britain through the contributions of Wallace Clark. Clark's book, *The Gantt Chart: A Working Tool of Management*, was published in 1922, translated into Polish and German in 1925, and into French, Italian, Russian and Spanish by 1936. Gantt's graphics first appeared internationally through print, then through Clark's work on the Kemmerer Commission in Poland and possibly furthered by Clark's contact with Karol Adamiecki to involve Clark further in the international management movement. Clark established his consulting firm in 1927 after returning to Poland, and it became the means for introducing Gantt's charts into state-owned monopolies and private firms.

Table I illustrates a 12-nation, public and private sector summary of presently known applications of Gantt's work by Wallace Clark's firm in Britain and Europe. The versatility of this technique is apparent in its use in mining, manufacturing, assembly operations, publishing, shipbuilding, textiles and other situations such as state-owned monopolies of salt, tobacco and alcohol. Project management is typically considered the strength of Gantt's charts, but this study found its use in continuous processing, such as mining, in batch production of assorted product lines, in sub-assembly feeder lines for automobiles and for budgetary control. Whereas Gantt charts were applied most extensively in industrial operations, this study indicates Clark's recognition of other uses, such as financial planning and control. Gantt's ideas extended beyond scientific management's task-oriented analyses to a more general management view of the business firm in sales, human resources, production, materials handling, preventive maintenance and finance.

Economic situations in Europe and Britain appear to have furthered the demand for a means to improve performance when sales were falling and competition became more intense, particularly during the 1930s. The Kemmerer Commission and Clark's efforts were state-owned projects needing to conduct state business more efficiently, but the idea of improvement spread to the private sector, as nations and firms sought to improve their competitive standing. This would be the nature of problems that led Lyndall Urwick to convene the Geneva conference on budgetary control in 1930. Clark's writing on executive planning and control using Gantt's concepts for budgetary control met clients' needs for a general management understanding of relationships between production, sales, inventory and staffing for a firm to adjust to changing markets in economic hard times. Budgets presented a financial plan and became action-oriented in budgetary control, using information feedback from tracking performance to compare plans with results, identifying causes of variations and making corrections as needed. The emphasis of the Gantt technique on *time*, not cost or quantity, facilitated the application of budgetary control in numerous firms. Clark introduced budgetary control to France, and his office "was sufficiently important in the diffusion of budgetary control (in France) it can still be found under 'de méthode W. Clark'" (Moutet, 1997, p. 261).

This study found few instances where implementation of Gantt's charting technique were thwarted. Corporate governance at Hadfields delayed the work of Clark's firm but did not resolve the firm's inefficiencies. The case of Hadfields reminds us that the supply of a better way is not always in demand. Our knowledge of Clark's work in Germany deserves further study, but it appears that rationalization, as scientific management was called, was considered something for national study and, later, state control. AFC-Pechiney, part of the French aluminum industry cartel, eased Clark's efforts to introduce changes in a routine environment. Walter Polakov's efforts were successful in the USSR during his 18-month stay in the country, but Clark refused to follow his former colleague's efforts due to his concern that Communist politics would trump suggestions for efficiency. With these few exceptions, the Gantt chart was accepted regardless of state borders and did not encounter resistance, as did some earlier efforts to introduce scientific management ideas, such as time study.

This study of the dissemination of a managerial tool suggests further inquiry into possibilities to examine how other managerial ideas are spread. The role of published media and conferences in furthering new ideas is better known than the role of consulting firms. More is known about the implementation of Gantt's work in France

than other countries, industries and firms, and it is highly likely that his ideas have a more widespread acceptance in other nations than is currently known.

Notes

1. Others of this scientific management period visited or consulted in Europe and/or Great Britain: Taylor visited the Michelin Brothers and Louis Renault in France, Gantt visited Germany in 1913 as a member of an ASME tour and made an informal presentation about scientific management in Leipzig to the Society of German Engineers and Frank Gilbreth had consulting assignments in Germany and Great Britain. Two pretenders to scientific management credentials opened European offices: an Italian engineer, A. Morinni, shadowed Emerson's engineers in America and operated briefly from a Paris office before the Great War (Vielleville, 1914; Moutet, 1997). Charles Bedaux, French, formed his version of scientific management and had European and British consulting offices which closed with the onset of World War II (Kipping, 1999, pp. 190-220; Kreis, 1992, pp. 156-174).
2. Champsaur and Cailluet's conclusions must be tempered with Berland's observation that Pechiney enjoyed the protection of a national cartel enabling it to make technological advances and plans in a relatively stable competitive environment. Nicolas Berland, "Le Contrôle Budgétaire, Outil d'un Environment Routinier: Un Point de vue Historique", *Entreprises et Histoire*, Vol. 20 (1998), p. 68.

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