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Richard K. Fleischman

R. Penny Marquette

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Richard K. Fleischman
JOHN CARROLL UNIVERSITY
and
R. Penny Marquette
UNIVERSITY OF AKRON

THE IMPACT OF WORLD WAR II ON COST ACCOUNTING AT THE SPERRY CORPORATION

Abstract: The impact of World War II on cost accountancy in the U.S. may be viewed as a double-edged sword. Its most positive effect was engendering greater cost awareness, particularly among companies that served as military contractors and, thus, had to make full representation to contracting agencies for reimbursement. On the negative side, the dislocations of war, especially shortages in the factors of production and capacity constraints, meant that such "scientific management" techniques as existed (standard costing, time-study, specific detailing of task routines) fell by the wayside. This paper utilizes the archive of the Sperry Corporation, a leading governmental contractor, to chart the firm's accounting during World War II. It is concluded that any techniques that had developed from Taylorite principles were suspended, while methods similar to contemporary performance management, such as subcontracting, emphasis on the design phase of products, and substantial expenditure on research and development, flourished.

INTRODUCTION

It has long been hypothesized by accounting historians that advanced cost accounting *theory*, featuring time-studies, standard costing, and variance analysis, was born in the U.S. in the early 20th century during the age of Taylor and scientific

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management. More contentious is the argument that these innovations flourished in industrial managerial *practice* in succeeding decades. Traditional histories of cost accounting, such as Littleton [1933], Solomons [1952], Garner [1954], and Wells [1978], among others, have supported standard costing specifically as a key component of what Solomons [1952, p. 8] labeled "the costing renaissance." Standard costing has become a virtual surrogate for the methods that Taylor and others were espousing. Later-day historians, representing the major paradigmatic schools that have studied U.S. industrialization [Johnson and Kaplan, 1987, pp. 49-50 for economic rationalism; Miller and O'Leary, 1987, p. 238 for Foucauldianism; and Hopper and Armstrong, 1991, p. 433 for Marxism/labor process], have all seconded this judgment, albeit interpreting developments from widely differing perspectives. There can be no question that the theoretical basis of standard costing and variance analysis was laid in the significant outpouring of the period, featuring the work of Taylor [1903, 1911], Whitmore [1908], Emerson [1908-09], Harrison [1930], and others.

Many accounting historians have advanced the argument that Taylorism and scientific management were not merely *theoretical* successes at the turn of the 20th century, but *practical* successes as well. Among the authors who have espoused this view are many of the best known and respected names in accounting history and cost accounting theory, including the authors of the traditional histories mentioned above, as well as more recent scholars of standard costing, Sowell [1973] and Epstein [1978]. Standard costing and variance analysis are generally believed to have been one, if not the single, most important innovation arising from the work of Frederick W. Taylor [Epstein, 1978].

In fact, time-and-motion studies, the development of labor standards, the calculation of variances, and the analysis of results were actually the contribution of engineers (like Taylor), not accountants [Wells, 1978]. Nevertheless, the benefits of these new systems have clear application to cost accounting for purposes of both decision making and control. It is a natural assumption that the U.S. industrial sector would have implemented into practice the new methods advanced in the theoretical literature.

Only recently have several accounting historians begun to question whether the theoretical success of scientific management can be seen in a parallel expansion of scientific management techniques in general practice, at least in the U.S.

[Fleischman, 2000b; Fleischman and Tyson, 1999, 2000].[1] These works, based on archival research, revealed little evidence of sophisticated cost accounting or standard costing prior to the World War II period. The same theory/practice schism discussed by Fleischman [2000 a, b] was also observed by DeBeelde [1995, p. 91] in a study of the Belgian coal industry and by Anderson [2003] in an investigation of World War II munitions provisioning in Australia that parallels this paper in some respects.

School is still out with regard the prevalence of scientific management practice prior to World War II. Oakes and Miranti [1996] found that Louis Brandeis had popularized Taylorism in urging standard costing for regulating rates on U.S. railroads in the pre-World War I era. Bhimani [1993] felt that World War I had actually precipitated scientific management at Renault. By contrast, McKinstry [1999] and Brown [1993] found no evidence of standard costing in case studies of Albion Motors and Meccano, Ltd. respectively. Edwards et al. [1995, p. 37, fn. 45] observed the lag of scientific management's advance in the U.K. and France, both in terms of theory and practice, but in so doing accepted the traditional view of its prevalence in the U.S. In point of fact, Boyns [1998] referenced Ashton et al. [1995] and Locke [1979] to support the contention that scientific management's real introduction into the U.K. followed the Anglo-American Council of Productivity visits to the U.S. after World War II. Zimnovitch [1997] came to a similar conclusion in a study of standard costing at Saint-Gobain saying that the introduction of U.S. methods in France awaited the "productivity missions" of 1948-51.

There have been several studies based on the actual records of Frederick Taylor. Nelson [1974] conducted archival research into the Taylor archive at the Stevens Institute of Technology and found less than 50 firms mentioned by Taylor or his associates as having implemented elements of scientific management. For half of the firms mentioned, Nelson found the archives to be unclear regarding a company's degree of adoption of scientific management techniques. In a similar study, Epstein [1978] found only 36 firms mentioned in the Taylor archives that clearly exhibited adoption of Taylor's methods. In 1915, R.F. Hoxie, a University of Chicago economist, visited 30 firms

[1] Loft [1986, 1990] observed a number of scientific management practices in the British government's provisioning processes during World War I, findings that do not correspond to Marriner's [1980] work.

whose names had been supplied by Taylor and his competitor consultants, Emerson and Gantt, as having implemented scientific management principles. Hoxie [1920] reported back to the U.S. Commission on Industrial Relations that there was considerable variability in application and that no single firm had implemented all elements of a system recommended by any of the trio.

When Fleischman [2000b] merged these three lists (those of Nelson, Epstein, and Hoxie), eliminating the duplicates, he found only 80 firms that had been offered by Taylor and his colleagues as examples of scientific management in practice; a small group out of thousands of large U.S. businesses. At the end of World War I, Morris Cooke, an engineer and proselytizer for Taylor's methods, was reputed to have said, "We could not sell scientific management 30 years ago, and we can hardly sell it today" [quoted in Haber, 1964, p. 120].

A large stumbling block when attempting to implement scientific management techniques was the post-World War I rise of industrial unions, a group both philosophically and practically opposed to scientific management on several grounds. Time-study in particular seemed to offend workers who found it humiliating and saw it as a way to break tasks into tiny components, essentially "deskilling" and devaluing labor. Taylor's failure to convince labor that scientific management was in its best interest may have slowed the spread of standard costing and other scientific management techniques during the years between the two world wars [Hoxie, 1920; Nadworny, 1955; Braverman, 1974; Epstein, 1978; Hopper and Armstrong, 1991; Kanigel, 1997]. It has also been argued that scientific management and standard costing were simply too complex and too expensive for widespread adoption [Nelson, 1975; Montgomery, 1987]. Regardless of the reasons, there is only weak evidence suggesting the widespread implementation of standard costing prior to the end of World War II. In earlier research into two episodes of large-scale governmental intrusion into the American industrial economy, the War Industries Board of World War I and the National Recovery Administration of the Great Depression, Fleischman and Tyson [1999, 2000] found that little evidence existed of standard costing systems in this country.

Despite the lack of evidence thus far, there are reasons to expect that the advent of World War II might have provided impetus for the increased adoption of sophisticated cost accounting techniques. "Cost keeping," the antecedent of modern cost accounting, first arose in New England at the beginning of

the 19th century in large industries such as mining, textiles, and arms-making [Johnson, 1972; Porter, 1980; Tyson, 1990, 1992; Hoskin and Macve, 1996; Fleischman and Tyson, 1998] – all important industries in times of war. Prior to the Civil War, the most sophisticated user of cost accounting control method was the Springfield Armory, supporting the notion that arms manufacture lends itself to sophisticated cost accounting techniques [Chandler, 1977; Hoskin and Macve, 1988, 1994, 2000; cf. Tyson 1990, 1993, 2000]. Several incidents of labor unrest can be traced to governmental attempts to install time-and-motion studies at government arsenals and other facilities, attesting to the fact that the government was seriously interested in these techniques and their application to military installations. Prominent among these labor disruptions were those at the Naval Shipyard at Mare Island and the Watertown Arsenal. The strike at Watertown in 1911, reported to be a result of labor's hostility to time-and-motion studies, was so severe that Congress passed legislation prohibiting time-studies in governmental arsenals and shipyards, a prohibition that lasted from 1915 to 1949 [Montgomery, 1987, p. 221]. Nevertheless, increased patriotism and labor shortages during World War II might have been expected to counter organized labor's resistance to scientific management techniques. Finally, Loft [1986, 1990] has argued that the World War I relationship between munitions suppliers and the British government resulted in significant advances in cost accounting practices in Great Britain. Montgomery [1979, pp. 121-122] argued that scientific management's appeal increased in the U.S. during World War I. Perhaps the World War II experience would be similar. The American industrial sector was fully mobilized to support not only the country's own war effort but to function as well as "the arsenal of democracy". Would governmental contracting mandate a more careful attention to costs than had been the case previously? Would the genesis of standard costing in practice be in evidence at this rather late date in U.S. cost accounting history?

Although certainly not without its problems [Johnson, 2000], Fleischman [2000a] has argued that it is largely through the agency of archival research that the extent and existence of such theory/practice schisms can be more fully identified and evaluated. Accordingly, we have chosen the Sperry Corporation, a leading manufacturer of aircraft components and a "prime" governmental contractor, as a case study. Sperry has several advantages as a subject for this study of scientific management techniques during World War II. First, and most obvious, is the

existence of a large archive of Sperry material housed at the Hagley Library and Museum in Wilmington, Delaware.[2] Second is the fact that Elmer Sperry was, first and foremost, an engineer and, thus, more likely to embrace scientific management techniques. Third, Sperry Corporation had excellent labor relations. The archives are replete with examples of the president or general manager of the company sending personal letters to clerical and factory workers congratulating them on the births of their children or sending well wishes to ill or hospitalized employees. As early as 1940, 57% of Sperry's workers had been on the job for less than one year. By mid-1945, over 16,000 Sperry employees had entered the armed forces. Yet, throughout the war, despite stressful working conditions and the constant turnover in employees, there was not a single work stoppage or labor dispute at a Sperry installation [Acc 1910, #024].[3]

THE WORLD WAR II ACCOUNTING ENVIRONMENT

To understand accounting developments at Sperry Corporation during World War II, it is necessary to grasp the larger environment of the war's impact upon existing methodologies and the effect of large-scale governmental contracting on preexisting conditions. To this end, we surveyed the cost accounting journal literature of the wartime period as represented by the *National Association of Cost Accountants* (NACA) *Bulletins* and *Yearbooks*, the *Accounting Review*, and the *Journal of Accountancy*.

Most speakers at the NACA annual conventions did not convey much hope that cost accountancy had broached the schism with theory, particularly with regard to standard costing. Howell [1942, pp. 10-11], the NACA's president in 1942, observed in his presidential address, "It is astonishing to find the number of our members who, while they recognize the vocabulary of standard costs, do not comprehend its meaning". He went on to suggest that although standard cost accounting "marked a great advance in the science of cost accounting," it did have its "shortcomings and obscurities". Massell [1941, p. 6], a cost consultant with the

[2] The reader is directed to the Hagley's website at www.hagley.lib.de.us/1915.htm.

[3] References to the Sperry archive are by accession number (Acc 1910) and item number (#024). Where large amounts of information are located within a single accession number, references may also include box, file, and/or folder numbers.

Office of Production Management, pointed out to delegates that costs and prices in defense contracting had not been very closely related in the past and that cost estimating would have to become " more significant factor in price policy". Bennett [1945, p. 118], with the accounting firm of Cooley & Marvin, summed up the prewar milieu in flowery fashion: "Not many years ago the advocates of standard costs were like voices crying in the wilderness. They were looked upon sometimes kindly, more often not, by the orthodox brethren as adherents of some strange and slightly heretical faith".

The National Industrial Conference Board conducted a survey in 1938 that revealed that only 152 of 818 respondents carried work-in-process inventory at standard. McEachren [1940, p. 681] of Ernst and Ernst, in referencing this report, observed that although these statistics were not conclusive about the extent of standards utilization, they did "indicate that a large proportion of manufacturing companies probably do not have a standard cost system". A number of speakers at wartime NACA conventions suggested that standard costing was around, but that it was not particularly effective because these systems were adequate for control but not for pricing [Nourse, 1945, p. 37], were inflexible in the face of changing conditions [Bullis, 1945, p. 12], and had achieved a measure of sophistication only with regard their engineering (physical) as opposed to their accounting (bookkeeping) aspects [Bennett, 1945, pp. 125-127].

In our view, the state of the cost accounting art as America went to war belied the prevalent theoretical outpouring of the interwar period. Speeches to NACA delegates [Myers, 1943; Caminez, 1944; Greer, 1944; Bennett, 1945; Burke, 1945], although preaching to the choir, urged the value of standard costing and variance analysis in very rudimentary terms. One would expect more substantial issues related to standards had the methodology been more universally known. Finally, the standard costing addresses by Caminez [1944] and Bullis [1945] were delivered in sessions respectively named "Tomorrow's Cost Accountant" and "The Job Ahead," suggesting that current practice did not reflect the methodology thought to be so prevalent.

Government Contracting: The Legislation: The U.S. government, in its role as the "arsenal of democracy," was most concerned that the "disastrous results" of war provisioning in World War I, where cost-plus-percentage-of-cost contracting had fleeced taxpayers of an extra $15 billion according to Baruch's estimate, should not be repeated [Taggart, 1941a, p. 35; Taggart, 1941b;

see also Fleischman and Tyson, 2000]. In point of fact, the government had forbidden cost-plus contracts, opting instead for cost-plus-fixed-fee (preferred at the onset of hostilities) and, subsequently, fixed-price contracts with escalator clauses [Stewart, 1943, p. 20]. Moreover, the Office of Price Administration and Civilian Supply (OPA) was founded in spring 1941 to spearhead price stabilization and cost auditing efforts. Even earlier, on June 28, 1940, Treasury Decision (TD) 5000 had specified those costs that the government was not prepared to reimburse. The "Green Book" ("Explanation of Principles for Determination of Costs under Government Contracts") reiterated TD 5000 in April 1942. Public Act 528, also of April 1942, was the primary "renegotiation" statute that enabled the government to recapture "unintentionally realized excess profits" resulting from volume manufacture and learning curve improvements in the manufacture of war materiel [Seybold, 1942, p. 131].

Government Contracting: The Realities: It would appear on the surface that this magnitude of governmental control would precipitate a greater cost awareness and control among contractors. Indeed, the magnitude of data that governmental agencies required was staggering and the source of frequent complaint [e.g., Bullis, 1945, p. 9]. Seybold of Westinghouse [1942, p.130] spoke of the "unreasonable demands" of the questionnaires whose completion required the time and attention of 100 people. Two very distinguished accountants, Kohler and Cooper [1945, p. 270], decried the plethora of data-collecting agencies, suggesting that the OPA should standardize the reporting process. Wellington [1945, pp. 3-4], a public accountant with long ties to the NACA, identified the crux of the problem to be that the government was more interested in the formats in which costs were presented for reimbursement rather than in the processes by which costs could be controlled or reduced. Much of the early war literature noted the difficulties that ensued from the excessive number of field auditors and quality inspectors representing the various governmental agencies involved in contracting [Healey, 1941, p. 241; Seybold, 1942, p. 133; Camman et al., 1943, p. 7]. Seybold called for a single cadre of auditors rather than individual investigators from the Navy Department, the Signal Corps, the Maritime Commission, the OPA, and those charged with the enforcement of income tax, excess-profits tax, state tax, the wage and hour law, etc.

Not only were the efforts of cost accountants deflected by the government's statistical mandates, the system reflected by

the legislation did not function to induce cost-cutting attention. As observed by Taggart, a University of Michigan professor and the prime accounting figure in the National Recovery Administration, the cost-plus-fixed-fee contracting, in effect for most of the war, was intrinsically the same as the outlawed cost-plus contract in terms of lacking incentives to reduce cost [Taggart, 1941a, p. 37]. Although Kelley [1942, p. 373] called for cost standards to evaluate the efficiency of contractors, comparable cost data, and uniform procedures for reporting costs, it never happened. Rather, governmental agencies generally accepted whatever accounting methods contractors had historically used [Miller, 1942, p. 96]. It was believed that control would come via the renegotiation process wherein governmental adjustors would allow efficient and low-cost producers to retain a greater profit margin [Hoyt, 1943, p. 95; Caminez, 1944, p. 147]. Moreover, as Caminez [1944, p. 147] pointed out, efficient contractors would also reap public-relations benefits and advantage in termination- contract negotiation as the government's need for armaments was reduced when the war wound down. Once again, renegotiation fostered loose cost control and pricing as it was thought that the system would correct errors [Kohler and Cooper, 1945, p. 285].[4]

Standard Costing: There was universal agreement among all observers that the war negatively impacted standard costs, whatever the state of the art in the prewar milieu. Stempf [1943, p. 500; see also Wellington, 1945, p. 6] observed in the *Journal of Accountancy* that "prewar standards have become relatively meaningless, and, in general, industry has been forced to fall back on actual costs". It is easy to understand why standard costing was not appropriate in the industrial environment of World War II, even apart from the government's preference for dealing with actual costs. Factors included inexperienced workers, high labor turnover, unfamiliar products, lack of time-study engineers, material shortages, uncontrollable prices, small-lot emergency purchases, frequent specification changes, new inspection requirements, numerous artificial controls, etc. [Hoyt, 1943, p. 93; Caminez, 1944, p. 146]. Burke [1944, p. 253] put the blame squarely on the head of government:

[4] Although it is not directly relevant to costing practice during the war, renegotiation apparently did not reward the efficient producers as many had expected [Wellington, 1945, p. 4].

> Standard costs have received a definite setback in favor of actual costs. The existence of CPFF [contract-plus-fixed-fee] contracts and the manufacture of new products under rapidly changing conditions have been factors in this trend, but a more basic reason is the universal insistence of government officials on costs that are near actual as possible. Standard costs were accepted only where they could be converted to actual by the application of actual variance percentages.

The post-war NACA Committee on Research [1947, p. 919] likewise confirmed the requirement of actual costs as the basis for CPFF contracts, renegotiation, and termination.

Kohler and Cooper [1945, p. 306] concluded their 41-page survey of World War II accounting in the *Accounting Review* by observing that "accounting practice suffered perceptibly and even degenerated as the result of the war". However, Bullis viewed this retreat as an opportunity to advance the craft. "The postwar period will provide greater opportunity for accounting than any previous period in history" [Bullis, 1945, p. 17]. Unfortunately, he had said almost the exact thing in his NACA presidential address in 1933 on the occasion of the passage of the National Industrial Recovery Act [Fleischman and Tyson, 1999, pp. 52-53].

THE SPERRY CORPORATION AND ITS ARCHIVES

Sperry's archive (76 linear feet) is housed at the Hagley Museum in Wilmington, Delaware. Although voluminous by virtue of the lengthy, chronological run of the holdings (1910-1970), the collection is incomplete from a cost accounting perspective. Following the formation of Sperry Corporation in 1933, the most complete set of surviving records emanates from the Planning Department for 1935-1960, compiled by F.S. Hodgman. Unfortunately, Planning was a component of the Engineering Division and, as such, was staffed by engineers rather than accountants.

According to a provenance note written by the Hagley staff, the Sperry records at the Hagley were assembled by the Advertising and Public Relations Departments. "Unfortunately, given the way it was assembled, the original provenance was destroyed as documents were pulled out of context and filed into a Public Relations' Department vertical file" [Acc 1915, #060]. Many of the surviving documents related to Sperry's prewar story are contained in a file titled "National Defense – Mobilization Plans Survey of Emergency Procurement Requirements

1938-1939". The perilous situation with respect to record survival is illustrated by Lea's (vice president of sales) claim in 1956 that he staged an eleventh-hour rescue of these materials prior to their destruction [Acc 1915, box 53, folder 8]. As might be expected, the archive is far more complete in terms of newspaper articles, in-house newsletters, and publicity pieces than it is in terms of cost and accounting records. Furthermore, after the formation of Sperry Corporation, the types of surviving records in the archive changed radically. For the earlier period, a smaller volume of materials exists, but what is there is of a more traditional accounting type. During the World War II era, by contrast, most existing records were generated at the corporate level (Board of Directors' minutes, correspondence with government, planning). As previously mentioned, only the Planning Department's records have been preserved *in toto*, at least in the Hagley collection. Notwithstanding the incomplete holdings specifically related to cost accounting, there is still much to be learned about this leading governmental contractor.

Sperry Corporation Prior to World War II: Elmer A. Sperry (1860-1930) started his entrepreneurial career while studying electrical engineering at Cornell University. His invention of a modified dynamo to increase the output of electric current resulted in a contract to build a generating station for Syracuse's new, downtown, arc-lighting system. At 21, Sperry had already attained a national reputation. It was during his work on electrical systems that he developed and patented an automatic, electromagnetic regulator. Based on a closed feedback loop, the regulator could shut down all the lamps in an arc-lighting system in the event of an electrical overload. Although he left the field of electrical generation and manufacture in 1889, the concept of an automatic feedback loop, combined with a mechanism of self-correction, formed the basis for many of the inventions that would make Sperry successful and support the U.S. military in two world wars.

Sperry founded Sperry Gyroscope in Brooklyn, N.Y. in 1910, ostensibly to provide a business setting for the application of Leon Foucault's 1854 invention of the gyroscope to the aviation and maritime industries.[5] Using both Foucault's gyroscope

[5] Elmer's son Lawrence, the developer of the gyrostabilizer, founded his own company (Lawrence Sperry Aircraft) in 1915, but the enterprise failed after its founder perished in an airplane accident in 1924.

and his own automatic guidance and feedback control technology, Sperry developed a ship's gyroscope that would control the ship's engine and steering mechanism, automatically holding the ship on a predetermined course ["Safety-Minded Genius," Acc 1915, #056].

Working closely with the U.S. Navy, Sperry installed the first ship's gyroscope on the battleship *U.S.S. Delaware* in 1911. By 1915, the marine gyroscope was standard equipment on all naval vessels. In 1913, the first gyrostabilizer, controlling pitch and yaw as well as speed and direction, was installed on the *U.S.S. Worden*. The new technology was quickly adopted by commercial steamship companies as well [Acc 1915, #060].

Sperry Gyroscope established a subsidiary in London in 1915 to service the Allies in World War I. In 1929, the elder Sperry sold his company to Clement Keys, the president of Curtiss Aero and Motor. In 1933, General Motors absorbed the Curtiss-Keys combination, but the Sperry Corporation was created as a management and holding company. At this time, Ford Instruments became a part of the conglomerate, with subsequent expansion to include Waterbury Tool (1935), Vickers, Inc. (1937), New Holland Farm Machinery (1947), and Dillinger Manufacturing (1948), precedent to the formation of Sperry-Rand in 1955, and thence into Unisys in 1986. In the years between the two world wars, Sperry and his engineers developed the automatic pilot, the first airplane stabilizer, gyrostabilized bomb sights, and automatic-fire control systems. By the 1920s, Sperry Corporation had become known as the "Brain Mill for the Military".

In the 1930s and the 1940s, Sperry engineers worked with researchers at Stanford University and MIT to develop the microwave technology that forms the foundation of modern radar systems. At the beginning of World War II, Sperry was supplying approximately 100 highly technical products to the U.S. military, including directors (automated firing devices), sound locators, high-intensity search lights, gyropilots, bomb sights, gyrocompasses, range finders, and automatic gyrohorizons [Acc 1915, #053].

Business Organization: A 1931 organization chart shows Sperry's 367 employees divided into four large divisions: Sales, Engineering, Factory, and Finance with 58, 62, 138, and 99 employees respectively. There were only ten employees at the corporate level, a remarkably lean organizational structure by modern standards. Of the 58 members of the Sales Division, 33 were

service representatives located around the country. Engineering was divided both by function (specifications, standards, research, and drafting) and by product line (gyrocompass, gyropilot, searchlight, etc.). The Factory Division, by far the largest, was subdivided by functional activities (pattern making, inspection, plating, tool making, grinding, etc.). All facets of inventory control were handled by Production Control, a department within the Factory Division.

The 99 members of the Finance Division performed the treasury and internal audit functions. The Treasurer's Office had a small number of employees performing typical clerical functions, but was comprised mainly of people who would most likely be categorized as maintenance in modern organizations. The auditor's function was comprised of 22 people (number of employees in parentheses), including the auditor (1), general accounting (6), cost accounting (12), and estimating and price making (3) ["Organization Chart, Sperry Gyroscope Company, Inc., November 19, 1931," Acc 915, #025].

New Sperry products began in the Methods Department where the actual process of manufacture would be designed, including the selection of machine tools that would be most suitable, the proper sequence of manufacturing steps, and engineering estimates of the time required for the different operations. This work was then codified on "operations sheets". Once the Methods Department had completed its work, the factory would be given permission to proceed, and the Production Control Department would assume responsibility for securing raw materials and overseeing their proper use and control.

When production commenced, the Inspection Department followed various pieces through the different departments to ensure proper compliance with manufacturing specifications. The completed apparatus would be checked at the time of shipment, and the required information would be provided to the Accounting Department for billing purposes. "Cost records carefully maintained and compared with estimates so that errors in sales prices may be avoided in future work . . ." [Acc 1893, #044] would appear to have been the task of the three individuals in Estimating and Price Making in the Auditor's Department, although the documents do not specifically say so.

Record keeping at Sperry prior to the end of World War II was largely a manual affair. Cost data were collected on ledger sheets or cards, hand-ruled and handwritten during World War I and pre-printed during World War II. Final reports were prepared on manual typewriters with two-color ribbons so that

totals appeared in red. Many input records (production figures, journal entries, and others) were handwritten on the backs of "scrap paper" and unused forms.

Cost Accounting at Sperry before the War: While it is unknown how many accountants were employed in the earliest years, we have seen there was a substantial complement of cost accountants responsible to the head internal auditor. It is also the case that scientific management methods espoused by Taylor were known to Sperry. A 1920 article in the firm's newsletter, authored by C.S. Doran, the general manager, discussed the advantages of a scientific layout of the factory and the utilization of engineers to conduct time-studies and thereby establish optimal work routines. Employee suggestions for both processes were solicited. The Inspection Department was to maintain cost records comparing actual production to estimates.

Perhaps the best indication of the early state of cost accounting at Sperry Gyroscope in this era is contained in the minutes of a conference of the leading executives on September 10, 1918. F.C. Pinkham, the chief financial officer, said that the details of cost accounting had been worked out and that operationalization would follow. R.E. Gillmor, second in command only to the senior Sperry, observed that the Cost Accounting Department had the staffing to collect masses of data but that going forward the system should "answer three things" that were apparently unanswered theretofore [Acc 1893, folder 9, #045]:

(a) It should be satisfactory to the manufacturing division as a means of providing them information wherewith to judge the performance of each department as far as the factory is concerned and that department heads and supervisors can use.

(b) It should also satisfy the sales division and provide them with all the information they need to fix prices properly and see if a certain line of products is profitable.

(c) It should provide a basis for the reports to the board of managers to enable them to judge as to the profitability of various lines.

Doran suggested that the expense of productive and nonproductive labor and materials be separated, that research and development costs be segregated from manufacturing costs, and that the cost accounting staff should visit each department to

become familiar with the department's functioning and its accounting system.

Although cost keeping was moderately successful, the language above suggests that early cost accounting at Sperry was fairly rudimentary. This nascent state of Sperry's accounting was particularly evident in the area of overhead cost allocation. In 1918, a dispute with Price Waterhouse over whether factory overhead should be carried to cost of goods sold rather than finished goods resulted in a change of auditors [Acc 1915, #049]. Sperry's attempt to allocate overhead on the basis of direct-labor dollars was not a success. During a period of several months in 1918, Sperry Aircraft angered the A.S. Heinrich Corporation, a customer, by raising its application rate from 100% of direct-labor cost to 125% on contracts and even noting that the new rate "is abnormally low to allow on semi-experimental work of this character" [Acc 1893, folder 9, #033]. Perhaps the culmination of the problem came in a "Jobs Completed" schedule for May and June 1924 when the firm noted [Acc 1915, #016]:

> Due to the fact that adding 100% of Productive Labor as cost of Factory Overhead is not sufficient to cover actual cost of Factory Overhead and also because apparently the proper amount of Factory Overhead had not been charged to the jobs completed before March 31, 1924, there had to be added to the cost of the above jobs the sum of $2,543.12 as additional factory overhead.

The magnitude of this adjustment is told by the fact that it took the allocation to approximately 250% of direct-labor dollars. C.W. Nutt, the auditing firm, suggested in its notes to the firm's financials for 1924 that 180% would have been a more reasonable allocation than 100% [Acc 1915, #016].

Despite the overhead allocation difficulties, the Cost Accounting Department did produce some wonderfully detailed monthly reports. One such schedule, "Comparative Statement of Productive Labor and Burden Expense by Productive Departments," provided data (current month in black, the preceding in red) for 47 departments. Data categories included the costs of inspection and testing, idle time, deficient work, and burden rate per hour for both the current month and year-to-date [Acc 1893, box 22]. Another monthly report contained data related to specific product lines, including the percentage of total hours devoted to each and the average rate per hour for manufacturing expenses and engineering/drafting [Acc 1893, box 22]. These monthly reports, truly impressive in their magnitude,

were commented upon by Pinkham and sent directly to E.A. Sperry.

Nevertheless, Gillmor's observation that cost accounting during the early years generated much data with basic questions yet to be answered continued to hold through the Great Depression. The Cost Accounting Department was churning out monthly reports that were superficially very impressive. However, the system was not able to address the vital problem of overhead application. Moreover, there is no indication that standard costing was utilized despite the technique being the theoretical state of the art. The firm had the cost accounting staff, an appreciation of cost accounting's importance, and innovative management that demanded the flow of cost accounting data. Would the productive mandates of World War II, the closer relationship with government, and the reorganization into Sperry Corporation bring the benefits of the more sophisticated cost accounting practice suggested by the literature?

The Road to World War II: On April 10, 1935, six years before America's entry into World War II, R.B. Lea, vice president of sales, and L.B. "Bo" Coon, the planning manager, met with representatives of the Munitions Board, inaugurating a series of conferences to discuss the types and quantities of armaments that would be required once war broke out (always referred to as "M Day").[6] Lea claimed that Sperry was much more proactively involved in planning than other munitions providers.

The archive contains a remarkable document, dated March 16, 1936, in which were recorded the Sperry products required by various governmental agencies with data provided as to the quantities needed and the monthly units anticipated, reflecting a learning curve. Recipients of this output included the Ordnance Department, the Corps of Engineers, the Air Corps, the Bureau of Navigation, the Bureau of Ordnance, the Bureau of Engineering, and the Bureau of Aeronautics.

Acting out of fear that Sperry might be commandeered during wartime, Lea went to Colonel H.K. Rutherford, Director of Planning for the U.S. Ordnance Department, to request updated specifics as to what each governmental bureau would require.

[6] Many of the documents that relate the prewar story are contained in a file titled "National Defense —Mobilization Plans Survey of Emergency Procurement Requirements 1938-39" [Acc 1915, box 53, folder 8]. Unless otherwise cited, documents referenced in this section can be found at this location.

Perhaps as a result of that visit, Sperry commenced the operationalization of its "Emergency Procurement Plan" in fall 1938. Coon sent Lea an "Outline Procedure" on October 20 in which he elaborated how Sperry would calculate the direct-labor needs, the required machinery, the assembling capability, the non-productive labor, the appropriate floor space, and other miscellaneous requirements to attain the level of production specified in 1936. Additional data were now provided as to man-power requirements, machinery and floor-space needs, subcontractor assistance, and sources of supply for direct materials. While these calculations related to capacity constraints rather than to costs, time allowances from the files of the Estimating Department and cost figures from recent orders were deployed. One gets the impression that time-studies had been undertaken to assess how long machine functions were to take, but that these data had not been incorporated into a standard costing system. Moreover, Sperry was apparently in arrears in terms of physical layout. In his cover letter, Coon wrote: "No consideration has been given in any of these write-ups as to different methods of tooling or rearrangement of factory departments for conveyerizing (sic) of modern production methods. This could also be done in a detailed study".

Based upon Sperry's Emergency Procurement Plan, Colonel Rutherford, in April 1939, supplied a revised schedule of emergency requirements that has not survived in the file although the transmittal letter has. Lea, in his 1956 recollection [Acc 1915, box 53, folder 8], wrote of the high praise Sperry received for planning work that the Munitions Board "used in encouraging other companies to make specific plans and studies for M Day requirements". When the U.S. finally entered the war two years later, this planning was obsolete for the most part as Sperry was now called upon to produce "quite a different set of apparatus" than had been envisioned.

A more sophisticated planning process was reflected in certain documents contained in a file entitled "War Plans 1935-1938" [Acc 1915, box 53, file 5]. On July 11, 1935, Sperry was sent an "Accepted Schedule of Production" from the Ordnance Department of the War Department for 600 M3 directors, at a unit price of $38,000, with ten to be delivered four months after the procurement order, 20 in the fifth month, and 30 for months six through 24. On July 30, 1935, Coon sent to Lea and others three alternative plans for producing 100 "Antiaircraft Directors M3." According to Plan 1, there would be no change in existing equipment, layout, or tooling. The schedule would be:

1 – 9 months	0	13th month	4
10th month	2	14th month	5
11th month	3	15th – 27th month	6
12th month	3	28th month	5
		Total	100

Under Plan 2, there would be an outlay of $300,000 for tool design, layout alteration, new machine tool equipment, etc. Production would then be:

1 – 12 months	0
13th month	5
14th month	10
15th month	10
16th – 20th months	5
Total	100

Plan 3 required an outlay of $55,000 beyond Plan 2, producing the result:

0 – 12 months	0	
13th month	5	
14th month	10	
15th month	20	
16th month and beyond	30	
Total	100	in 17½ months

Coon's plans were provided as schedules for the time it would take to produce 100 directors under peacetime (Plan 1) and two emergency scenarios (Plans 2 and 3). It was estimated that a peacetime production plan would save eight months for the first 100 directors in contrast to commencing production from ground zero. It is not known how the Ordnance Department responded to these data. While this particular production/learning curve exercise is the most complex, it is by no means an isolated negotiation.[7]

This theme of the advantages to be gained from peacetime production was underscored in a letter from R.E. Gillmor to the National Research Council, Committee on Aircraft Production, on April 26, 1940 [Acc 1915, box 40, #026]. Sperry's general manager addressed the issue of productive capacity and unit

[7] The materials estimation process was likewise done with great care. There exists an aluminum study for 100 directors dated November 25, 1938. It includes a standard scrap calculation per pound of finished product [Acc 1915, box 53, folio 6, #059].

cost under three conditions which he labeled "normal," "emergency," and "war". Increased unit cost under "normal" conditions would result only from increased product quality. In "emergency" situations, cost increases would be a function of relatively untrained workers and the need to write off special tool investment. Finally, in "war" unit cost increases would result from overtime and other wasteful methods. Gillmor urged that these cost increases "could be ameliorated by looking upon national defense as a continuing problem," thereby smoothing distinctions among these conditions.

SPERRY DURING WORLD WAR II

As a leading contractor, Sperry was intimately involved in the system established by the government to regulate war-materiel provisioning. The archive contains many references to the renegotiation process. The minutes of Board of Directors' meetings suggest that Sperry considered itself the "leader" in renegotiation [Acc 1910, box 23, vol. 9]. The claim was made in the August 29, 1945 minutes that Sperry was the first to propose renegotiation and to reduce prices voluntarily. The first mention of renegotiation in the minutes occurred on April 14, 1942, when the firm agreed to renegotiate because its subcontractors were making excessive profits in light of the lower production costs associated with a "considerably expanded rate". It is unclear, however, whether these savings were the result of a learning curve, capacity considerations, or both [Acc 1910, box 23, vol. 7, no. 1]. In a document called "Report for 1943 Renegotiation" [Acc 1915, box 82, p. 3], Sperry called it company "policy" to lower the prices of its products when manufacturing experience, reflected by reduced prime costs, was gained. Initial ceiling prices on new products were lowered to a firm price, most frequently retroactive to first delivery. It is difficult to assess the magnitude of repayments to the government as they were in a state of flux since price reductions could take place years after the point of sale. However, one Sperry document called "The Story of the Sperry Corporation" alleged that through the end of 1943, $128 million had been returned to the government through the renegotiation process [Acc 1915, box 40, #023, p. 57].

In 1943, the U.S. military asked its prime contractors to prepare histories of the various products they supplied. The Sperry archive contains a document that provided precise instructions as to how these histories were to be prepared. The

first section was to be a description of the product, the process of its development and initial production, the contribution of the product to the war effort (including its limitations), and the anticipated "continuation of improvement" through research and development. A second section supplied the sales price by contracts, labor costs over time, and additional information to track efficiency as reflected in lower product cost and sales prices. Most statistically complex was the concluding section on production history. Here manufacturing accomplishments and difficulties, relations with prime and subcontractors that had participated in the product's manufacture, quantities required, and associated delivery schedules and contract performance were to be discussed. A number of these individual product histories have survived [Acc 1915, box 40, #029]. What is interesting about them is their reflection of time rather than cost management, a more contemporary manufacturing philosophy. It is not to be suggested that Sperry was 40 years ahead of its time. As the company itself observed, its was not a typical manufacturing environment because of the precision instrumentation required for products with hundreds of moving parts [Acc 1915, box 40, #029].

Despite the sophistication of Sperry's planning and renegotiation processes, the firm had many of the same complaints about contracting issues with the government that were referenced in the cost accounting literature of the period. In a March 17, 1943 statement submitted by Sperry Corporation to Mr. S.C. Coleman of the U.S. Navy, a Sperry representative explained that while the company understood the necessity for speed, that pressure to get war materiel "into production before design and tooling is complete . . . [resulted in] a continuous series of changes . . ." As an example, Sperry cited a product placed into production only six months earlier that had undergone 1,489 changes in a single month [Acc 1915, #029]. In April 1940, Gillmor complained to the National Research Council about the "useless perfectionism" of governmental quality inspectors [Acc 1915, box 40, #026]. In the same correspondence, Gillmor launched a protest against the auditors of the War, Navy, and Treasury Departments who disallowed certain items of overhead, such as selling expense. In general, Gillmor was protesting a fixed limit on profits, urging that "profit limitation provides every incentive for increasing costs and none for decreasing them".

Sperry was keenly aware of the importance of the design phase of operations as we have seen in describing the activities

of the Methods Department. The complaint was lodged that the pressures of wartime militated against thorough trials being conducted before product launch [Acc 1915, box 40, #024]. A rather amusing, undated, handwritten page appears in a file entitled "World War II Renegotiation of Government Contracts, 1942" [Acc 1915, box 40, #031]. The anonymous author averred that in the 20 years leading up to 1935, research and development failures had cost Sperry $1.3 million in losses. It was noted that the company maintained a museum of these costly failures.

Finally, the company was most concerned about losses it anticipated as a result of the termination of contracts as the war ran down. This was a realistic concern. Table 1 below provides some indication of the investment in men, material, and equipment that Sperry made during, and specifically for, the war [Acc 1910, #024, figures rounded]:

TABLE 1

Sperry World War II Statistics

	Employees	Land and Buildings	Machinery and Equipment
January 1, 1940	5,400	$1,308,000	$2,411,000
Wartime peak	56,000	5,926,000	4,376,000
December 31, 1945	15,000	1,694,000	1,902,000

The government, however, was not willing to allow these future costs to be factored into pricing or negotiation. Costs here included inventory buildups of wartime products unsuitable for sale in peacetime, the consolidation of plants as demand decreased, the cost of retooling for peacetime, and the cost of superfluous fixed assets. T.A. Morgan, the president of Sperry Corporation, complained to the House Committee on Naval Affairs that the various price adjustment boards with which the firm had to deal did not allow a provision for reserves for termination expenses as a current cost in renegotiation [Acc 1915, box 40, #026]. These termination issues were fully discussed in "The Story of the Sperry Corporation" [Acc 1915, box 40, #023, p. 62].

Sperry's wartime contribution was significant. By 1943, the company was manufacturing 300 different products for the war effort, two-thirds of which had been developed within the prior ten years. The following excerpt from an internal Sperry document [Acc 1915, #023] provides a picture of how some of these products worked together:

> The sound locator picks up approaching planes before they are visible and determines their exact position, speed, and direction of flight. . . . Simultaneously, the anti-aircraft director, functioning as a computing mechanism, determines the direction, elevation, and setting required to aim the anti-aircraft gun at the approaching airplane and transmits this information automatically to the guns through a remote control system.

Not only did Sperry invent and manufacture these products during the six-year period from 1939 to 1945, Sperry also ran in-house schools where they housed, fed, and trained over 77,000 military and naval personnel in the use and maintenance of Sperry equipment.

Subcontracting: A very significant aspect of Sperry's relationship to the U.S. military in World War II was the firm's role in defining a model for subcontracting. The archive contains an extensive file of articles and other publicity regarding Sperry and subcontracting [Acc 1915, box 40]. The firm's Publicity Department was quite expert in placing articles in a wide variety of periodicals that published information about Sperry's contribution to the war effort. The details were typically the same, featuring Sperry's pioneering efforts to establish a subcontracting network and, subsequently, to institute quality-control procedures for its supply of component parts.

Sperry's subcontracting for government provisioning commenced long before the outbreak of hostilities, as had the planning processes for "M Day". Sperry surveyed 1,000 New York City area firms in spring 1937 in order to evaluate those most fit for a subcontracting relationship [Norcross, 1941, p. 77]. The first subcontract was negotiated in 1937 with the American Machine & Foundry Co. (AMF) and called for 2,000 machine hours of work. AMF, a manufacturer of bakery and tobacco-processing equipment, would eventually dedicate 90-95% of its capacity to 13 government contractors, without ever having a direct defense contract [Gesner and Beckley, 1941]. From this modest beginning, Sperry's outsourcing grew exponentially, reaching 486,000 machine hours per month from 145 sources by October 1941 [Morgan, 1941, p. 7]. A report of November 29, 1943 averred that 50% of the dollar value of Sperry's shipments was materials either subcontracted or bought from suppliers, and that 35% of all man-hours charged were from subcontracted work. Even at those levels, the volume of subcontracting

was down from peak levels the year before [Acc 1915, box 40, #027].

More significant than the volume of Sperry's subcontracting was the relationship between the firm and other munitions manufacturers, both prime and subcontractors. Prime contractors were those that delivered entire instruments to the military and held contracts directly from some government agency for that provisioning. Included were such industrial giants as Ford, National Cash Register, IBM, and Chrysler. The minutes of the March 6, 1942 Board of Directors' meeting contained approval for a policy that granted prime contractors and their subcontractors licenses to manufacture certain patented items without royalty for the duration of the war. This resolution was reiterated at the March 18 meeting, along with Sperry's commitment to provide engineering and manufacturing assistance at cost [Acc 1910, box 23, vol. 7, no. 1]. By the end of the war, 140 Sperry products were being manufactured by 26 prime contractors under a royalty-free plan [Acc 1910, box 23, vol. 8, minutes of August 29, 1945].

Equally significant were the relationships the corporation forged with its suppliers. As early as September 1938, with the articulation of the "Emergency Procurement Plan" Sperry had identified the shortfalls of direct labor, machine equipment, and floor space required for the volume of armaments the government was requesting. At that time, 14 subcontractors had been selected on the basis of past experience that "were qualified and trained to our close tolerances and the Sperry standard of work . . ." [Acc 1915, box 53, folder 8, #053]. By spring 1939, the company expected to inform the War Department of additional subcontractors that were currently being investigated. As of August 28, 1939, a finalized list of subcontractors had been developed with both additions to, and deletions from, an original list of 32 previously articulated [Acc 1915, box 53, folder 8]. By 1943, the number was to grow to 500 ["Report for 1943 Renegotiations," p. 22, Acc 1915, box 82].[8]

According to an article that appeared in the *New York World Telegram*, Sperry required 60,000-70,000 parts, almost 50% of which were farmed out to 76 subcontractors. The paper quotes a spokesman from the N.J. Gear and Manufacturing Company [Williams, 1941]:

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[8] A "Report on Subcontracting." dated November 1943 [Acc 1915, box 40, #027], claimed that the number had not changed materially since 1941, but that new firms had been added and old ones weeded out.

> [Our] first attempts at Sperry Gears were mostly rejected. Then the Sperry Engineers came . . . and assisted . . . in adjusting…machines to close tolerances. . . . After six months of patient toil [we were able] to produce gears that passed inspection. I learned . . . that when Sperry engineers said 'one one-thousandth of an inch,' they mean one one-thousandth of an inch.

The significance of Sperry's subcontracting operations is demonstrated by the fact that the gyroscope subsidiary alone had a staff of 150 people employed to handle the details of external relations [Morgan, 1941, p. 7]. L.B. Coon [1941], the planning manager, wrote an informative article for *Mechanical Engineering* in which he discussed how to establish a subcontracting organization. A separate subcontracts department, it was recommended, should be established with reporting responsibility to the planning manager. This department should include methods engineers to supervise data collection on the subcontractors' capacities in terms of machine time and floor space, a corps of clerical workers to provide monthly reports, and a group of production expediters ("follow-up" men) to circulate among the subcontractors to ensure compliance to schedules. There were also to be inspectors at the suppliers' installations to ensure the quality of component parts. Sperry learned early on that it was expeditious and cost/beneficial to locate the inspection process at the source of supply. The prime contractor's methods department would be deployed to provide details as to how work should be performed and how much time should be allowed for various functions. Cost accountants would be involved in helping to establish price quotations based upon the subcontractor's actual cost experience. Coon observed that subcontractors tended to under-quote prices in order to get relationships established. The subcontracted price would be established by determining a money rate per hour for each plant, taking into account individual wage scales, burden rates, and reasonable profit, and then multiplying that rate by the predetermined time estimate.

In summary, Coon [1941, p. 516] advanced six points to define all subcontracting operations:

1. Preliminary planning is essential for determining subcontract requirement.
2. The regular organization is not adapted to absorbing the subcontract program. Greater control can be obtained through the medium of a special structure.

3. A systematic and thorough training period will pay dividends.
4. Evolve a flexible system of cost control which will ensure a fair profit to the subcontractor, without necessitating lengthy and time-taking negotiations.
5. Maintain close personal contact between both organizations to insure delivery and cost control.
6. Do not in any case 'walk away' from the subcontractor's internal difficulties. Accept them as your own and lend assistance.

A more widely circulated set of principles for Sperry's subcontracting process was its twelve-step "creed" (Exhibit 1) [Norcross, 1941, p. 77; Morgan, 1941, p. 8]:

EXHIBIT 1

THE SPERRY CREED FOR SUB-CONTRACTING

1. Schedule the amount and types of your sub-contracting as far in the future as possible.
2. In surveys of potential plants, secure complete information on size of building, type of machines, kind of product being made, skill of personnel available, output, possibilities for expansion.
3. When you have chosen your subcontractors, provide them with as much help as though they were new departments of your own company.
4. Provide complete blueprints, job sheets, and cost sheets. Don't hold back any manufacturing secrets.
5. Set a fair price, preferably a cost-plus basis on early orders. Your subcontractor must make a profit to stay with you. Admit to yourself that there is always considerable scrap on early orders.
6. Lend or help to secure for your subcontractor, if necessary, any tools or new equipment he may need.
7. Give freely of your supervisory help. Send in methods engineers and shop men who have the "know how" on the product to be made.
8. Keep complete machine charts as to work done and work on order. Watch for bottlenecks in methods and materials.
9. Help your sub-contractor with training and personnel problems if needed.
10. Remember that educational orders may be necessary for six months on difficult work.
11. Follow-through on every production detail.
12. Don't be over-optimistic as to early results. Sub-contracting is a long, tough job.

Sperry received full credit for its subcontracting network. For example, *Farming Out Bulletin No. 5* of the U.S. Labor Division (1941) contained a full description of the system in "Subcontracting Methods of the Sperry Gyroscope Co." [Acc 1915, box 40, #023, pp. 19-27]. The November 6, 1941 edition of the *Utica Observer Dispatch* proclaimed: "The Sperry Company is

pointed to as the prize exhibit of how subcontracting can best be done" [Acc 1915, box 40, #023].

Growth: The Sperry archive contains a plethora of statistical data charting the meteoric growth of the company as a result of the World War II experience. In addition to its own employees, an April 1942 document that placed the then Sperry labor force at 25,000 estimated an additional 75,000 employees at the plants of prime contractors and subcontractors working on Sperry products [Acc 1915, box 40, #013]. Other personnel growth numbers from 1943 measured an increase in engineering and research from 600 to 4,000, of licensed engineers from 120 to 680, and of women in the work force from 10% to 43% [Acc 1915, box 82, pp. 25-26]. Other growth indicators were net income and sales. Table 2 below illustrates as well the low margins government contractors were permitted during the war [Acc 1915, box 55, files 1-4]:

TABLE 2

Sperry Sales Revenue and Net Income

Year	Sales	Net Income	Margin
1933	$ 3,571,630	$ 495,630	13.88%
1936	15,220,446	2,570,568	16.89
1939	24,827,498	5,462,060	11.00
1942	249,318,939	5,777,961	2.32
1945	217,452,692	6,954,438	3.20
1948	120,859,852	8,770,552	7.26

Research and Development: New product development was an essential component of Sperry's operations. In point of fact, the company claimed that, "we are the only company in the country which maintained continuous research on military instrumentation between the last war and this" [Acc 1915, box 40, #024]. According to the same source, 1,700 people were employed in the research organization, "engaged solely on new developments".[9] At the beginning of World War II, Sperry estimated that 85% of its sales revenue came from products developed during the Depression decade [Acc 1915, box 53, folder 7, #057]. During the war itself, Sperry expended $35 million on research and development, with the government funding 45% of the cost. One hundred and forty new products resulted [Acc 1910, vol. 9,

[9] A March 1943 report to the Navy put the number engaged in research at 1,600 [Acc 1915, Box 40, #026].

#052, minutes of August 29, 1945]. A lengthy list of new products developed during the 1930s and the early war years are provided in a February 1944 document, "Nature of Pre-War Business . . ." [Acc 1915, box 40, #030].[10] They included the automatic pilot, radar-detection equipment, engine-control instruments, radio-navigation systems, power controls for land and naval guns, electronic telescopes, and many others [Acc 1910, #024].

A typed listing of "experimental expenses" for 1925-1946 was compiled with 1947 and 1948 handwritten at the bottom [Acc 1915, box 53, folder 14, #055]. The impact of World War II on R&D is immediately apparent as reflected in Table 3:

TABLE 3

Experimental Expenses

1937	$183,831	1943	$2,563,295
1938	269,739	1944	3,799,707
1939	459,233	1945	3,287,095
1940	571,356	1946	2,864,299
1941	1,363,753	1947	843,989
1942	1,383,129	1948	565,713

There have survived in the archive monthly reports on research and development contracts undertaken with the military during the war [Acc 1915, box 53, folder 17, #055]. These reports are typed on huge folio pages with numerous data categories. The contract price is given, along with the costs-to-date divided into factory labor & burden, engineering labor & burden, design labor & burden, and material and sundry expense. Information is provided for those contracts where expenditure had exceeded contract price, both for the current year-to-date and for prior years. Current costs are recorded for the month of the report and for year-to-date. Finally, there is a schedule of engineering and development expense generated by the Engineering Division, referenced as "Schedule X". Here the budget for the specific subdivision is provided (e.g., aeronautical, armament, marine), along with the amounts authorized for specific jobs. Actual expenses are recorded for (1) shop labor & overhead, (2) material, (3) engineering labor & overhead (4) drafting labor & overhead, (5) sundries, and (6) air lab & marine lab [Acc 1915, box 53, folder 14, #055]. The amount of detail maintained on

[10] Morgan wrote to the House Committee on Naval Affairs in July 1943 to the effect that Sperry was producing 300 different war products [Acc 1915, box 40, #026].

research and development expenditures is one of the most impressive aspects of the Sperry archive.

Labor Control: The Sperry Corporation had an exceptionally structured organizational plan. Gillmor [1941, p. 4] described how "all lines of authority and responsibility are clearly shown on the Organization Chart mounted in the Executive Offices". More importantly, the Sperry organization plan was detailed in four manuals. The "Organization Manual" defined the distribution of responsibility and was, in the first instance, the aforementioned chart in narrative form. The "Standard Practice Manual" defined operating procedures, including detailed instructions as to how work was to be performed. This specificity for job functions seems very much in the scientific management tradition. The most interesting of the manuals was the "Salary and Wages Administration Manual". Gillmor averred that the skills and characteristics required for each occupation were described, along with the procedures for rating performance and determining eligibility for promotion. Individual workers were to submit to semi-annual reviews by a committee comprising the department head, the division chief, and a member of the Personnel Department, although no evidence survives that these evaluations were ever undertaken. There also existed an "Accounting Manual", about which Gillmor [1941, p. 4] only observed that it "specifies the distribution of operating expenses by responsibility". It is unfortunate that none of these manuals has survived in the archive.

It would appear that a structure existed for labor control, both through the definition of tasks and the establishment of performance standards subject to semi-annual review. However, we have no evidence that the system functioned as theoretically envisioned. In point of fact, an anonymous, undated collection of comments maintained in a miscellaneous file indicates that labor "control" was very different from that envisioned by Taylor ["What the Company Does", Acc 1915, box 40, #024]. On the "nature of discipline" the author observed:

> . . . not to be associated with severity or punishment, but with the Biblical origin of the word which means the processes of training by which the individual becomes a disciple for that in which he believes and a disciple of his leader, able to carry on without direction.

Perhaps a more compelling illustration that the system was not functioning according to Taylorite principles is contained in the following damning quotation from the same source:

> An explanation that operation sheet times are at present nothing more than very approximate guesses and likely to be one-quarter of the time necessary or four times the time necessary. Practically all of them have had to be determined hurriedly with no opportunity to observe the operation in practice and often times without knowing the particular machine tool that will be used. They serve one important purpose, and that is that on the average over several hundred operations they are very close to correct and provide a good guide for estimating costs and for scheduling. When it comes to a particular operation, however, the worker is his own best judge as to what the time should be and as to whether he is doing well or badly. Eventually the times will be correct, as we are now making studies of the operations on the job, but it will take months to accomplish this.

The impact of World War II on the labor force is reflected in Exhibit 2 [Acc 1915, box 53, folder 7, #057] where 56.6% of Sperry's employees had less than a year's experience with the firm.

There is evidence that, during the war, statistics were maintained to curb absenteeism with chronic offenders terminated [Acc 1915, box 53, folio 8, # 053]. A report of the Industrial Relations Research Department for February 1944 compared worker termination rates to other companies and found conditions at Sperry favorable on that parameter [Acc 1915, box 40, #029]. However, wartime dislocations militated against more effective forms of labor control. In Gillmor's 1940 letter to the National Research Council [Acc 1915, box 40, #026], the general manager related how the firm had to take complex tasks that skilled operatives would perform and break them down into simple, repetitive tasks appropriate for lower-skilled workers. Amazingly, the deskilling process described predated America's entrance into the war by 20 months!

ANALYSIS AND CONCLUSIONS

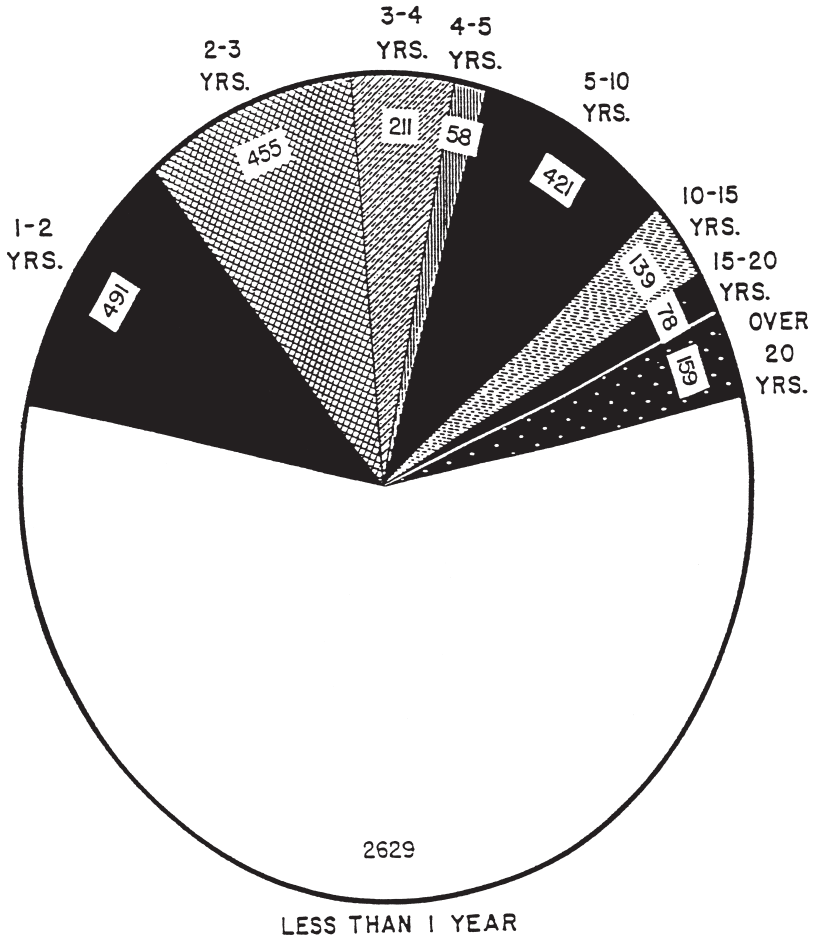
In terms of Sperry's cost accounting, the company had adopted a number of state-of-the-art methodologies reflecting scientific management theory. The company had deployed time-study to determine scientifically the processes for accomplishing tasks, with rules for work collected into manuals. Sperry had a Methods Department almost from its inception that issued instructions on manufacturing methods and time allowances for various operations taken in sequence. The advice of shop-floor workers was solicited in the process [Mills, 1920, p. 12], with the

EXHIBIT 2

SPERRY GYROSCOPE COMPANY, INC.

DISTRIBUTION OF EMPLOYEES BY LENGTH OF SERVICE

OCTOBER 1, 1940



TOTAL: 4641 EMPLOYEES

resulting procedures subsequently codified into the Standard Practices Manual. A report to the Navy in March 1943 discussed how standardized practices had grown since 1937 because of labor turnover and expansion and how 15 industrial engineers in the Organization and Procedures Department and 50 in Manufacturing Engineering were attempting to cope with these issues on an ongoing basis [Acc 2925, box 40, #026].

Procedures were also codified for the evaluation and reward of operatives, although again, evidence does not exist of their utilization. Sperry also approached the question of physical plant layout in engineering terms. However, there is no evidence that the company ever instituted a standard costing/variance analysis system as part of its package of scientific management methodologies.

World War II represented a step backwards for Sperry's scientific management in that labor-force shortfalls and inexperience rendered older, time-study-based routines and evaluation techniques dead letters. Only further study will reveal whether the prewar measures were recaptured post-1945. Although Sperry did not have a standard costing system in place itself, the costing literature of the period indicates just how detrimental an effect the wartime experience had on companies that did have such a system. The impact of the war on Sperry's labor-control processes serves as an indication of how World War II dislocations were dysfunctional to purposeful cost accounting, at least historically.

It is true that governmental contracting can spawn a greater costing awareness, featuring the expansion of cost accounting departments to generate the masses of data needed for contract pricing [see also Anderson, 2003 for corresponding developments in Australia during World War II]. However, this exercise was rather low-level and artificial costing, particularly because governmental costing exclusions (as in TD 5000) are inappropriate for peacetime.

Sperry was not alone in its failure to have an adequate system of cost control. M.L. Black and H.B. Eversole of the OPA were quoted in the "Cost Current" section of the *NACA Bulletin* [1946, Vol. 28, No. 8, p. 517]: "The predominance, in systems, of process or actual costs and, in overhead distribution methods, of direct labor costs suggests the standard costs and more studied application of overhead are still in the earlier stages of adoption with respect to industry as a whole".

The OPA's chief accountant, H.F. Taggart, attempted to quantify the problem. He estimated that only 15% of the

country's manufacturing companies had cost systems worthy of the name, representing approximately 25% of total industrial output [*New York Certified Public Accountant*, 1947, p. 1444].[11]

Notwithstanding its spotty record in adopting scientific management techniques, the Sperry Corporation was a very innovative and sophisticated enterprise. It had a distinctive vision of its future, reflected by exceptional planning processes. Exhibit 3 is a sales forecast for 1945 and 1946 that typifies graphic presentations common in the archive. It is interesting to note that Sperry anticipated the war's termination as indicated by the decline of sales from $13 million in June 1945 to $8 million in September 1946. It should also be noted that the graph reflects the phasing out of old products and the introduction of new ones [Acc 1915, box 53, folder 7, #057].

An interoffice memo from F.S. Hodgman of the Engineering Division to Lea in 1939 advised that, henceforth, costs were going to be investigated by individual product lines rather than at more macro-levels. In addition to allocating a share of common costs, the plan called for costing out the design phase [Acc 1915, box 53, folder 5]. As early as 1941, the company began to reserve one percent of sales to cover postwar readjustment of facilities and personnel [Acc 1910, series I, volume 6, minutes of March 31 and June 13, 1941].

The experience at Sperry Corporation cannot be generalized uncritically to other wars or other companies. The pressure at Sperry was probably greater. Sperry's ability to create new instruments and new equipment actually widened the military's tactical options. To the extent that Sperry instrumentation supported expanding military capabilities, it was significant in allowing the military to continually alter its weaponry and, hence, to respond quickly to the changing tactics of the Axis Powers. Nevertheless, inspection of industry-based articles in the *NACA Bulletins* and *Yearbooks* from 1938 to 1945 did not unearth any articles claiming that the war had advanced the practice of cost accounting. At best, the majority of the articles remained "tutorial" in nature, supporting the claim that sophisticated cost accounting was still not generally practiced.

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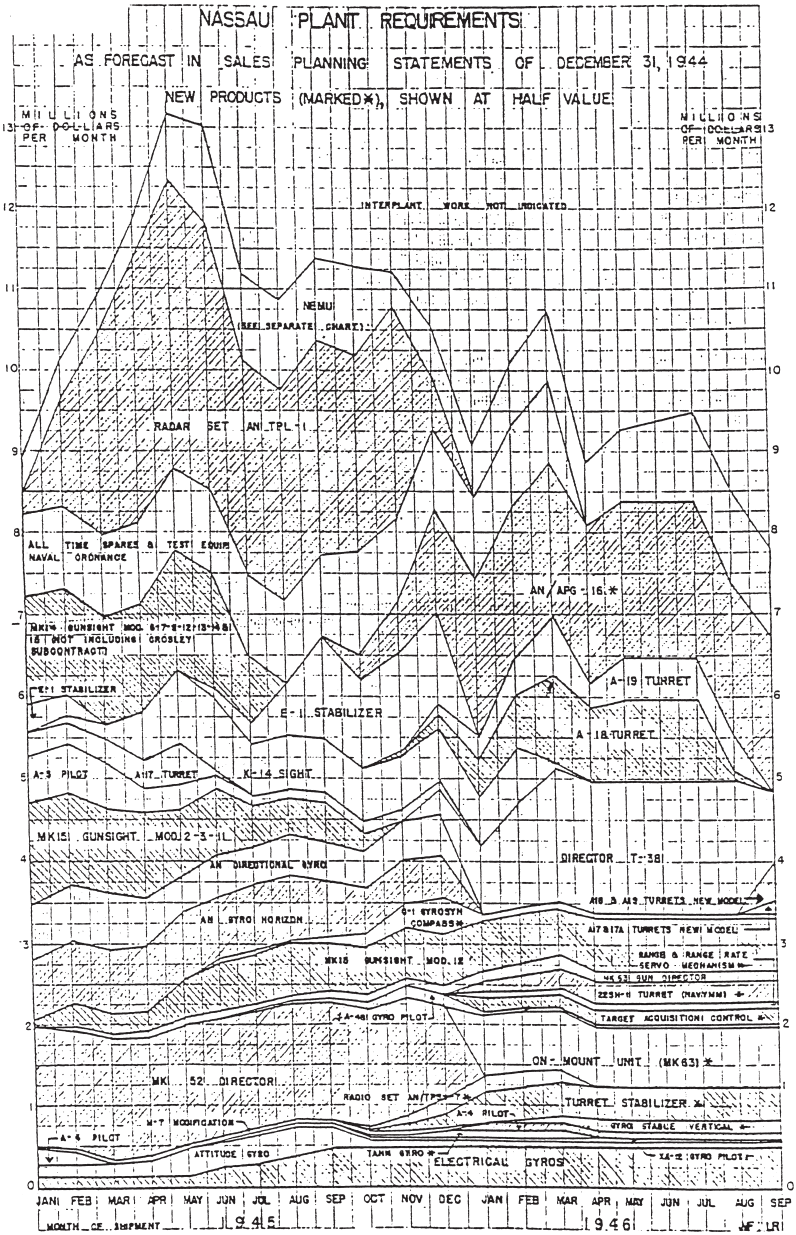
[11] The NACA's Committee on Research undertook a substantial project on standard costing that was published in five installments in the *NACA Bulletin* in 1948 [Vol. 29, Nos. 11, 14, 19; Vol. 30, Nos. 3, 8]. The study concentrated on how standard costing was used in 72 manufacturing firms. The issues of the extent of standard costing and the selection method that identified the surveyed firms were not addressed.

EXHIBIT 3

Sales Forecast, 1945-1946



While we did not find advances in sophisticated cost accounting techniques, what we did find in the Sperry archive was equally interesting and rather unexpected. With parallels to Japanese management innovations of the 1980s, Sperry realized the advantages to be gained from managing *time* as distinct from *cost* [Stalk and Hout, 1990; Blackburn, 1991]. As early as 1920, I.H. Mills [1920, p. 13], the factory superintendent, observed in *The Sperryscope*:

> The importance of time can scarcely be overemphasized. It forms the larger part of the cost of production and when its value is fully appreciated, the way is opened for economics of production which make it possible to conduct a business profitably and allow it to be established on a sound financial basis. It is a widening circle—economy in the use of time, lessens the cost of production . . .

At a later point in time, it was disclosed in the Office of Production Management's piece on Sperry in the *Farming Out Bulletin* that monthly variance reports that the firm demanded from its subcontractors were measured in time rather than cost [Acc 1915, box 40, #023, p. 22].

Finally, what was most singular in the Sperry archive, in our opinion, were certain techniques developed at Sperry that sound strangely modern. These methods include a substantial awareness of the product-launch component of operations, featuring an orientation toward research and development, the allocation of design-phase costs to product, and the ramifications of the learning curve [Tanaka, 1989; Cooper, 1995].

Sperry was in the vanguard of subcontracting expertise, today's outsourcing, albeit more as a function of capacity constraints than cost/benefit [Horngren et al., 2003]. This aspect of Sperry's operations could have constituted a primer for the proliferation of outsourcing in today's industrial sector. Perhaps even more directly related is how the Sperry experience presaged the influence that major companies, such as Toyota, exercise over their suppliers in JIT environments today [Fruin and Toshihiro, 1993].

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