

RELATÓRIOS COPPEAD

Dezembro 2009

388

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DEVELOPMENT OF THE
AMERICAN ELECTRICAL
MANUFACTURING
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GENERAL ELECTRIC
& WESTINGHOUSE

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Relatórios COPPEAD é uma publicação do Instituto COPPEAD de Administração da Universidade Federal do Rio de Janeiro (UFRJ)

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Ficha Catalográfica

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Fleck, Denise Lima.

The building and development of the American electrical manufacturing industry and its top two companies – General Electric & Westinghouse / Denise Lima Fleck. – Rio de Janeiro: UFRJ /COPPEAD, 2009.

65 p.; 27cm. – (Relatórios COPPEAD; 388)

ISBN 978-85-7508-075-7

ISSN 1518-3335

1. Estratégia empresarial. I. Título. II. Série.

CDD – 658.4012

Pedidos para Biblioteca:

Caixa Postal 68514 – Ilha do Fundão

21941-972 – Rio de Janeiro – RJ

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THE BUILDING AND DEVELOPMENT OF THE AMERICAN ELECTRICAL MANUFACTURING INDUSTRY AND ITS TOP TWO COMPANIES – GENERAL ELECTRIC & WESTINGHOUSE

Denise L. Fleck

ABSTRACT

The paper describes the development of the American electrical manufacturing industry and of its top two companies, General Electric and Westinghouse, from the early 1870s to the late 1990s.

This paper describes the formation, consolidation and dismantling processes of the electrical industry structure. Although there are no clear-cut dates that unequivocally establish the processes' starting and ending points, the historical description is organized along five major periods: industry formation (1870s-1910), duopoly consolidation (1910-late 1930s), duopoly dismantling (late 1930s-late 1950s), exploring new roads (late 1950s-mid-1970s) and navigating the chosen path (mid-1970s on).

PERIOD I: INDUSTRY FORMATION (1870s-1910)

In the late 1870s the Brush Electric Company pioneered exterior illumination by developing arc-lighting systems and Thomas Edison invented the high-resistance incandescent lamp and subsequently developed a complete system for the generation and distribution of electric power. Both illumination systems used the direct current (DC) system. George Westinghouse's inroads into the industry in the mid 1880s with the alternate current (AC) system challenged and eventually replaced the DC system. Arc lighting, for open spaces, and incandescent lighting, for internal use, complemented each other, and together, they challenged gas lighting. In addition, the industry diversified into electric motors and traction. In 1892 Thomas Edison's Edison General Electric Company (EGE) and Thomson-Houston Electric Company (T-H) merged and the young electrical industry started to organize around Westinghouse (WH) and the newly-born General Electric (GE).

Throughout the 1890s and 1900s the top two companies' actions continued the shaping of the industry. Eventually, only those two companies developed a full line of products. Viewing GE's formation as a turning point in the industry's early history, this section first describes the years anteceding GE formation and then the years following the merger.

The years anteceding GE's formation (1870s-1891)

In the 1870s electrical phenomena were ill-understood. On both sides of the Atlantic, electricity attracted the attention of engineering-minded people who undertook independent efforts to construct dynamos and develop electrical lighting. Electrical lighting systems were conceived as an alternative to, and eventually replaced, the gas illumination system that by 1875 had become customary.

In the late 1870s, a number of innovators were developing the arc lighting system for street and large-space illumination. Arc lighting was first displayed during the 1876 Philadelphia Centennial Exposition. Although they did not catch the attention of visitors¹, arc lamps, and later on electric motors, would rapidly spread and replace gas lighting and steam engines. Charles Brush was the pioneer-innovator in arc-lighting, having succeeded in developing a lighting system that produced a high-quality light at a lower cost in order to displace gas from large-space illumination. In 1879 Brush installed the first arc-lighting system and by the end of 1880, over 5,000 Brush arc lights and dynamos were in operation².

Elihu Thomson was the improvement-innovator who together with Edwin Houston gave rise to the Thomson-Houston Electric Company (T-H). After a few years of work, by the end of 1881, Thomson felt he had finally built an arc-lighting system, which was technically superior to any other in the market³. In the middle of 1882 a group of Lynn businessmen, including Charles A. Coffin, became interested in Thomson's system and T-H was founded in 1883 to exploit arc-lighting patents of Elihu Thomson and Edwin Houston. Coffin, the salesman and organizer, took charge of the company teaming up with Thomson, the ingenious inventor.

¹ J. A. Cox, *A Century of Light*, (New York, N. Y., 1979).

² H. C. Passer, *The Electrical Manufactures 1875-1900: A Study in Competition, Entrepreneurship, Technical Change, and Economic Growth*, (Cambridge, Mass., 1953).

³ Elihu Thomson was very knowledgeable about patents and how to circumvent them. According to Rohrer who went to work with Thomson in 1884, "I would have an idea – the Professor [Thomson] would listen to it and immediately point out how it infringed somebody else's patent. Then he would say, 'I think we may be able to dodfe them this way.' Pulling an old envelope from his pocket he would rapidly sketch the arrangement he thought would work. 'Now go and make this and we shall see,' he would finish, and turn at once to something else." Source: P. L. Alger, *The Human Side of Engineering: Tales of General Electric Engineering over 80 Years*, 1972, 35.

T-H flourished in the arc lighting business by developing valuable strengths to face a quite friendly environment. On the technological side, system design quickly stabilized and T-H did not introduce any major technical improvements after 1883. Patents covering basic components were not issued to protect pioneer-innovators, because neither of the basic elements of the arc lighting system – the dynamo and the arc light – was patentable. However, over time, improvement patents became very important, and T-H was particularly strong having had an improvement patent on automatic regulator upheld in 1888. On the marketing side, the awards received in technical exhibitions – such as the London Inventions Exhibition in 1885 – helped T-H to build a reputation that was important for selling the Thomson-Houston system both at home and abroad. In addition, the company built its own sales force, having decided early on to focus on the most promising market segment, central stations, rather than on isolated plants. In fact, by 1891, the latter accounted for no more than 10% of T-H's arc lighting business.

The wide market for arc lighting gave rise to a moderately competitive environment with low intra-industry competition. Yet, since arc lighting was a substitute technology for gas lighting, competition was higher with gas illumination companies. Before T-H's improvement patent was upheld in 1888, arc lighting technology was quite stable and the market so large that companies could grow rapidly and still not have to compete among themselves for business. Thereafter, T-H initiated a policy of buying out other manufacturers of arc lighting apparatus when the opportunity arose. Acquisitions were made to eliminate rivals, to secure the services of highly skilled technical personnel working for the acquired firms, to obtain key patents, and to enable T-H to expand its productive capacity. After all, it was much faster to buy existing facilities than to construct them. For example, when T-H acquired the Brush Company, T-H's plant at Lynn was in operation twenty-four hours a day. T-H emerged as the dominant firm in arc lighting, having acquired most of the early arc-lighting manufacturers of any significance, except Weston that eventually became part of WH.

Arc lighting was used to illuminate wide-open spaces. Because it produced light by burning a substance primarily composed of carbon, it was restricted to uses where an open flame was permissible. In addition, the intensity of the bright light it produced could not be reduced. The substitute technology for interior gas illumination was incandescent lighting. Thomas Edison was the pioneer-innovator in this field, while Elihu Thomson once more was an improvement-innovator.

When Edison approached the electrical industry in search of profitable areas of business, he focused his attention on incandescent lighting⁴. After his successful invention of an incandescent lamp late in 1879, Edison devoted himself to a careful and systematic study of gas illumination. Edison aimed at imitating the gas system as closely as possible, while differing from gas only in providing a superior and more desirable light. His approach put aside the arc lighting business path, which looked very promising, as well as every technical advance that had brought arc light to the commercial stage. In fact, to become as efficient as arc lamps were, the initially extremely inefficient incandescent lamp would require Edison to face various technological challenges and to invent a new system that bore no resemblance to the arc-lighting system. To carry out the invention of various components simultaneously, Edison organized his research laboratory in a way that enabled him to direct the work of his assistants on the problems that he posed. Besides his deep involvement in the technical aspects of the system, Edison was highly concerned with the economic factors. To him, the successful system was the one that could provide reliable and satisfactory lighting service for home at a price lower than gas. On September 4, 1882 Edison opened a central power station in lower Manhattan. From 1883 to 1887 he would embrace the mission of disseminating electric light and power, by installing central stations and isolated plants⁵.

Patents were not very effective in protecting Edison's incandescent lighting system. For one, the complete technical details of the Edison system were published in a newspaper, the *New York Herald*, in December 21, 1879⁶. Vigorous enforcement of Edison's patents rights could possibly have prevented usurpation of his inventions. Yet, Edison was extremely busy completing his system and directing the implementation of the first incandescent lighting systems and could not devote the required attention should Edison's company have initiated infringement suits against unlicensed use of Edison's patented inventions. Only in 1885 were the first patent suits initiated. Still, only one of these suits was carried through – against the United States Electric Lighting Company – but the hearings did not start until 1889. Completion of the suit took two more years, and because the decision was appealed, it took an additional year for the Edison patent to be

⁴ According to Passer, no evidence has been found to explain why he turned to the incandescent light in the fall of 1877. At that time, there were many inventors working on arc lights and incandescent lights. His choice might perhaps be explained as a marketing-oriented decision. The knowledge he did have that over 90% of the revenues of the gas companies came from home and office illumination, may have been decisive in his decision to concentrate on developing a system that could advantageously replace gas lighting in closed spaces. See Passer, *The Electrical Manufactures 1875-1900*.

⁵ L. S. Reich, *The Making of American Industrial Research: Science and Business at GE and Bell, 1876-1926*, (Cambridge, 1985).

⁶ This happened "some time before Edison had intended it to appear. He was not then ready to market the lighting system, and would not be ready for several years. When Edison's solution to the incandescent-lighting problem was completely described in print, the other inventors working on the incandescent light were given the opportunity to work out their own systems while Edison was completing his". See Passer, *The Electrical Manufactures 1875-1900*, 99.

determined. Edison's company efforts to protect the business by threatening the other incandescent-lamp manufacturers and their customers were not very successful. In fact, most lamp manufacturers seriously questioned the validity of the Edison lamp patents to the extent that some manufacturers retaliated against Edison's suits by initiating suits against local Edison light companies (Edison's licensees).

Upon George Westinghouse's entry in the industry, competition augmented further in the incandescent lighting market. He initially offered direct current (d.c.) incandescent lighting system in 1884 through his Union Switch and Signal Company. In the fall of 1886, he came up with his alternate current (a.c.) incandescent lighting system, marketed by the newly formed Westinghouse Electric Company (WH). George Westinghouse (GW) was known as a thirty-day man, for whom the profits of a new idea or new enterprise would begin to appear in about thirty days⁷. Besides the vast and wide qualities as inventor, engineer⁸, GW possessed superior mental skills⁹, which included unusual concentration and memory. As he personally made most of the key decisions¹⁰, his firms developed but poorly a professional managerial hierarchy¹¹. George Westinghouse would emphasize engineering and manufacturing over marketing, finance, and organization building. He would also emphasize fragmentation and assume the integration role. For example, when WH initiated gas and steam turbine production in 1895, he chartered the separate Westinghouse Machine Company, rather than adding a division to WH. GW sited each of these enormous plants in adjacent towns east of Pittsburgh, to make possible his direct oversight¹². Over time, WH progressively adopted a number of initiatives GE pioneered years before¹³.

In 1887, shortly after WH's introduction of the a.c. incandescent lighting system, T-H began the production and sale of an a.c. incandescent lighting system. Shortly after, WH filed a suit against T-H for infringement of a transformer patent WH owned. The suit

⁷ He was "extremely quick to see a situation and judge the possible merits of a device". See S. W. Usselman, "From Novelty to Utility: George Westinghouse and the Business of Innovation during the Age of Edison", *Business History Review*, 66 (Summer 1992): 251-304.

⁸ George Westinghouse (GW) "was an engineer, not a wizard... with lots of initiative, with nerve to attempt difficult things, and money enough to see them through to success or failure". *Ibid*, 267-268.

⁹ According to Prout, "In a certain eleven years, Westinghouse took out 134 patents, started six important companies which still exist, took the air brake through its one great crisis, and, most important of all, started the alternating current revolution in industrial history". See H. G. Prout, *A Life of George Westinghouse*, (New York, NY, 1921).

¹⁰ George Westinghouse "had a constant part in executive conduct as well as planning and administration – perhaps a part too close for the best results". He "routinely toured the floors of his plants – checking the progress of work, chatting with master mechanics, and nodding to apprentices". See Usselman, *From Novelty to Utility*, 269.

¹¹ George Westinghouse's personality traits "overshadowed everyone in the Westinghouse Company even as late as 1929". See *Fortune*, 1938, p. 49.

¹² See P. Scranton, *Endless Novelty: Specialty Production and American Industrialization 1865-1925*, (Princeton, NJ, 1999).

¹³ A case in point is the centralization of "finance, billing, and control over major policy decisions while providing considerable autonomy to the manufacturing divisions", and the introduction of training programs for skilled workers and engineers. See Scranton, *Endless Novelty*, 232.

was dropped after T-H consented to a settlement whereby it recognized the validity of the patent and agreed to pay royalties per horsepower of rated capacity for each transformer sold¹⁴.

In addition to providing illumination, electricity was being explored as a means to produce mechanical power. Besides the three largest firms – EGE, T-H, and WH – other concerns flourished in this field. By 1887, for example, there were fifteen manufacturers of small motors in the US who had produced about 10,000 such motors. Frank Sprague was a pioneer-innovator in the development of electrical motors, devices which transform electrical energy into mechanical energy. He started working for Thomas Edison in 1883, having resigned from Edison's employ in the spring of 1884 to devote all his time to motor work. In November 1884, he formed the Sprague Electric Railway and Motor Company¹⁵. After buying stock that the Sprague Company had issued to support its growth, EGE absorbed Sprague in 1889.

T-H entered the field of electric motors in 1887, and early in 1888, its President, Charles Coffin, stated that he considered the possibilities of electric lighting exhausted and that he consequently wanted to branch out into electric railway. To enter this new field, Coffin decided to acquire Van Depoele's firm, one of the companies already marketing an electric-railway system. Teaming up with Van Depoele, Elihu Thomson and a T-H engineer converted Van Depoele's small scale system into a large-scale one. By the spring of 1889, T-H had developed an electric railway system that could be used successfully on the largest streetcar lines of the US.

WH entered the electric traction field in 1890. Throughout the decade, a technical competition for designing railway motors took place between WH's engineers and those working for rival firms – initially those from EGE-Sprague and T-H, and later on those of GE (Reich, 1985). After GE's formation in 1892, the vigorous competition between the engineering staffs of WH and the newly formed GE produced radical improvements in railway motors. No evidence has been found that there was, at that time, any tacit agreement between GE and WH to set product prices and share the market. Being a very complex product, the railway motor had many components and features, which could be

¹⁴ Later on, a supplementary agreement was reached setting minimum prices for the transformers, establishing penalty royalty rates for transformers sold in cities of less than 10,000 inhabitants, and specifying that WH was to supply T-H with certain types of a.c. equipment. See Passer, *The Electrical Manufactures 1875-1900*.

¹⁵ Primarily interested in research and development work, Sprague subcontracted Edison to manufacture the company's products. Up to 1887 these were almost entirely motors for industrial uses. In 1887, the increasing motor sales encouraged Sprague to establish his own manufacturing plant. While his motors were achieving increasing success in industry, Sprague was studying electric traction and secured his first railway contracts in the spring of 1887. To complete the Richmond railway project, Sprague had to handle a large number of technical problems whose solution contained the technical features that permitted successful operation on a large scale and set the pattern for electric street-railway development. In fact, by the fall of 1889, eighteen months after the Richmond road began regular operation, Sprague and T-H had equipped 67 roads each, while 46 other roads had been equipped by other smaller manufacturers.

combined in several different ways. As a result, its design followed no rigid standard that could enable an easy comparison of competing products. Technical reputation of WH and GE engineering staffs propelled the improvement of the product stimulating price competition. Engineers believed that to be a real success, any ingenious design had to win in the market place. This required competitive prices, which were usually set on the assumption of heavy sales.

By 1891, EGE, T-H and WH were the three largest firms in the electrical manufacturing industry. Of the 3,000,000 incandescent lamps in use, nearly 1,300,000 were Edison, about 600,000 were T-H, and 500,000 were WH. WH was approximately equal to EGE and T-H in incandescent central station equipment in service, although it was much smaller than the other two in sales, authorized capital, and employment (refer to table 1).

	WH	EGE	T-H
Annual sales*	\$5,000,00	\$10,900,00	\$10,300,000
Authorized capital stock*	0	0	\$10,400,000
Profits**	\$5,000,00	\$15,000,00	\$2,700,000
Employment*	0	0	4,000
Factory space (sq feet)**		\$2,098,000	340,000
Customers**	1,300	6,000	3-4,000
Number of central stations (incandescent)		400,000	
a.c.		3-4,000	500
d.c.			100
Central stations capacity in 16-candle-power lights	350	none	
a.c.	negligible	400	520,000
d.c.			82,000
Street railways equipped**	700,000	none	204
Street railway cars**	negligible	750,000	2,760
		180	
		2,230	

Table 1 – The Three Leading Firms in the Electrical Manufacturing Industry, 1891
 (Sources: * Passer, 1953, p. 150, ** Hammond, 1941, p. 404)

The years following GE's formation (1892-1910)

As early as 1889, financiers who supported EGE started to plan a merger between EGE and T-H. Thomas Edison was opposed to the idea arguing that "if you make the coalition, my usefulness as an inventor is gone. My services wouldn't be worth a penny. I can invent only under powerful incentive. No competition, means no invention"¹⁶ However, Edison held but a minority interest in EGE, and a number of other factors would dictate the carrying out of the merger. First, both EGE and T-H held strong patent positions in arc lighting, incandescent lamps and traction, having both firms significantly improved the quality of electrical products. Yet, neither could aim at producing top-quality goods without fear of infringing on each other's patents. Also, given that their manufacturing lines were complementary except in traction, out of a merger would emerge a very strong company covering the whole electrical field. Finally, EGE had the much needed capital resources T-H needed for expansion, and T-H's superior management team strongly appealed to EGE owners¹⁷.

In the newly formed GE, top management team included former executives from both companies, although the large majority came from T-H. Moreover, former T-H's president, Coffin, became the first GE president. Upon completion of the merger in April 1892, instead of three, the industry had two big companies, one (GE) being several times larger than the other (WH). Table 2 shows the three firms' strengths and weaknesses right before the merger.

¹⁶ Passer, *The Electrical Manufactures 1875-1900*, 321-22.

¹⁷ See K. Birr, *Pioneering in Industrial Research: The Story of the General Electric Research Laboratory*, (Washington, DC, 1957).

Lines of business	EGE (Edison General Electric)	T-H (Thomson-Houston)	WH (Westinghouse)
Arc lighting	. absent. Edison had no interest in arc lighting	. strong position in isolated plants and central stations . had secured control of Brush, the pioneer innovator . the dominant firm accounting for more than 50% of industry output	. absent. George Westinghouse had no interest in arc lighting
d.c. incandescent lighting	. pioneer innovator . owned basic patents in incandescent lamps . had developed good business in lighting equipment for central stations and isolated plants	. had few contacts with central stations which supplied d.c. current for incandescent lighting . by 1891 it held a minor position in the d.c. incandescent lighting	. late entrant (1884) . by 1891, its position was negligible, since it had bet on a.c. transmission from 1886 on
d.c. electric power and street railways	. through the acquisition of Sprague, it had gained a strong position	. had not developed its line to the same extent as Sprague	. strong position achieved through superior technology in railway motors
a.c. power and light	. absent from both light and power because of Edison's opposition to a.c.	. had entered the field shortly after WH . had a long period of experience in a.c. equipment	. strong position, though this was not yet important in 1891
Electric railways	. had experience, reputation, and patents of a pioneer innovator	. had experience, reputation, and patents of a pioneer innovator	. weak
	. by merging these two strengths, it seemed to make possible a position in electric railway equipment equal to the dominance in incandescent lighting equipment long enjoyed by EGE and the dominance in arc lighting long held by T-H		

Table 2 – Contenders' Strengths and Weaknesses as of GE's Formation (1891)

As a result of the merger, GE had become the largest firm in the industry. However, shortly after its foundation, GE faced the 1893 Financial Panic. On the other hand, because WH had not financed central stations as EGE and T-H had, the Panic did not affect WH as much as it afflicted GE. As a result of the 1893 Panic, the electrical manufacturing industry faced depressed conditions up to 1898. Besides the drastic shrinking in sales and profits, the utility securities that both EGE and T-H had accepted in part payment for equipment sold sharply declined in value. GE's assets had to be written off, having declined from \$50 million in 1893 to \$27 million in 1900. Such precarious

conditions turned GE's president, Charles Coffin, into a very conservative businessman¹⁸. He once expressed his conservative philosophy to his comptroller: "Never take a profit until you have it, and always take a loss when there is any possibility of a future loss"¹⁹. Moreover, he subsequently used "the severe economic conditions of the mid-1890s to dictate terms to GE's often foundering competitors"²⁰.

Even though the 1892 merger of EGE and T-H into GE did reduce the number of major players in the industry, competition in the a.c. business was remarkably intense. Electric a.c. power started in 1888. However, it took WH six years to bring a.c. power to the commercial stage. By July 1893 WH was ready to supply a.c. power equipment on a regular commercial basis. In October 1893 WH won the generator contract for Niagara Falls, a victory over its major rival, GE, as well as over the ongoing disbelief in the a.c. system. In fact, the scepticism about the a.c. system was widespread. So much so that Lord Kelvin, a member of the International Niagara Commission, advised the Niagara organizers to avoid the "gigantic mistake of alternating current"²¹. Although GE assigned its best engineers to the Niagara project, it was the pioneer innovator WH who received the contract for the first three generators. GE was awarded contracts for the transformers, the transmission line to Buffalo, and the equipment for the substation there.

So intense was industry competition, that more than once, industrial espionage was an issue. In the course of the effort for winning the Niagara contract, WH made charges against GE. Some of WH's missing blueprints were found in GE's Lynn factory. Apparently, a janitor in the WH engineering department had stolen the plans from the company file. In September 1893 charges of conspiracy were brought against GE officials who admitted some of the espionage, but claimed that their only purpose was to learn of possible violations by WH of a certain injunction related to the manufacture of incandescent lamps. While price knowledge plays an important role in the preparation of bids for homogeneous competing products, in the context of heterogeneous, complex products, acquiring knowledge about rivals' product quality rather than their prices becomes of utmost importance. The Niagara Falls episode provides an example of such an attempt from GE to secure information concerning WH. Another attempt took place in the spring of 1895, when WH charged that GE had paid a WH employee the amount of \$25 in exchange for information on WH's outputs in each line of business.

¹⁸ "When he had run T-H, he had been willing to take substantial risks to stimulate the growth of the company and the industry, but as president of GE he exercised such extreme caution in the expansion of business that he often disconcerted the other officers". See Reich, *The Making of American Industrial Research*, 51.

¹⁹ Fortune, January 1931, p. 98

²⁰ L. S. Reich, "Lighting the Path to Profit: GE's Control of the Electric Lamp Industry, 1892-1941", *Business History Review*, 66 (Summer 1992): 305-34, 306.

²¹ *Ibid*, 287.

As the bankruptcy threat was over, GE looked for further ways to stabilize intra-industry relations. Relationship with suppliers is a case in point. For example, in 1895, GE signed agreements with three glass manufacturers – Corning, Libbey, and Phoenix – assenting to buy the entire supply of glass from the three companies and to divide its purchases in ratios of 2:2:1, respectively. No other lamp producer was to buy bulbs and other lamp-glass requirements from those manufacturers more cheaply than GE. In addition, GE reserved the right to start its own glass production should it see fit²².

Rivalry with WH remained strong. Apart from espionage, by 1895, WH and GE had filed hundreds of patent infringement suits against each other. The immense costs involved favored the signing of a patent agreement, which was to run for 15 years. The cross-licensing agreement between GE and WH in March 1896 brought to an end the hundreds of patent infringement suits that both companies had initiated against each other. The two companies exchanged licenses to all of their patents except those for electric lighting, due to specific clauses in GE's licenses to utility companies. Such clauses dated back to Edison's license granting period. When he started selling his systems he guaranteed his licensees exclusive rights to use Edison's lamps.

According to the GE-WH agreement, the value of production was to be in a ratio of five (GE) to three (WH). Should either company exceed its share, it would pay the other a royalty. Having reached this agreement, both companies started to sue smaller firms, forcing them either to license the patent pool or to sell their businesses to one of the two companies. Interestingly, once one of them (for example, GE) initiated a suit against a third company, the latter would quite often end up in the hands of the other company (WH, for example).

In August 1896, GE and 6 other companies organized the Incandescent Lamp Manufacturers Association (ILMA), which had for its purpose the fixing of lamp prices and the allotment of business and customers of each. Many other manufacturers joined ILMA later on. Agreements were made between ILMA members and WH, whereby WH agreed to maintain prices fixed and established by the association²³. The following year ILMA fixed proportional output keyed to GE's sales and set prices based on GE's prices. GE got 50% of the market, WH no more than 15%, and the remaining went to all others²⁴.

²² See A. A. Bright Jr., *The Electrical Lamp Industry: Technological Change and Economic Development from 1800-1947*, (New York, NY, 1949).

²³ See Bright, *The Electrical Lamp Industry*, 103-4.

²⁴ Reich states that WH received about 15% and the others divided the remaining 35%. In his 1992 paper, Reich asserts that WH received about 12% and the remaining 35-40% went to all the others. See Reich, *The Making of American Industrial Research*; Reich, *Lighting the Path to Profit*.

In the late 1890s a number of independent lamp manufacturers competed with GE, WH and among themselves. In order to improve their competitiveness, two small companies envisaged the consolidation of all smaller manufacturers into a holding company under protection of GE. The National Electric Lamp Association was created in 1901 and was fully operational by 1904. To secure financial resources and technical aid, GE gained controlling stock in National owning 75 percent of the common stock, and holding an option on the remaining 25 percent²⁵.

Constrained by the quota system in the American market, George Westinghouse expanded his empire of firms worldwide during WH's first decade. By 1896 GW had established one electrical operation in England, and two other companies, in England and Germany, to operate in his first major accomplishment, the air brake business. In 1896, he advanced in some detail his idea of a vast scheme of foreign companies²⁶. The 1896 plan planned the formation of new companies in Britain, France, Belgium, Russia, and Austria (to include the Balkan States), while Norway, Sweden, and Switzerland "should probably be reserved for the Westinghouse Company (British) as part of its territory"²⁷. In 1899 GW established British WH at Manchester, building a concern far larger than it would ever be needed for the next twenty years. During the first years of the new century GW organized companies in Russia, France, Belgium, Austria, Italy, and Canada. Despite a clear territorial demarcation as of each company's constitution, it might have eventually been advantageous for a company to sell or construct in the territory of a sister company. In such a case, a stipulated percentage fee should be paid. In addition, patent rights, drawings, plans, specifications, and engineering and manufacturing information were to be exchanged. With the backing of the parent company, the European companies would be prepared to contract for complete installations of shops and city railways.

As the nineteenth century came to an end, GE had accomplished many feats. It had become the largest company in the electrical industry, and together with WH, which was about half its size, they formed a duopoly fiercely competing with each other on technological innovations. Both companies had diversified in similar ways, and both held almost every line of product in the industry. Finally, GE had also established stability in the lamp manufacturing industry by means of the several agreements signed, which kept production volume and sales price under control.

²⁵ A group of representatives of the small manufacturers secured full control and management of National. Coffin required that the financial connection with GE to be kept as silent as possible. See J. W. Hammond, *Men and Volts: The Story of General Electric*, (Schenectady, NY, 1941). GE and National established market shares and selling prices for lamps. As a result, the smaller companies became virtual subsidiaries of GE. This arrangement gave the appearance of competition in the American incandescent lighting market. Over the next ten years, GE got \$600,000 in dividends. See: Reich, *The Making of American Industrial Research*.

²⁶ See Prout, *A Life of George Westinghouse*.

²⁷ *Ibid*, 263.

However, during the 1890s, like most American electrical manufacturers, GE had been infected with complacency on technology improvement. At that time, many engineers would believe that most of the major improvements had been made by then²⁸. As a matter of fact, throughout the decade, GE had not made systematic efforts to improve incandescent lamps. It had spent small amounts on improving incandescent lamps²⁹. Yet, little of this went to filament research, where breakthroughs would likely be made, although GE did engage Edison's West Orange Laboratory to investigate new filament types. Alarm sounded in 1898 when the Austrian von Welsbach developed a filament made from osmium that was 60% more efficient than GE's carbon filament – and longer lasting as well³⁰. Attempting to purchase threatening patents before they fell into unfriendly hands was a matter of GE's policy, and throughout the 1900s GE systematically bought European patents. Among the patent applications and inventions acquired were Welsbach's (tungsten filament inventions), Bergmann's (all inventions and applications covering incandescent lamps and their methods of production), Just and Hanaman's (tungsten filament). But this defensive policy encompassed many risks.

To face the technological obsolescence threat, GE inaugurated its research laboratory in 1900. The Lab's initial primary purpose was to work on lamp development. It was also expected to discover new profitable fields for GE to exploit, by performing original research. So far, GE had tended to wait for outside developments in those new fields that largely deviated from its established product lines³¹. In fact, the eclectic scientific background its researchers had – chemistry, physics, mathematics – paired up with the open-minded approach to research its director Willis Whitney had, opened up the way for diversified research projects. Among the Research Lab first accomplishments were: metalized filament incandescent lamp, which came to be known as the GEM lamp (1905); ductile, pliable tungsten filament (1910); modern gas-filled lamp, and neon lamps (1913). GEM consisted of an improved carbon filament, 50% more efficient than the standard carbon filament. The 1910 ductile-tungsten triumph gave GE a dominant position in the lamp industry³². Although tungsten had been investigated from 1900 to 1908, no process had yet been conceived to turn it into a wire, which could be used commercially. Interestingly, GE's accomplishment had cost it about one-seventh as much as it spent in acquiring the American patent rights for the non-ductile tungsten filament³³. Unwilling to abandon its carbon-filament lamp, for several years, GE would require that wholesalers

²⁸ See Reich, *The Making of American Industrial Research*.

²⁹ GE spent \$9,000, \$5,000, \$15,000 in 1894, 1895, and 1896 respectively. See Reich, *Lighting the Path to Profit*.

³⁰ *Ibid*, 311.

³¹ See Reich, *The Making of American Industrial Research*.

³² See H. A. Liebhafsky, *Silicones under the Monogram*, (New York, NY, 1978).

³³ See Bright, *The Electrical Lamp Industry*.

and utilities accept shipments of carbon-filament lamps in order to get the GEM and tungsten filament lamps they wanted³⁴.

While GE concentrated research efforts as early as 1900, WH's research was scattered throughout East Pittsburgh. In 1906, the Westinghouse Research Division was established to consolidate all WH's laboratories in operation so far. Before WH could profit from this consolidation, the 1907-1908 depression in the American economy deeply affected the company. This time, it was WH's turn to face major financial problems. Having grown his empire too fast and too large, the self-reliant GW took too many risks to implement his vision. The diversified empire GW had built around the world had been mainly financed with his own money. A few other investors held minor stakes in the business, and no powerful group of bankers had been protecting GW's companies. Quite on the contrary, GW had systematically refrained from bringing in financiers to his companies, because he would not give up control of his firms to anyone. The 1907 Financial Panic in the American economy left WH in a poor situation, which called for the intervention of financiers. Although kept at the presidency, GW lost its power in the company and left it altogether in 1911.

³⁴ See Reich, *Lighting the Path to Profit*.

PERIOD II – DUOPOLY CONSOLIDATION (1911-late 1930s)

By 1911, the electrical industry structure comprised numerous small firms orbiting the GE-WH duopoly. Allis-Chalmers, a heavy-engineering and farm-equipment firm that had grabbed a large share of the market for steam turbine and hydro-electric generators³⁵ stood out from the smaller companies in the industry. Interestingly, up to the 1950s, Allis-Chalmers' growth trajectory³⁶ resembled GE's and WH's (refer to figure 1).

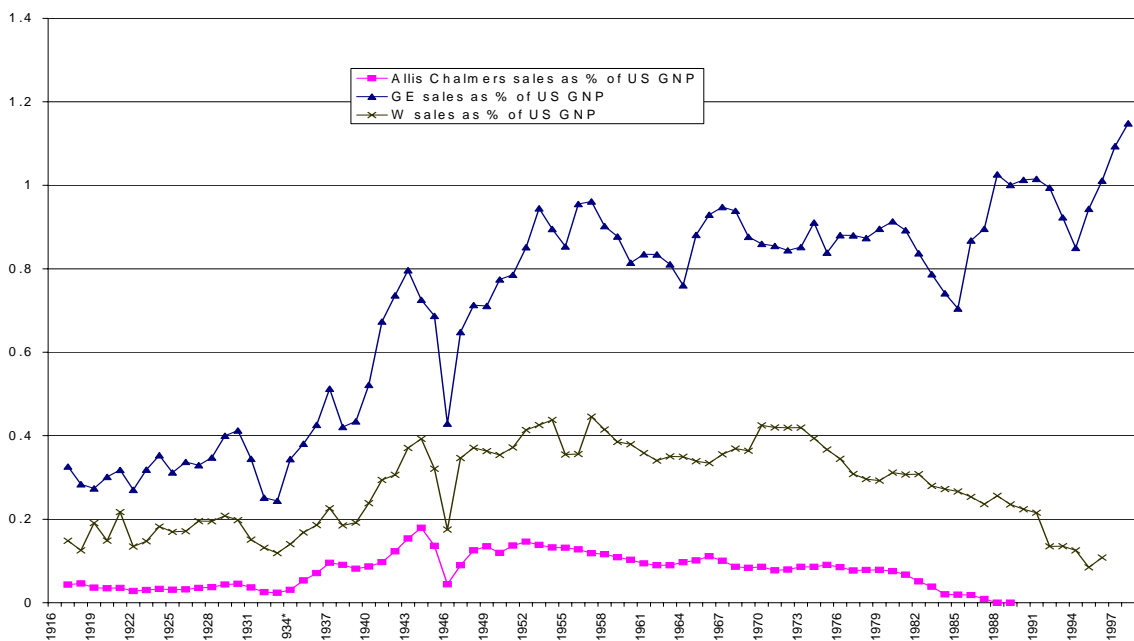


Figure 1 – The Growth Trajectories of General Electric, Westinghouse and Allis-Chalmers

As the new decade started, both GE and WH would undergo important transformations. In March 1911, the Department of Justice filed a suit against GE, WH and 37 other companies³⁷. The allegations maintained that GE controlled the lamp market through a variety of schemes, including GE's relationship with National and other companies, the use of process and improvement patents in the suppression of competition, the preferential agreements with glass bulb and lamp-making machinery manufacturers, and the distribution system that required wholesalers to accept a variety of lamp types while maintaining prices at levels chosen by GE.

³⁵ See R. W. Schatz, *The Electrical Workers - A History of Labor at General Electric and Westinghouse 1923-60*, (Urbana, 1983).

³⁶ The growth trajectory depicts the evolution of the companies' size in the American economy. The size indicator used – annual sales as a percentage of the US GNP – is a proxy for the firm size relative to the economy. (Fleck, 2001)

³⁷ Reich states that "the Department of Justice brought equity proceedings under the Sherman Antitrust Act against GE and 38 other companies. The Department of Justice contended that relationships within the industry only purported to be competitive, but in fact amounted to close cooperation". See Reich, *Lighting the Path to Profit*, 314.

As of 1911, National ran 18 subsidiaries that continued operations under each company's own name with coordination and technical services supplied from a central headquarters. GE's market share in lamps was 42% and National's was 38%. Besides, GE owned 75% of National's common stock and had an option to buy the remaining stock³⁸. In 1910, GE had signed an agreement binding GE and National to buy 85% of their glass requirements from Libbey and Corning (42.5% for each) and to make the balance themselves. Admitting the facts of the suit, but denying that they constituted violations of the law, GE argued that "the patents were inherently monopolistic and that its use was within the scope of the patent laws as well as in the spirit of the Constitution, all of which pre-empted the recent antitrust laws"³⁹. GE agreed to acquire the remainder of National's stock and make its ownership known; to terminate special agreements with WH and with the glass bulb makers and lamp-making machinery suppliers; to discontinue market-sharing arrangements with other manufacturers; and to stop setting the prices that wholesalers and retailers could charge for GE's lamps.

Another, yet more auspicious, event took place in 1911. GE's Research Lab (GE RLAB) development of the ductile tungsten filament, which had been completed in 1910, was recognized in the courts, and GE was granted the ductile tungsten lamp patent. Later on, in 1912, the Just and Hanaman patent which GE had acquired in 1909 was granted and assigned to GE.

Following the October 1911 consent decree, which expressly stated that "patent licenses might specify any price, terms, and conditions of sale desired, although they could not fix resale prices"⁴⁰, GE took a number of initiatives. GE acquired Providence Gas Burner and became the only manufacturer of a full line of lamp bases in the US until 1923⁴¹, becoming able to keep track of lamp output by the unlicensed firms through its sale of bases to them. GE also acquired Fostoria Bulb & Bottle⁴². In addition, GE set up a new licensing system based primarily on the GEM and tungsten-filament patents, granting WH a new A-license to sell up to 15% of the combined net sales of patented lamps made by the two companies at a royalty of 2%⁴³. GE introduced an agency plan of selling lamps,

³⁸ As a result, between 1904 and 1910, GE had received about $\frac{3}{4}$ of the more than \$600,000 dividends paid by National. See Bright, *The Electrical Lamp Industry*.

³⁹ See Reich, *Lighting the Path to Profit*, 315.

⁴⁰ See Bright, *The Electrical Lamp Industry*, 158.

⁴¹ In 1923 GE sold to WH its trade secrets for the production of lamp bases. After that date, WH manufactured bases for its own use, while GE continued to supply other producers, both licensed and unlicensed. Unlicensed firms also satisfied some of their requirements through imports. Prior to 1927 the Providence Works allowed special discounts to GE lamp factories and to WH. See Bright, *The Electrical Lamp Industry*, 251.

⁴² GE produced bulbs for lamps until 1918, along with Corning Glass, Libbey Glass and 2 smaller glass plants. These later went out of business shortly after 1918, and GE and Corning were left in control of almost all domestic production of glass parts for electric lamps. *Ibid*, 252.

⁴³ In 1919, the royalty was reduced to 1%. The royalty rate rose to 10% on the value of sales exceeding the quota. WH was also bound to follow the prices, terms, and conditions of sale established by GE, although it was granted permission

whereby local dealers became agents under contract of GE⁴⁴. Moreover, GE took action against Laco-Phillips and won it in the courts (1916). Laco was affiliated with Dutch Phillips, and sold Holland-made lamps that were exported to the US. Finally, GE started to offer licenses under the Just and Hanaman patent to all firms that had been producing tungsten-filament lamps in 1915⁴⁵. As a matter of policy, GE would avoid to drive patent infringers out of business by competitive price reductions. Instead, GE would eliminate these independent lamp manufacturers by legal action and/or purchase.

By developing the ductile-tungsten filament in 1910, GE RLAB had accomplished the central mission that had motivated its creation: to defend GE's most profitable business, putting GE in control of a superior technology. From then on, GE RLAB would work to help GE maintain a dominant position in the field. GE RLAB would work to assure GE's control of improvements to ductile-tungsten lamp technology, of any other filament materials that might compete with tungsten, and of lamp manufacturing methods that might bring down manufacturing costs. In fact, as late as 1939, when the basic tungsten patents had expired many years before, GE still retained 87% of the American lamp business due to its sustained competitive advantage.

The 1910 accomplishment, moreover, gave GE RLAB such respectability within the corporation that allowed for a few changes in the lab's policies. Research was diversified into other fields such as X-rays, vacuum tubes and radio. GE RLAB's director, Whitney, would add many new staff with varied scientific background. Whitney believed that chance favored the prepared mind. He had two management concerns: to provide researchers with an encouraging environment, while to also get researchers to work on those types of problems he believed suited most the company's commercial interests. In sum, in the course of its first two decades, GE RLAB had fulfilled its promises. It had actually defended

to use GE's "Mazda" trademark. WH was required to grant royalty-free licenses to GE under all its present and future incandescent-lamp patents for the duration of the license. GE did not grant a general license to WH under foreign lamp patents controlled by the licensor, although WH was licensed under the patents of certain countries. If WH had exported patented lamps to other countries, to which GE also could not export under its international agreements, it would have invited infringement actions under patents which WH had admitted in the A-license were valid. Ibid, 236.

⁴⁴ Stocks of lamps were not sold to them outright but taken on consignment, the company retaining ownership in the lamps while they were in the agents' hands and relinquishing ownership only when the agent sold the lamps. Thus the sale by an agent to a consumer was a first sale rather than a resale. Ibid, 237. In consequence, GE circumvented the prohibition to set prices to wholesalers and retailers. As the lamp owner, GE was entitled to set prices as it saw fit.

⁴⁵ These licenses established a quota system that permitted each licensee's business to grow in the same proportion as the incandescent lamp business of GE. Patent licenses were not offered to those producers who had initiated operations after the patent had been adjudicated. The new licenses granted to the smaller companies were called B-licenses. They permitted each firm, upon payment of a 3% royalty, to make and sell a specified small quota of incandescent lamps, based on the ratio between 1915 sales of tungsten-filament lamps by the company and by GE. Whereas WH could make both large and miniature lamps, almost all the lesser companies were licensed only for one or the other, and they were not licensed for export at all. They agreed to extend royalty-free licenses to GE under all patents or rights relevant to electric lamps owned or controlled by the licensee during the term of the principal license. Such licenses were to continue for the full life of each patent, however. The licensees were permitted to establish their own prices, terms, and conditions of sale, but they were not allowed to use the "Mazda" trademark. Ibid, 240-41.

GE's most profitable business, lamps; had launched new ones in the fields of radio, appliances (electric toaster in 1905, refrigerator in 1917) and X-rays; and had gained the respect of scientific leaders around the world for its contribution to knowledge⁴⁶.

In 1912, WH was changing the top command composition. An outside executive, Guy E. Tripp, was chosen to replace George Westinghouse as Chairman of the Board. George Westinghouse's removal from power left the company poorly articulated thereafter, since the internal coordination of the many pieces of the huge business and organizational systems GW had conceived had been mainly concentrated in his powerful mind. In addition, the foreign subsidiaries GW had founded mostly in Europe were destructed or sold a few years after his departure on account of WWI and the Russian Revolution. For the next fifty years WH's international activities would be restricted to manufacturing in Canada, licensing technology, and exporting through WH Electric International, the company's New York-based subsidiary. Under Tripp's direction, WH apparently underwent a centralization process, which did not, however, produce substantial integration.

As for GE, Coffin was concerned about the company's future. The antitrust menace had been successfully handled, but Coffin perceived the wide influence of law issues on the firm's continued existence: patent disputes, trade controversies, domestic and international contracts, employees' rights. This same year, he brought in Owen D. Young, a lawyer who once had defeated GE in the courts. Young put in order GE's law department and adopted a hybrid approach when defending the company in the courts. Whenever possible, Young would attempt to make his litigations not only a defense, but also a source of new and profitable activity for the company. For example, in 1916, Hoskins Co. sued GE for patent infringement. GE defended the case and lost it. Then, Young persuaded GE to take an interest in the Hoskins patent, and together, Hoskins and GE granted licenses to more than 100 rival companies.

WWI brought new challenges to US corporations. On the one side, the Army took away an increasingly large number of workers to fight in Europe. On the other side, high-tech companies had a unique opportunity to apply their skills to solve military problems, and expand into new fields. A case in point is GE's X-ray tubes. Research on X-ray tubes initiated at GE's Research Lab (GE RLAB) in the late 1900s, and eventually enabled GE RLAB to manufacture X-rays on a small scale. Working on solving its several technical weaknesses, GE RLAB engineers came up with a new, more complex tube. Assessing its commercial prospects, GE RLAB engineers suggested the manufacturing of these new

⁴⁶ See G. Wise, *Willis R. Whitney, General Electric, and the Origins of U.S. Industrial Research*, (New York, NY, 1985), 248.

tubes to be discontinued. In their view, given their higher complexity, and consequently higher price, the market for them would be too small to warrant manufacture. GE's top management insisted that production should go on, notwithstanding⁴⁷. In early 1914, the new X-ray tubes went into production. As foreseen, sales were low, costs were high and production volume was limited. This situation however changed as the military began to order tubes on a large scale for portable X-ray units during WWI.

During WWI, however, apart from the Secretary of the Navy, very few people in the US government seemed interested in taking advantage of scientific aid to solve war problems⁴⁸. As a matter of fact, research laboratories like GE's and Bell's pioneered initiatives on their own, even before the US entered the war. GE RLAB, for example, pioneered the production of magnesium, which so far had been produced only in Germany. GE RLAB developed the production process and produced it in quantity as long as the chemical industry was not ready to take over. Feeling an increasing menace to the US, the Secretary of the Navy, J. Daniels, organized the Naval Consulting Board, with Thomas Edison as Chairman and Willis Whitney, GE RLAB's director, as a member. At the request of the Naval Consulting Board, GE's Research Lab became involved in submarine detection, acoustic systems, mass production of vacuum tubes for radios supplied to the Navy and the Army's Signal Corps, search light electrodes, incendiary bombs, gas masks, submarine mine detonators⁴⁹.

In 1918, while WH sold its holdings in the British WH, Coffin drafted Gerard Swope from Western Electric to form and head International General Electric (IGE) as the center for foreign operations. So far, GE had held equity and contracts with foreign electrical companies. These contracts provided for the exchange of patent rights and set out exclusive sales territories, reserving the American market for GE. GE had no interest in invading foreign lamp markets. For one, GE already received income from foreign lamp sales through the equity positions. In addition, lamp prices outside America were low, as a result of fierce competition. Moreover, the American market accounted for half the lamp sales in the world. As a result, GE sought to maintain mutually beneficial relationships with would-be foreign competitors to keep them out of the American market⁵⁰.

⁴⁷ As a GE patent counsel clarified: "Mr.Coffin & Mr.Rice have expressed the opinion very strongly that the tube should be exploited in such a way as to confer a public benefit, feeling that it is a device which is useful to humanity and that we cannot afford to take an arbitrary, or even perhaps ordinary commercial position with regard to it". See Reich, *The Making of American Industrial Research*, 89.

⁴⁸ According to Hawkins, "the laboratories which contributed to the war effort did so for the most part on their own initiative and at their own expense. Sometimes prolonged persuasion was needed to induce receptivity in the armed forces". See L. A. Hawkins, *Adventure into the Unknown: The First Fifty Years of the General Electric Research Laboratory*, (New York, NY, 1950), 61.

⁴⁹ In each case, making good profits for GE under government contracts. See Reich, *The Making of American Industrial Research*.

⁵⁰ See Reich, *Lighting the Path to Profit*, 313.

In 1919, not seeing much commercial future in the radio technology, GE was inclined to sell its radio patents to the British Marconi. However, Franklin Roosevelt, as Assistant Secretary to the Navy, wrote to Young asking GE not to sell its patents to any foreigner. GE decided then to enter the radio business. This same year, GE bought from British Marconi the latter's interest in American Marconi and organized Radio Corporation of America (RCA)⁵¹. By virtue of its patents in wireless transmission, AT&T was brought into RCA in 1920. By 1921 WH had rounded up many of the wireless patents not controlled by RCA, particularly the Armstrong regenerative circuit patent, which was a basic item in radio receivers. In 1921, WH joined GE and AT&T, turning its patents into the RCA pool. It was agreed that the radio music boxes, now christened Radiolas, should be manufactured jointly by GE and WH in the proportion of 60% and 40%, respectively, and should be bought by RCA at cost plus 20%. The patent pool was sufficiently extensive to make the legality of any independent radio set extremely dubious. Yet, by Dec 1, 1923, it was estimated that the radio industry included 200 set makers and no less than 5 000 parts makers. All operated in complete disregard of RCA patent control and all, from the RCA standpoint, were flagrant patent infringers⁵².

In several respects, the radio-tube industry developed very differently from the lamp industry. In fact, Fortune magazine once reported that "radiomen at Sylvania sound a little unhappy when they say that RCA did not know how to exercise the same kind of leadership as did GE"⁵³. Although RCA held most of the basic patents, it did not erect any protective tent over production volume or prices. RCA granted licenses to all comers on a royalty basis only. No quota or price-maintenance provisions were incorporated in the licenses. In addition, RCA had initially followed a high-price policy, attracting new competitors. As a result, dozens of little tube companies sprang up. RCA was not successful when it tried to freeze them out by inserting a clause in its licenses to radio-set manufacturers, requiring the set manufacturers to use only RCA tubes. The clause was contested in the courts and RCA lost the suit. Finally, radiolas were built in several GE and WH establishments, with neither in a position to give orders to the other. Mass production of obsolete sets went ponderously on for months before new models, slowly filtered through parent company and subsidiaries, finally arrived at the plant.

⁵¹ RCA took plant, patents, personnel, goodwill, and other assets of the American Marconi, which was dissolved. Articles of incorporation provided that executives must be US citizens; that foreigners could not hold more than 20% of RCA stock; and that a representative of the Navy should attend board meetings. See Fortune, Sep 1932, p. 48.

⁵² Almost from the first months of the radio boom they took from RCA a majority of the radio-box business. In the early days, RCA sold about 1 set out of every 3. In later times the proportion dropped to about 1 out of every 4. And in many radio seasons a single competitor (usually a different competitor in different years) outsold the RCA itself. See Fortune, Sep 1932.

⁵³ Fortune, May 1947.

In 1922 Charles Coffin retired. The pair Gerard Swope-Owen Young, whose educational backgrounds were engineering and law, respectively, started the second managerial dynasty of General Electric (figure 2 depicts the managerial dynasties of GE and WH over time⁵⁴). Finding GE's President, Edwin W. Rice, unsuitable to replace him as Chairman, Coffin persuaded Rice to simultaneously retire. Owen Young replaced Coffin as Chairman of the Board, Gerard Swope became GE's President. Coffin and Rice were given honorary titles of Chairman and President, respectively.



Figure 2 – Managerial Dynasties of General Electric and Westinghouse

Coffin had wished for quite some time to place Young at the chairmanship. In addition, Swope had had such an exceptional performance running International General Electric (IGE) that Coffin thought him suited for the presidency. But Coffin wondered whether Young and Swope would make up a harmonious, productive team. So, Coffin decided to send them to Europe on a mission and made up his mind when Swope and Young returned from the several months long trip. During the trip the two executives proved they not only respected each other but also realized that they shared a common ground on which to base team work. Young would take care of the major policies of the company and take the lead in representing GE before its stockholders and the public, while Swope would be the executive head of the company and run the business.

⁵⁴ Figure 2 builds on the growth trajectories of GE and WH, previously shown in figure 1.

Coffin had run GE with a firm hand for nearly thirty years. Swope would follow suit⁵⁵. As early as 1901, while working for Western Electric, he pioneered market research⁵⁶. His methodical application of the engineering principles he had learned at the MIT helped him to lift out of the losses the offices he was in charge of during his stay at Western Electric.

Coffin's conservative policy was not discontinued. Not only it was sustained, but its scope was amplified. Instead of generating unproductive risk aversion, it was explicitly associated with decision-making speed⁵⁷. As Swope became president, his analysis of GE identified a number of weaknesses: high indebtedness; large number of plants producing a small number of products; poor understanding of the company as a whole; too much focus on one's department and too little concern for other parts of the organization (for example, a clear disconnection between engineers and salesmen); management's disregard for the training of younger employees and the security of older ones⁵⁸.

Swope's goals for GE included putting GE's monogram on everything electrical going into the American home, growing the company as fast as the industry and lasting as long as Du Pont, and giving better training and security for the men in the industry. His business philosophy prioritized firms' obligations in the following order: first to the public, by providing more things for more people at lower cost; then to employees, simply because it was good business, since highly productive workers were well paid and secure; then to the industry itself, because only through common agreement could items be standardized, fire protection could be coordinated and so on; and finally to stockholders, who wanted a fair, regular and uniform return. In view of his analysis, goals and philosophy his actions would emphasize *integration* of the company, and *coordination* both inside and around GE.

In 1924, the government brought an antitrust suit against GE and WH. These companies were charged that the license agreement between them and their agency system of distributing lamps were illegal. In November 1926, the Supreme Court stated that GE owned patent rights that covered entirely the manufacturing of electric lights with tungsten filaments, and that secured to GE the monopoly of their making, using and

⁵⁵ Swope's meticulous, centralized style was often called "Prussian". See Fortune, May 1947, p. 166.

⁵⁶ "He analyzed his business to find out exactly what he sold, to whom and where he sold it ... He kept account of his proportion of the total market and broke down his costs, translating his statistics into charts – an innovation – and hurling his energies at the weaknesses revealed". See D. Loth, *Swope of GE: The Story of Gerard Swope and General Electric in American Business*, (New York, NY, 1958), 45.

⁵⁷ As a matter of fact, the 1926 Annual report stated that "the value of a plant cannot be determined by first cost nor by appraisal on the basis of reproduction cost less normal depreciation. It is for these reasons that your Company has followed the policy of providing a general plant reserve in excess of normal depreciation rates, so as to enable it to take promptly out of service buildings or equipment which, although not worn out physically, are inefficient and uneconomical".

⁵⁸ See Loth, *Swope of GE*.

vending. This decision in fact held that a license to produce a patented product may include a price-fixing clause. In June 1928, GE and WH agreed to sign a new “A-type” agreement dated as of January 1, 1927, and scheduled to run out in 1944⁵⁹. The agreement increased WH’s share of the industry and allowed GE to prevent uncontrolled competition.

Throughout the 1920’s, GE helped Europeans to organize the international lamp cartel. European lamp manufacturers faced a highly competitive situation that eroded profits. Young’s intervention helped the European manufacturers to form a Swiss corporation to administer quotas, prices, exchange of technical information, and sharing of patent rights. GE was invited to join the international cartel, but declined.

When working on any issue, Swope would come up with a broad overview, perform a detailed analysis, and quantify whatever might help him identify whether the goals were being achieved⁶⁰. In order to be able to assess GE’s performance, he believed he needed to be in touch with the field, having acquired a reputation for “poking that nose into every corner of GE operations”⁶¹.

By working out yardsticks, Swope improved GE’s productivity⁶². Figure 3 plots the longitudinally comparable productivity indicator (total sales per employee as a % of US GNP). It shows a considerable increase throughout Swope and Young’s tenure, followed by a sharp decline during WWII.

⁵⁹ The new agreement licensed WH to make several other types of lamps covered by GE patents; increased WH’s quota to 22.4421% of the aggregate net domestic sales of electric lamps by GE and WH, increased WH’s quota 1% each year until 1930, when it would become fixed at 25.4421%; fixed the royalty at 1%; and included a penalty of 30% for exceeding the quota.

⁶⁰ Loth described Swope’s approach to supervision “as measuring by as many yardsticks as possible the extent to which his goals were being achieved. Most of his standards were expressed in mathematical terms. He liked figures.” See Loth, *Swope of GE*, 125.

⁶¹ See Loth, *Swope of GE*, 137.

⁶² Swope had noticed that “certain of GE’s assets were out of balance and had been for years. For example, physical plant and the number of workers were about the same in 1939 as they had been in 1922 ... This meant that far back in the World War I era, managers at factory level had got too much plant approved by top executives too far away from the factory floor”. See *Fortune*, December 1955, p. 112.

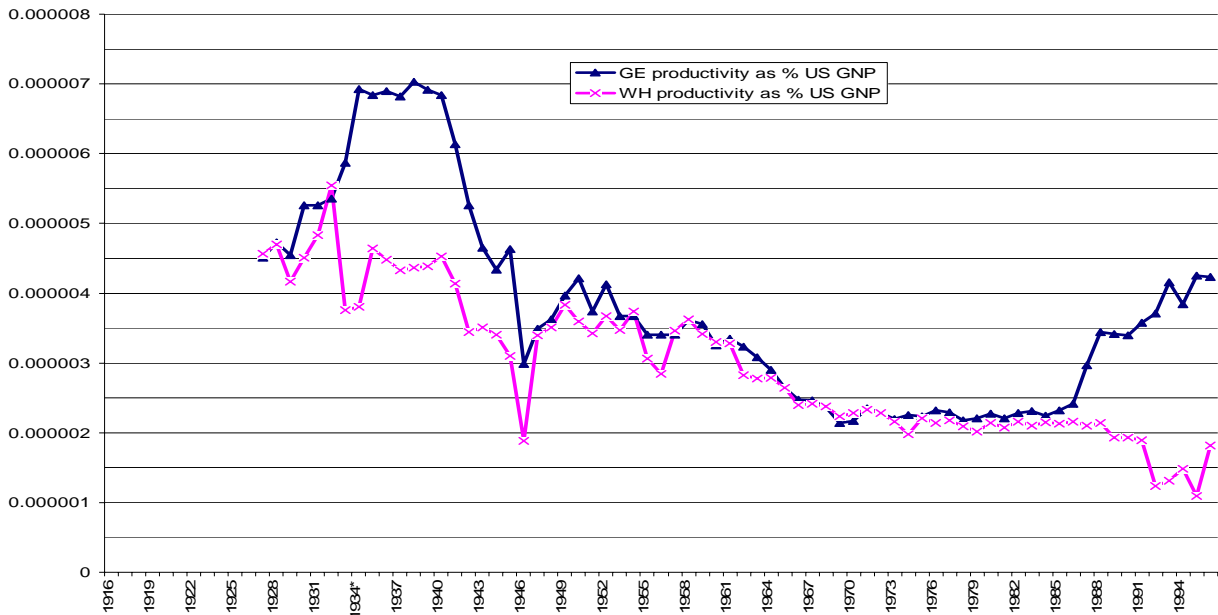


Figure 3 – GE & WH Employee Productivity

Swope conceived “the benign circle of electric power” concept, according to which, two classes of products – apparatus and appliances – contribute to each other’s growth⁶³. GE and WH undertook cooperative efforts to diffuse consumer products nationwide. They, in conjunction with electrical utilities, many of which until the late 1920s were GE and WH owned, sponsored a nationwide essay contest for school children, on the uses and advantages of electrical consumer products. As the benign circle notion spread across the electrical industry, additional effort was undertaken to design consumer products. The electric refrigerator was one such product. To challenge the then dominant player, General Motors’ Frigidaire division, GE came out with a new concept of a hermetically sealed refrigerator – the Top Monitor model. GE’s refrigerator became the dominant design from then on. For four years, GE benefited from its competitive advantage increasing dramatically its market share and reaping large profits.

WH was slower to come up with its refrigerator set. Besides, in 1927 it faced the sudden death of its chairman, Guy E. Tripp. This unexpected event found WH unprepared to replace him. It took almost two years for WH’s Board of Directors to choose Tripp’s

⁶³ Apparatus such as a turbine generator “makes possible the sale of more lamps, appliances, motors and other users of power. And as more people buy lamps, appliances, and so on, they create the need for another turbine generator and more transmission equipment”. See R. J. Cordiner, *New Frontiers for Professional Managers*, (New York, NY, 1956).

successor. It was Andrew W. Robertson, a lawyer who was head of a Pittsburgh utility holding company.

Swope and Young introduced a number of personnel practices and plans, including life insurance, a pension fund, and service bonus. Their first profit-sharing plan proved unsuccessful. A few years after its introduction, the results of the plan were analyzed. GE management found out that only 2,000 out of the 14,000 employees still retained their GE stock. Other plans were introduced later on aiming at fixing the mistakes identified, and guaranteeing that GE employees kept their stocks for long periods of time.

Swope took a number of initiatives to promote the integration of GE's several units. At one point, Swope called a conference of managers of the various operating departments to establish an advertising policy. Although GE already had an advertising manager, such a policy had never been implemented, and each executive handled his own advertising independently of the others, and often quite contradictory to them. Then, he turned his attention to the lamp department, which made a great many different brands, none of them identified with GE by name. He reduced the number of lamp factories, concentrating lamp manufacturing in larger, formerly idle plants. In addition, by 1923, changes in design and machinery had trebled lamp production. He also renewed the Advisory Committee role, which now became a forum for managerial exchange and discussion of ideas concerning policy and a channel through which his authority reached into the essential operations of every department⁶⁴. Swope, however, reserved to himself the final decision in the inevitable disputes. Another integrative action was the creation of the Elfun Society. In 1928, Swope conceived the idea of creating an independent society to promote the getting together of GE's management to discuss policy and promote communication within GE⁶⁵.

Swope believed that for GE to fully take advantage of the extremely favorable conditions the electrical industry enjoyed, GE had to develop relations with its stakeholders on "a businesslike basis", or the firm would face endless difficulties⁶⁶. The public relations program Young and Swope launched targeted stockholders, employees and the public. Shortly after they took office, they inaugurated a system of quarterly reports to shareholders

⁶⁴ See Loth, *Swope of GE*.

⁶⁵ Refer to *Reflections* (Schneectady, NY, 1978). ELFUN's mission was to promote Excellence, Leadership, Fellowship, Unity and Nurture of the General Electric Spirit. The real motivation behind the organization of Elfun was that "when he [Swope] came into the leadership position in the Company in the mid-1920's, found it practically impossible to get to the middle management through the Vice Presidents. There was great strength in this officer group which had been generated through years of centralized operations. Unable to get to the middle managers through the officers, he devised the Elfun Society as a means for communicating directly with middle management", 46. Celebrating Elfun's 50th anniversary, Reginald Jones, GE's CEO as of 1978, wrote: "Elfun bears the unique asset that distinguishes General Electric from other companies. Elfun provides spiritual continuity.", 80.

⁶⁶ See Loth, *Swope of GE*.

signed by both executives, and gradually expanded the amount of information in the annual report. As for employees, Swope appeared at their meetings and welcomed questions, taking “pride in having ready answers”⁶⁷. Swope saw unionization as a fact of business life⁶⁸. He also believed that industry could do a better coordination job than the state. As a result, Swope took a number of initiatives to improve intra-industry coordination. In 1926, he headed the formation of the National Electrical Manufacturers’ Association (NEMA). Shortly after, he stimulated the formation of a nation-wide union of electrical workers.

NEMA was the outcome of the merger of three industry organizations – the Electric Power Club, the Associated Manufacturers of Electrical Supplies, and the Electrical Manufacturers Club. To accomplish its purpose – “to advance the art of manufacturing adequate and reliable electrical equipment and to standardize apparatus” – NEMA intended to cooperate with the American Department of Commerce in constructive work, both in standardization and simplification. Each electrical manufacturer sent delegates to NEMA meetings to exchange market statistics and other information, as well as, to further the adoption of standardized product quality, dimensions and ratings. Such meetings fostered cooperation among competitors in several fronts. Intent on avoiding any appearance of illegal collusion, NEMA members stayed away from price discussions. However, discussions of standard cost-accounting systems and of average cost were held⁶⁹. Aware of the increasing antitrust enforcement, most companies were prudent in what concerned holding meetings with competitors. As a result, the practice of holding two types of meeting – an official one with minutes duly recorded and NEMA officials present and an informal one with discussions off the record – emerged.

Swope was also aware of possible dangerous effects of increasing size on efficiency. Increasing size called for delegation of responsibility and authority. Each year, at promotion time, Swope perused the records on every employee in the company who made \$10,000 a year or more⁷⁰, a task that he undertook to keep informed of the abilities and work of employees and to be able to better allocate them in the future. On several occasions he exhorted the virtues of entrepreneurship⁷¹.

⁶⁷ Ibid.

⁶⁸ Swope “put unionization in the same category of managerial problems as increasing costs of an essential raw material or the rise of an efficient competitor in a national market which never had had domestic production of its own. It was a condition, not a theory, and could not be argued or fought or bought out of existence”. Ibid, 169.

⁶⁹ According to one company attorney, clear effort was made “to establish a uniform system of accounting, which naturally results in uniform prices”. See R. G. M. Sultan, R. G. M., *Pricing in the Electrical Oligopoly, Vol 1 - Competition or Collusion*, (Cambridge, Mass., 1974), 29.

⁷⁰ See Loth, *Swope of GE*, 123.

⁷¹ “If we could fill this body of executives and leading men with the spirit of adventure to try even unheard-of-things, the company would either make progress or go broke, and the older of us would try our best to keep it from going broke”. Ibid, 173.

Swope introduced a new managerial style in several ways. In contrast to Coffin and Rice, Swope paid visits to GE's plants⁷². In addition, awareness of stakeholders was increased, and both integration and coordination of GE's facilities was reinforced. During his tenure, GE grew and diversified. His *benign circle of electric power* concept inspired a major diversification into electric appliances. As a matter of fact, appliances came to account for 30 percent of GE's total business. It however took time for the company to realize the importance and organizational needs of what had been launched as a side business. As a result, the functional structure, which required the top managers of engineering, production, and sales to devote attention to both apparatus and appliances lines, progressively brought inefficiency and slowness to GE's growing businesses.

During the Great Depression, electrical equipment orders collapsed hugely. Sales dropped from \$81 million to \$16 million between 1929 and 1933. To counter the depressed economic conditions, the American government passed the National Industrial Recovery Act (NIRA), which discouraged price competition. To help implement the Act and restore business vitality, NIRA created the National Recovery Administration (NRA) agency. NRA promulgated codes of fair competition, whose violation was subject to government penalties. Believing that the visibility of prices discourages price-cutting, the NRA code for the electrical manufacturing industry required each company to file 100 copies of its price lists for circulation. Selling below price list became not only an unfair trading practice, but also illegal. Any price change must be announced by issuing new price sheets. As a result, NRA's scheme helped to prevent the erosion of prices and to foster market share stability. During the 1930s, the informal, "off-the-record" meetings of competitors tended to focus on price levels. Given the price-checking activities fostered by the governmental agency, the younger engineers and managers were often persuaded that such meetings with competitors were common. In 1935, however, the US Supreme Court held invalid the NRA's scheme. In consequence, the informal meetings among competitors went underground, and evolved into an organized effort to influence market prices. As of 1937, regular meetings were held to train everybody to understand one common approach to figuring a book or list price for product lines of increasing complexity and diversity⁷³.

In the 1930s, a number of events – antitrust suits, patents expiration, and foreign competitors – started to menace the industry structure in place. An antitrust suit against RCA was initiated in 1930, which called into question the relations of GE and WH with RCA. A consent agreement was reached a few years later, whereby GE and WH would not anymore hold stock positions in RCA. In 1933, GE lamp patent ran out, but GE managed

⁷² This gave him a "certain popularity with factory workers who never before had the slightest contact with the president of the company". Ibid, 115.

⁷³ Those were covert meetings to discuss prices. See Sultan, *Pricing in the Electrical Oligopoly*, 33.

to grant new licenses to its licensees, in essentially the same form, scheduling licenses to run out in 1944. In the early 1930s cheaper Japanese lamps invaded the American market. To counter the increased lamp imports without reducing standard lamps prices, GE and its large lamp licensees brought out a new line – Type D – of incandescent lamps. This model, designed to have fairly high efficiencies and short lives, would be priced cheaper than the products in their standard lines. An appeal was also made to the US Tariff Commission to raise duties on incandescent lamps. The Treasury Department ordered the imposition of dumping duties against Japanese lamps on the ground that they were likely to be sold at less than fair value and injure the domestic industry. In addition, Japanese lamps with markings similar to GE's had their admittance refused. As a result, Japanese lamps had their market share progressively reduced.

PERIOD III – DUOPOLY DISMANTLING (late 1930s-late 1950s)

In addition to antitrust suits, patent expiration and foreign competition, several companies that licensed GE patents started to take independent initiatives, signalling their search for autonomy. In 1937, for example, WH created an overall advertising department, initiating high-powered institutional advertising for the first time in its existence. A huge effort at the time, WH's advertising appropriation was \$4.3 million, nearing its \$5.5 million R&D budget. In 1938, Sylvania, a lamp producer, came out with its own fluorescent lamp shortly after GE & WH had announced their fluorescent line. Moreover, in the mid-1940s GE's lamp licenses expired and were not renewed.

On top of these events in the industry, the almost five years long Great Depression imposed severe damages to the American economy. The electrical industry was seriously affected in most of its product lines. Sales declined abruptly and electrical manufacturers' profits progressively reduced. Notwithstanding those unfavorable conditions, GE managed to remain profitable throughout the Depression years. By keeping lamp prices unchanged, GE's efficiently run lamp business enabled it to make profits while its competitors were losing money. As a matter of fact, in 1933, while GE's lamps income was \$17.6 million, its other businesses had a total loss of \$11 million.

In 1937, Charles E. Wilson was called to fill a newly created post of Executive Vice-President, and was put in charge of the appliances business. He had been with GE for almost forty years, since he was 13 years old. Wilson had impressed Swope as early as 1928, when Swope lead a discussion on the most desirable managerial structure: "horizontal", i.e., functional, or "vertical", i.e., divisional. Despite the fact that Swope was one of the most horizontal-oriented managers, Wilson openly and vehemently attacked the horizontal structure. From then on, Swope would assign increasing responsibilities to Wilson, who eventually replaced him in 1940.

In 1938 the American economy faced depression again, and once more, the electrical industry experienced sales and profits decline. Throughout the industry, productive resources were underused or idle. Facing a likely contraction in their productive resources, several GE plant managers looked for other uses of their manufacturing facilities. They initiated contact with the military, and realized that their plants could be adapted to manufacture arms. As a result, they started to produce weapons even before WWII started.

Shortly after the war broke out in Europe, the American government approached large industrials, such as GE and WH, seeking their help in the war effort. Westinghouse at

first decided to refuse munitions orders, seen as "irregular" work outside the standard WH line of manufacture. The committee that suggested this policy had been organized by WH's Chairman, Andrew Robertson. It was composed of plant managers, who concluded that munitions orders could not be produced in the company's existing plants. In addition, the committee found new plants and tools investments unjustified. On at least three other occasions, Robertson was approached to manufacture munitions, but the Pittsburgh plant manager decided against taking such orders. The WH policy regarding this matter would then hold that WH should reserve its skills and equipment for the huge demands that were bound to come in its own field – turbines, generators, transformers, switchgear, meters, electronic equipment, and lamps – and let others make munitions⁷⁴.

GE reacted differently to the government's call. As early as 1938, Wilson, then a GE vice-president, had set up a *post-war planning committee*, which was composed of one or two key men from each of GE's main departments⁷⁵. Their analysis indicated that in order for GE to successfully keep growing, the organization had to undergo decentralization, and its businesses should diversify. As a result, GE approached WWII effort more aggressively than WH. As a result, when Wilson took over the presidency in 1940, GE was deeply involved in the war effort, having already started a large diversification into many high-tech demanding defense products.

By the spring of 1940, as GE's war orders were becoming increasingly more important, Charles Wilson appointed a four-man Defense Advisory Committee to integrate and expedite all GE's war orders. The group, later on called War Projects Committee, was supposed to help the company conversion into a mass-producer of special products. This required GE to accelerate the acquisition of more factories, the hiring of more employees, the procurement of more supplies, the development of more and different research, as well as, the change of consumers goods facilities to war products. By the end of 1941, the conversion of GE's manufacturing facilities to produce war products was well advanced. The company then started to plan for the postwar world. It tentatively figured out the conversion work that would be needed, in view of an optimistic postwar scenario, according to which the American population income would reach 100 billion dollars.

When Wilson took over in 1940, he introduced delegation of authority to a certain extent. He assigned powerful business portfolios to a large number of divisional vice-presidents and assistants, dividing in this way authority among more executives, but refraining from delegating decision authority to lower managerial levels. As this decentralization process was under way, GE's President and Chairman, Charles Wilson

⁷⁴ See D. O. Woodbury, *Battlefronts of Industry: Westinghouse in World War II*, (New York, NY, 1948), 11.

⁷⁵ The committee's assignment was "to give GE a thoroughgoing self-scrutiny". See *Fortune*, May 1947, p. 168.

and Philip Reed, respectively, resigned. By the end of 1942, both were called to Washington to work for the War Production Board. Gerard Swope and Owen Young were brought back from their retirement and ran the company during this two years long emergency, while Wilson and Reed served in Washington. Given their interim role, Swope did not undertake any reorganizing *action*, but he freed up his assistant Ralph J. Cordiner to think about the future.

During WWII, GE's cost-conscious attitude had to adapt to the ever higher war time pressures. Production bottlenecks were solved by the fast acquisition of out of use factories, by standardizing the design and the production process of complex apparatus, and by dividing the production load among subcontractors, and even among competitors⁷⁶. On certain occasions, people were hired at the rate of 1,000 a week. As a result, by the end of WWII, GE had duplicated the total number of plants (from 34 to 68), and increased its floor space almost 40%, from 29 million square feet to 41 million square feet.

By June 1940, WH also organized the Emergency Products Division to handle products other than the ones the company had already standardized. Its policy would be to never accept work that another and more logical manufacturer could do as well. The division's program for WH war projects comprehended a small number of major projects; the choice of projects that best suited WH's experience; and the location and design of new buildings in line with a long-range expansion program for WH's regular peacetime products – should new buildings be required. n Despite its initial intent, WH ended up not only taking military orders outside its lines of products but also designing and manufacturing entirely new devices to cope with military battlefield needs – for example, radar, and jet engines. Special war products, however, did not account for more than 20 percent of WH's production during the war. Favoring a strategy that minimized investment in plants for war products, WH undertook the operation of Ordnance Plants, and as a result had its floor space increased by 18% only (from 14 million square feet to 16.5 million square feet).

During the war, the industry operated under special conditions. For one, the industry operated with government control over prices. Notwithstanding this, those meetings continued for the purpose of supervising pricing. By the end of the war, an allocation system for sealed-bid business was in place for some lines of product, such as switchgear⁷⁷. In addition, during the war, the granting of new patents was suspended so as not to impact the war effort. Cooperation among peacetime competitors was to take place

⁷⁶ See J. A. Miller, *Men and Volts at War: The Story of General Electric in World War II*, (New York, NY, 1947).

⁷⁷ See Sultan, *Pricing in the Electrical Oligopoly*.

in different ways – for example, by handling common supplies or by transferring knowledge among themselves. Law suits were suspended for the duration of the war. A case in point is the 1941 Government's suit against GE. The suit contended that the last basic patent on incandescent lamps had expired in 1933. It alleged that the licensing system constituted, therefore, an illegal restraint of trade. Moreover, the relations between management and unions were not antagonistic. In sum, the war effort did engage the whole nation.

WWII brought new opportunities for manufacturing expansion, technology advancement, and diversification into new fields: defense material, electronics, nuclear energy, and materials. Both companies did diversify into new technological fields. Moreover, as of 1944, WH International announced that in addition to its international licensing program, it was going into business as an importer.

As the war came to a close, Wilson and Reed returned to their top positions at GE. It became increasingly clear that the former industry structure was about to change. The stable duopoly of the large integrated electrical manufacturers, GE and WH, surrounded by numerous smaller companies offering limited lines of electrical products would be threatened from inside and out. Smaller firms in the industry would dare to undertake new technological challenges and the former state of controlled competition was to never be active again. Besides, new high-tech companies were to emerge, and foreign competitors were to start to grab increasing shares of the American electrical industry.

GE's planning studies indicated the likelihood of a consumer products boom in the post-war years. In consequence, at war end, GE underwent major conversion efforts and heavily invested in consumer appliances. In 1948 GE started to mention the need for "broadening the base", signalling that GE acknowledged a growing need for reducing product prices and increasing their volume. The scope of WH's conversion work was considerably smaller, since 80% of its war production consisted of normal industrial products such as turbines and generators. Industry players were busy repositioning their portfolio of businesses. GE directed strong efforts into consumer products and defense contracts. WH, on the other hand, was slower at taking such initiatives, having initially stressed the familiar heavy apparatus business, which before the war had been more profitable than consumer appliances⁷⁸.

During the post-war era American companies faced both opportunities and threats. For one, the 1946 depression brought unemployment and strikes. Still, industrial companies were offered numerous expansion opportunities in their traditional lines of business, as well as in many wartime technologies. GE & WH started to diversify into new

⁷⁸ See Fortune, August 1958, p. 89.

areas such as nuclear, aircraft gas turbines, electronics, and radar. WH radio broadcasting operations expanded into television broadcasting, while GE electronics business expanded into computer manufacturing. In addition, in both companies, defense systems would gradually account for growing shares of the company's total business.

Both companies changed their top management position in 1950. Gwilym A. Price, who had been brought to WH in 1943 to negotiate the termination of war contracts, replaced Robertson as WH's Chairman. Ralph J. Cordiner replaced Charles Wilson at GE.

Cordiner's career trajectory was quite unusual. When Wilson moved to Washington, he persuaded Cordiner, by then an ex-GE executive, to follow him as Vice Chairman of the War Production Board. Cordiner was an old GE engineer turned merchandiser. While at GE, Cordiner had pointed out to Swope the need for GE to dedicate as much effort in appliances as the independent companies did, if GE wanted to succeed in the appliances business. Swope apparently agreed with him, but took no concrete measures to change the situation, and Cordiner left GE in 1939 to take over the presidency of Schick. Upon his return from Washington in 1943, he moved back to GE as assistant to Swope.

After three years of thinking and joint work with Swope and Wilson on major policy issues, Cordiner had identified *diversity*, rather than size, as GE's main problem. GE restructuring had to foster decision-making flexibility at the operating level, while insuring long-term planning to headquarters. Cordiner devised the fragmentation of the company into operating departments independent of central authority on operating matters. During 1948 and 1949, Cordiner's plan was tested in GE's affiliated companies – Hotpoint, Trumbul, and others – which had kept decentralized management since their acquisition by GE. Wilson intended to implement the plan in 1951 before his scheduled retirement at the end of that same year. Yet, the Korean War started in 1950. Experienced in managing war efforts, the American government re-established its war effort organization and called Wilson back to Washington. As a result, Wilson's retirement and his replacement by Cordiner were anticipated in almost two years. Shortly after Cordiner became president, he launched the decentralization process.

The 1946 postwar depression brought unemployment, and strikes. The stability GE had enjoyed in labor matters for almost three decades was disturbed. GE had traditionally pioneered benefit and pay programs. By 1922 several of these programs had already been inaugurated. Swope and Young extended them and introduced new ones. After 1933, unionization of GE's employees started, having caused no convulsion as had been the case in other companies and industries. Soon after the relationship of GE and the

United Electrical, Radio and Machine Workers (UE) had been established the WWII defense period began. During the war, UE demands grew, but wage increases were circumscribed by the War Labor Board regulations, which turned down most union demands. During the war, UE began a policy of making identical demands upon all electrical manufacturers. By war end, UE demanded from GE, WH, and the electrical division of General Motors (GM) an increase per day that the three companies rejected. In January 1946 strikes started affecting all three companies. After one-month strike GM came to an agreement. GE's strike lasted two months and WH's four. Both companies ended up accepting the conditions GM had negotiated.

Following the 1946 strike, GE started a systematic study of its labor relations. The study was still unfinished when the 1947 negotiations took place. Once again, GE followed GM's agreement conditions. Yet, from then on and for the next twenty years, GE would completely change the balance of power in its relation with unions. Shortly after the 1946 strike, Wilson selected Lemuel Boulware to head up a new employee-relations function meant to re-examine the policies and program of the company. Boulware was a pioneer in marketing and an early advocate of the use of market research and surveys to determine what customers wanted before products were engineered and manufactured. He had been brought to GE after the war and put in charge of the affiliated companies, none of which joined the 1946 strike against GE.

Boulware and his team set out to perform a thorough analysis of GE's personnel and employee relations. This included employees, unions, GE's several layers of management, the communities where GE operated its facilities, government, stockholders and the public at large. Their study revealed that what employees expected was precisely what GE had been trying to do. GE had however seriously failed in providing full information not only to its employees, but also to all other stakeholders. Convinced that GE had been "doing right voluntarily" for a long time, Boulware diagnosed GE's failure in employee relations mainly as a failure in marketing⁷⁹. The Boulware collective bargaining concept encompassed the following actions: careful research and a full exchange of views with the union bargaining agent before an offer was made; GE's disclosure of what the company believed proper, changing its view only on the basis of what could be considered new factual information; and ample publication to all stakeholders fully informing about company plans, programs, and proposals. This

⁷⁹ "What seemed to be needed, therefore, was to apply the tools of marketing to employee relations – market research, product planning, market development, and merchandising. ... [GE] set out to take the initiative in employee relations by putting out a good product, altering that product only on the basis of factual information, and merchandising the product on all fronts in order to obtain the earliest and most effective sale thereof". H. R. Northrup, *Boulwarism: The Labor Relations Policies of the General Electric Company: Their Implications for Public Policy and Management Action*, Bureau of Industrial Relations, Graduate School of Business Administration, The University of Michigan, (Michigan, 1964), 28-29.

approach, which would be called Boulwarism, consequently denied unions the possibility of proclaiming a political victory over the company.

Cordiner had to face challenges everywhere. For one, the booming American economy pointed out profitable avenues of growth in the upcoming years. But at the same time, the Korean War increasingly called for more technological research and defense-oriented products. As a result, GE faced personnel shortage to simultaneously handle the technologically challenging war issues and the booming market for electrical products and electrical energy in the United States. Retired engineers and salesmen were called back to help GE reconcile these two strong pressures on business growth. By allocating experienced, retired people to GE's traditional lines of business, the younger talents were assigned the innovation-challenging defense projects. Besides this, Cordiner faced management's high resistance to the new order. In the course of the first two years, about 2,000 men were shifted or hired. For GE veterans, this implied a change in geography, authority and status. In Cordiner's view, GE's managers faced a number of challenges. These were: developing subordinates; leading by persuasion rather than command; achieving teamwork, integration, and balance; measuring results; using properly all types of compensation; and setting up criteria for determining the scope of a business at Department, Division and Company levels⁸⁰.

Cordiner took a number of initiatives to handle the wide variety of challenges. Recruiting methods were increasingly systematized to cope with Cordiner's 1953 estimates that, in the following ten years, GE would need to fill 1,525 executive positions (Fortune, October 1953). Moreover, he inaugurated Crotonville, a managerial training center, which among other things would help the formation of "the well-rounded man" – an individual who does not think up ideas himself, but mediates other people's ideas⁸¹.

In 1952, Cordiner established a Measurements Project to devise common measurements at three levels: operational, functional and managerial work. Performance evaluation was sought from each and every unit. For example, as of 1957, when most research-minded companies had their laboratory budgets increasing about 10 per cent a year, GE had its Research Director devoted to the elaboration of evaluation methods of R&D activities⁸². Measurement also played a major role in the management of costs and

⁸⁰ See Cordiner, *New Frontiers for Professional Managers*, 71.

⁸¹ In the words of a personnel director, "the decision should be made by the group and agreement reached after discussion and consultation prior to action". Individual brilliance was undesirable. As a management trainee stated, "All the basic creative work in engineering has already been done", justifying the assertion that "I would sacrifice brilliance to human understanding every time". See Fortune, October 1953, p. 268.

⁸² A method to allocate effort on basic research was devised. According to Fortune's report in 1957, GE's research administrators "keep a running survey of all the important scientific journals and count the number of papers devoted to each field. If research seems to be lagging in some field that GE is interested in, they will step up their research effort there. Having found, for example, relatively few recent papers on incandescence, GE plans to continue doing about half

productivity. Value analysis, devised in the early 1950s, stipulated that after engineers had designed a product, a group of trained men who had nothing to do with the original design would go over each component looking for less expensive ways to accomplish the same functions.

As mentioned before, in 1950, Gwilym Price replaced WH's Chairman Robertson upon his retirement. As of 1940, Robertson was considering his retirement and had his attention attracted to a lawyer-banker. In the course of a three years period at the bank's presidency, Price had pushed his bank from sixth position in the Pittsburgh area to a strong third. Robertson hired Price in 1943 to plan the termination of WH's war contracts (over \$3 billion). In 1946, Price replaced Robertson at WH's presidency, while Robertson kept the chairmanship. In 1950, Price replaced Robertson entirely.

Price inherited a collection of highly diversified businesses and highly autonomous divisions⁸³. The company needed to regain some integration. Price once declared that when he joined WH, "the most difficult thing for me to understand was its sales structure"⁸⁴. By then, WH had a vice-president in charge of sales and another one looking after all the manufacturing divisions. Each and every disagreement that arose between manufacturing divisions and sales force had to be resolved by the president. Moreover, manufacturing divisions enjoyed such autonomy that complex bids gave rise to several rounds of negotiations within WH. Whenever a sale involved more than one manufacturing division, as in a bid on a utility power plant in which the transformer, generator, and switchgear divisions might all participate, the process within WH for deciding on price, delivery dates and so on, took three to five weeks, before a bid could be submitted. Such sales accounted for more than half of all WH apparatus sales, which normally were more than twice as profitable as consumer goods.

Price waited until the sales vice-president retired in 1948. Then, he hired a consultant firm a friend of his from US Steel had indicated. Mark W. Cresap, who was a partner at this firm, submitted reorganization recommendations, which were implemented

of all the research that is done in this field. High-energy nuclear physics, in contrast, is currently one of the most popular scientific subjects; so here GE will simply try to keep abreast of what is being published". See *Fortune*, October, 1957, p. 217.

⁸³ *Fortune Magazine* described WH as a hodgepodge of "semi-autonomous manufacturing divisions producing disparate products and serving divergent markets. Divisions making steam turbines, locomotive equipment, soft-drink coolers, elevators, vacuum cleaners, transformers, aerosol bombs, aviation gas turbines, radar equipment, toasters, and a host of other products operated quite independently of each other and with little regard for broad company welfare. Within the manufacturing division, moreover, there were some queer product groupings such as TV sets and industrial electronic equipment, motors and consumer appliances. There was a copper mill, an iron foundry, and the largest phenolic-plastic plant in the country. There were also three wholly-owned subsidiaries: WH Electric International Co with 200 distributors in sixty-five countries; WH Electric Supply Co with ninety-five branch offices and warehouses in the US; and WH Radio Stations Inc, which operated six commercial broadcasting stations". See *Fortune*, December, 1952, p. 121.

⁸⁴ See *Fortune*, December, 1952.

shortly after. Price withdrew Cresap from his own firm, and in 1951 Cresap was named vice-president and assistant to the president of WH⁸⁵. Cresap recommended the adoption of a line-staff management organization with operational decentralization and top-management policy control. As a result, the manufacturing divisions were grouped into four broad market classifications – apparatus, consumer products, defense and general industrial products. A group vice-president responsible for engineering, manufacturing and sales was placed in charge of each of these four groups. Functional executives served in a staff capacity and had no authority over the line organization. Together, the four group vice-presidents and the ten principal staff officers served on a new management committee, the top policy-making body below the director level.

As of 1958, a former WH executive, who had left WH in the early 1957, synthesized his view of WH's organizational efforts: "There are cycles in WH management, from tight head-quarters control to loose control. When I left, they were in a very tight period. Now it is time for a swing the other way"⁸⁶.

Price declared he hoped to build "not the biggest but the best company in the field"⁸⁷. By "best", he meant the most profitable. Interestingly, WH was then emphasizing its least profitable business, i.e. consumer products. Moreover, the lamp division was losing money because of its poor management of volume production, now free from the former market share allocations associated with GE's licenses. In the absence of production quotas, managing lamps production volume proved challenging. In 1951, the big lamp division had to slash lamp production to 60 percent of the sales rate, because the company had built inventories and WH's sales unaccountably dropped some ten percent. Price maintained, however, that profitability was a long-range concept.

By the late 1950s, the electrical industry was under close scrutiny of the Justice Department. GE, WH and 27 other electrical manufacturers were facing the courts. Forty-five of their executives were charged with conspiring to fix prices, manipulate bids, and divide markets on electrical equipment valued at \$1.7 million annually. The trial came to an end in 1961, revealing that GE had been involved in 19 conspiracies, concerning products, which accounted for more than 10% of GE's total sales. GE received total fines in excess of \$400,000, and WH \$370,000. Fifteen GE executives were sentenced. Three GE executives, and two from WH were sent to jail for thirty days⁸⁸.

⁸⁵ Price wanted Cresap to succeed him. In 1958 Cresap was named WH's CEO, while Price remained as Chairman. But Cresap contracted hepatitis in 1962 and died in 1963.

⁸⁶ See Fortune, August 1958, p. 89.

⁸⁷ See Fortune, December 1952, p. 186.

⁸⁸ The "Electrical Conspiracy" was brought to light in the late 1950s and came to trial in the early 1960s. According to Sultan, "in the electrical industry, the widening involvement of many managers helped the conspiracy to collapse. The

PERIOD IV – EXPLORING NEW ROADS (late 1950s-mid-1970s)

In addition to appliances, by the late 1950s, the two companies had diversified into a number of technologically connected fields. A case in point is electronics. Early starters in radio manufacturing, GE and WH occupied important positions in the electronics industry. GE together with RCA produced nearly 25% of all electronic goods. In receiving tubes, GE, Sylvania and RCA produced over 70% of those made in the US. WH was one of the other five significant tube manufacturers. However, electronics was undergoing a major transformation. Vacuum tubes still dominated the market, but they were gradually losing ground vis-à-vis semiconductors. Moreover, new firms were threatening the leading firms in the field.

New promising high tech-oriented businesses emerged by the end of WWII. The cold war and military conflicts around the world turned the American government into an important consumer of high tech products. GE, and later on WH, devoted increasing attention to this market. By 1958 defense products accounted for 24% of GE's sales, and they remained an important source of revenues for GE up until the 1970s. WH developed expertise and reputation in several technologies such as radar systems and underwater weapon systems. In the early 1960s, WH's defense products accounted for around 20% of its revenues. As of 1994, government contracts still accounted for 26% of WH's sales.

Nuclear energy was another promising field into which GE jumped as early as 1946, being followed by WH two years later⁸⁹. Proposing two different types of technology, the two companies engaged in a fierce competition for world leadership in nuclear power stations⁹⁰. By 1976, WH led in nuclear power over its nearest rival, GE⁹¹.

Research laboratories in each company produced innovations in several fields. WH, for instance, developed new products and processes in water purification, air pollution monitors and control, high-power gas lasers, to name a few. GE had, among other things, managed to manufacture man-made diamonds, to produce artificial rain, and to develop some types of plastics that could replace metals and glass in certain applications. In the

need to gather market intelligence would sustain some of the meetings, despite their obvious failure to influence the market price. But commitment to making the conspiracy "work" declined, once a broader spectrum of managers became involved. Cheating and double-crossing on agreements occurred with great frequency. In the end, it did not require the law to break up the agreements". See: Sultan, *Pricing in the Electrical Oligopoly*, 341.

⁸⁹ In June 12, 1948, funding became available for a nuclear submarine propulsion plant. Westinghouse agreed to perform engineering development for the auxiliary systems. See: J. W. Simpson, *Nuclear Power from Underseas to Outer Space*, (La Grange Park, Ill., 1995).

⁹⁰ The two technologies were BWR (Boiling Water Reactor) and PWR (Pressurized Water Reactors). GE chose BWR and WH chose PWR. See: Simpson, *Nuclear Power from Underseas to Outer Space*.

⁹¹ According to Simpson (1994), "the PWR concept has proved to be the best, and it helped put Westinghouse in the position of world leader in nuclear plants". Ibid, 200.

late 1950s and early 1960s, GE launched a number of “growth ventures”, including computers, commercial jet engines, new chemicals and plastics.

For two decades, GE’s labor relations policies kept unchanged. They were discontinued in the late 1960s after the courts deemed them inappropriate and ruled them out. WH, on the other hand, failed to conceive any consistent labor relations policy. In the ten years after WWII end, WH had had four industrial-relations directors, and alternately entertained soft and hard labor relations. Unlike most companies, WH did not succeed in tightening work standards that had inflated at the insistence of the military services during WWII. In late 1953, WH hired Donald C. Burnham from GM as manufacturing vice-president staff. Burnham was asked to improve assembly line efficiency by applying automation techniques. Time studies started, and as a result, in 1954 and 1955, WH faced more than forty walkouts and a six-week strike. Shortly after these disturbances were over, GE signed a five-year contract with the unions, leading WH’s president, Price, to aim for a similar agreement. Union representatives, however, were intent on avoiding another contract on similar terms. Contract duration and time studies issues became deadlocked, and WH’s workers initiated an almost six months-long strike. In 1957, WH decentralized its labor relations. Line management would assume responsibility for labor relations, while corporate industrial relations would play a mere advisory role, except in the event of company-wide bargaining.

As mentioned earlier, in the late 1950s and early 1960s, the electrical conspiracy scandal came to light, incriminating forty-five executives in the electrical manufacturing industry. GE managers were implicated in the conspiracy scandal, despite the company’s instructions requiring compliance with antitrust laws. By the end of WWII, GE was determined to clarify top management’s position with respect to the GE’s compliance with antitrust laws. The company, therefore, issued a general instruction and required GE’s managers to sign a statement indicating compliance. The general instruction issued in 1946 admonished GE managers “about their obligation to obey antitrust laws”⁹². Twice thereafter, in 1948 and in 1950, the instruction was reissued with supplements. In addition, a policy directive clearly stated that “no personnel having pricing or marketing responsibility could henceforth attend NEMA (National Electrical Manufacturers’ Association) meetings”⁹³.

Through such efforts, Wilson and later on Cordiner were signalling a major change in a long-established tradition in the electrical industry of holding conclaves among competitors to discuss prices. Multiple pressures – foreign competition, unstable economic

⁹² See Sultan, *Pricing in the Electrical Oligopoly*, 34.

⁹³ *Ibid.*

conditions, top management's emphasis on bottom-line results – as well as the understanding among some GE managers that top management really wanted the meetings to continue, led most managers to disregard top management directives. After all, the intricate system that permeated all the companies involved had not been dismantled, and not taking part in it was believed to constitute a competitive disadvantage.

In fact, the system withstood Cordiner's organizational revolution initiated as he took office in 1950. His five years long work on a reorganization plan meant to revitalize GE aimed at decentralizing authority, which was concentrated in the president's office; at fighting security, complacency, and mediocrity; and at rewarding on the basis of performance. Cordiner split GE into 27 autonomous divisions comprising 110 small companies. These would be run as if they were individual firms, which set their own budgets and made capital expenditures up to \$200,000. The mechanism for developing the desired entrepreneurial climate was an organized planning system made up of entrepreneurial/strategic, administrative and operational plans⁹⁴. Moreover, Cordiner's new philosophy of decentralized management specifically forbade meeting with competitors on prices, bids, or market shares.

Throughout the change process, over 2,000 managers were shifted or hired. However, those reassigned to divisions that traditionally held price conversations with competitors were pressured for compliance with the traditional behavior. Top-down and bottom-up pressures materialized. In some cases, after signing their compliance with GE's general instruction, some managers felt uneasy and refused to pursue further contacts with competitors. Replacements for these positions were sought throughout GE's ranks. Candidates were offered promotion and clarified about the reasons for the opening position. Upon acceptance of the new job, they engaged in colluding with rivals. Bottom-up pressure for collusion occurred when executives landed in a business where people believed that only by pursuing collusion were they to reach ever increasing yearly goals: more profits as a percentage of net sales and larger percentage of available business.

GE's reaction to the trials outcomes differed from WH's. While WH believed that corporate punishment would not do any good, GE did punish those involved. Initial punishment comprised demotion, transfer, and pay cuts. It was eventually followed by forced resignation.

Cordiner fought on several fronts, but succeeded in just a few ones. Company's restructuring reduced the power of manufacturing units, decreasing, therefore, GE's

⁹⁴ See M. R. Vaghefi and A. B. Huellmantel, "Strategic Leadership at General Electric", *Long Range Planning*, 31 (2): 280-294.

fragmentation threat. On the other hand, Cordiner's concept of "interchangeable professional managers" brought about undesirable side effects. This concept endorsed uniformity in pay, in goals, and in skills. To prevent the development of new power imbalances and introduce flexibility in the allocation of managerial personnel, Cordiner conceived the idea of interchangeable professional managers. By so doing, however, Cordiner failed to foster entrepreneurship, one of his proclaimed goals. He set uniform goals for all units – 7% return on sales and 20% return on investment – and surely aimed at rewarding people based on performance, as a way to fight reward based on length of service. Nevertheless, this policy stimulated people to avoid risks and entrepreneurship. Finally, by seeking to standardize as a way to counterbalance diversity, his early diagnostic on GE's source of problems, Cordiner stimulated a process of regression to the mean, discarding promising outliers. A case in point is Jack Welch, who joined GE in the early 1960s. Upon completion of his first year at GE, Welch decided to leave the company. On the occasion, Welch argued that standard salary raises failed to distinguish and stimulate employee's excellence and initiative. His boss managed to retain him by offering him the opportunity to develop the plastics business.

Upon Cordiner's early retirement, the Board chose Fred J. Borch to succeed him in 1963. Borch would face a business portfolio in need of renewal, and an organization in need of reassurance. In fact, Cordiner's "well-rounded man" and "interchangeable professional managers" did not stimulate initiative and entrepreneurship. Borch, by contrast, would allow for new ventures initiatives. A case in point is Jack Welch's career development. Having started the plastics business from scratch, Welch was assessed in line with his business achievements, which happened to be outstanding. Entrepreneurship included risky experiments. Therefore, the blowing up of a pilot plant in 1966 – while testing a new manufacturing process – brought neither punishment nor business slow down.

Apart from this distinction, Borch carried forward Cordiner's organizational revolution. The notion of strategic business units was put forward and implemented and a comprehensive system for business planning was established. Also, employee education was emphasized⁹⁵. In addition, GE instituted a new "Educational Incentive Awards program"⁹⁶. During Borch's final year, he sponsored two long-range initiatives. First, a new company-wide program was launched to improve quality of products and services

⁹⁵ GE's 1971 Annual Report stated that "company-conducted educational programs are a GE tradition and are essential to assuring the competence of the current and future work force. In 1971 the range of GE courses extended from entry-level training to courses in advanced management. Over 5,000 employees completed professional and managerial courses." (p. 24).

⁹⁶ According to GE's 1971 Annual Report the General Electric Foundation would grant \$326,000 to seven universities "proposing imaginative changes in curriculum, community involvement and other programs relating to such contemporary problems as minority education and environmental studies" (p. 24).

and to promote among customers the perception of superior price-performance products⁹⁷. Second, he approved the building of a new headquarters facility in Fairfield, Connecticut, to house the Company's senior management and supporting staffs⁹⁸.

At WH, top management succession took place one year after Cordiner's. In 1964 the ex-GE manufacturing engineer Donald C. Burnham, who had been with WH for 11 years, replaced Price. Burnham conceived an expansion strategy to internationalize and transform the domestic WH into a multinational firm. During the 1960s WH re-examined its international strategy. As WWII came to an end, WH had lost most of its investment in its 12 foreign subsidiaries. From then on, the company mainly exported its products or licensed its technology. The Canadian subsidiary was the only manufacturing operation it still owned abroad. Burnham planned to buy several companies in Italy, Belgium and France, and merge them into a \$1 billion sales operation. In 1969, however, this strategy was deeply weakened, as French President de Gaulle vetoed the acquisition of a keystone French company. Intent on expanding WH domestically, as well as, internationally, Burnham changed the overall strategy, and adopted a piecemeal approach. He broke WH into 4 companies, and gave each of the four presidents enough autonomy to search for growth opportunities. WH's 125 division managers were given the responsibility for both foreign and domestic business. In addition, he established an operational goal of 10% growth in sales per year and a 15% return on investment for each division. That way, Burnham impelled division managers not only to create new lines of business, but also to find customers and companies to acquire abroad.

Growth efforts at both the domestic and international levels considerably increased the quantity and diversity of businesses in WH's portfolio. New businesses included water-desalination plants, low-cost housing, land development, water-quality control, car rentals, motels, health care, soft-drink bottling, chain of resort inns, mail-order, Swiss watches, and educational services and material. Such diverse portfolio actually fit the broad scope of WH's mission during Burnham's tenure – solving the problems of people⁹⁹. Burnham's major 1969 reorganization had loosened the reins, enabling a decentralized diversification that took WH far away from its core businesses. The breaking up of WH into four "companies", granted their presidents enormous autonomy, and more often than not they went separate ways. It was up to Burnham to integrate the four pieces.

⁹⁷ GE's 1971 Annual Report stated the purpose of rallying "all of our people behind the goal of making GE products and services the "Best Buy" for customers. Progress toward this goal will require and, we are confident, will receive extra effort by each component and every employee to improve our quality, service and value, while also seeking to make our operations more productive, cost-conscious and still more competitive" (p. 4).

⁹⁸ GE's 1971 Annual Report explained that "the present GE headquarters facility in Manhattan will continue to be fully occupied by the Company to serve as headquarters for the International Group and to consolidate other components now using quarters at various New York City locations" (p. 24).

⁹⁹ WH's Annual Reports

By 1976, WH's foreign business accounted for 31% of total sales, a volume 3 times as large as the 1971 foreign sales volume. What is more, from 1969 to 1973, WH's total sales grew, while GE's were declining. As a result, for the first time in the history of these two companies, financial analysts were inclined to recommend WH's stock rather than GE's (refer to figure 1).

Indeed, the two decades following GE's outstanding 1957 sales performance, were problematic. GE was increasingly losing ground in electronics. Its dominant position in the profitable tubes segment turned its initial advantage into a weakness, bringing about unproductive hesitation and delayed action. In the computer business, GE belatedly entered the field in 1957, initially targeting special-purpose computer segments – banking, utility billing, and credit accounting. In 1960, GE decided to become a general-purpose computer manufacturer like IBM¹⁰⁰. It aimed at reaching a 10 to 15% market share. As of 1969, IBM's market share was 69%, while GE was fifth in the industry with a 4% market share. After 12 years of losses amounting to \$209 million, in 1969, GE's computer business finally produced a modest profit for the first time – \$4.7 million. Borch decided to take advantage of this favorable situation to sell its business. GE moved ahead of other rivals and managed to negotiate exit from its computer business at very advantageous conditions, given the circumstances¹⁰¹.

In the nuclear field, as early as 1955, GE had built at a loss the world's first commercial-size nuclear power plant. The \$15 to 20 million losses were looked upon as an R&D expense, given that the actual building of the plant enabled GE to resolve thousands of engineering issues that could not have been solved at the drafting table. Notwithstanding the project's technological success, similar plants could not be sold at a profit throughout the next 8 years. Then, GE came out with the turnkey plant concept¹⁰². Between 1963 and 1966, the concept was very successful at getting GE nuclear power plant contracts at a fixed price. GE's fixed price contracts with uranium suppliers hedged the company against uranium prices raise. Yet, other costs inflated as much as 20% a year during the Vietnam War, and left GE in a poor position. GE wrote off engineering and development costs as they were incurred. As a result, GE estimated that its nuclear business would not be profitable until the late 1960s. So, in 1966, GE quit making turnkey

¹⁰⁰ Initially Cordiner forbade GE to enter the field to compete with IBM, GE's largest electronics customer. In addition, Cordiner apparently believed that GE did not have a competitive advantage in the computer business. He believed this was an assembly, rather than a manufacturing, business and therefore GE could not capitalize on its skills. See H. R. Oldfield, *King of the Seven Dwarfs: General Electric's ambiguous challenge to the computer industry* (Los Alamitos, Ca, 1996)

¹⁰¹ GE sold its business to Honeywell in 1970. GE was able to persuade Honeywell to pay a large sum of money for a division that had essentially no value to GE (or perhaps negative value should GE have to close it down). Although GE failed in the computer business, it succeeded in getting out of it. See W. E. Fruhan Jr., *Financial Strategy: Studies in the Creation, Transfer, and Destruction of Shareholder Value*, (Homewood, Ill., 1979).

¹⁰² GE not only supplied the reactor, but took full responsibility for building the entire plant at a fixed price.

bids, and WH followed suit. By 1970, GE had lost over \$200 million in the nuclear venture.

As for GE's core businesses, the booming economy in the late 1960s caught GE short of capacity in lamps and appliances. The rapid capital expansion it undertook to restore capacity depressed the company's earnings even further. Some of its old businesses, such as small electric motors and lamps, continued to be highly profitable, providing in some cases a return on investment as high as 40%. However, foreign competitors increasingly invaded the American market in consumer electronics, turbines and appliances. New fields, such as commercial aircraft turbines and engineering plastics, were promising but not yet substantially profitable. Some costly acquisitions in entertainment, modular housing, personal services and education did not prosper. On top of GE's misfortunes in business, GE's approach to labor relations – Boulwarism – was defeated in the courts in the late 1960s¹⁰³. The collapse of Boulwarism brought to an end the stability GE had enjoyed in its labor relations for two decades.

WH's Annual Reports described both 1971 and 1972 as "the most successful year in WH history". In July 1972, Burnham announced a "step-down-at-60" program", whereby senior officers would retire at the age of 60¹⁰⁴. Following the two "most successful years", 1973 had significant, unexpected losses. Due to the loose controls that came along with Burnham's 1969 reorganization, several divisions and subsidiaries had been functioning without significant surveillance from headquarters. As a result, losses took management by surprise, and the organizational pendulum swung back towards a centralized management system¹⁰⁵.

Ironically, WH's superiority over GE occurred just as, apart from their core businesses, their business portfolios bore little resemblance to each other. While most GE

¹⁰³ Introduced at the end of the 1940s, Boulwarism was a new collective bargaining approach that concentrated all bargaining initiatives at GE, leaving unions in a quite secondary position. Named after Lemuel Boulware, an early advocate of market research and surveys, he diagnosed GE's failure in employee relations mainly as a failure in marketing. He believed GE needed to apply the tools of marketing to employee relations – market research, product planning, market development, and merchandising. The Boulware collective bargaining concept encompassed the following actions:

- . Careful research and a full exchange of views with the union bargaining agent before an offer was made;
- . GE would put what it believed proper on the table and change it only on the basis of what could be considered new information;
- . Ample publication to all stakeholders fully informing about company plans, programs, and proposals.

This approach, therefore, denied unions the possibility of proclaiming a political victory over the company. See Northrup, *Boulwarism*.

¹⁰⁴ According to WH's 1972 Annual Report, the program "assures that the top seven positions in the Company will be filled by competent young executives, and releases the talents and experience of the former top executives for programs of long-range significance to society and to Westinghouse" (p. 3).

¹⁰⁵ WH's 1973 Annual Report stated that "because these loss operations have had such a disproportionate effect on our overall results, we have instituted a tighter, centralized management system to prevent such areas of weakness from developing into major problems in the future. The division manager is still in charge of his operation, but our new, more sensitive system will help detect and solve problems more rapidly and effectively" (p. 1).

businesses still turned around a unifying technology¹⁰⁶, WH had diversified to such an extent that its businesses had been through successive groupings under broad, imprecise labels¹⁰⁷. Moreover, WH's apparent ascendancy over GE was short-lived. In July 1974, facing a severe cash crisis, WH was forced to line up \$500 million of revolving medium-term credits with a group of 15 banks. Like GE, WH's most expensive products costs skyrocketed. As a result, WH had to honor its fixed-priced contracts despite a double-digit inflation. However, there were many other problems. For one, big markets failed to materialize in ventures such as electric cars, vessels for exploring the ocean depth down to 20,000 feet, and unmanned rubber-tired transit system for medium-sized cities. Besides, WH had to discontinue or sell off money-losing businesses such as major appliances, auto rental, and desalination. Though disappointing, these failures did not produce costly losses. On the other hand, in water-quality control, home building, and mail-order, the amount of losses were huge by virtue of WH's commitment to projects that were costly to complete. Finally, WH's leadership in the nuclear field became a major threat to WH's existence.

In the 1960s and early 1970s, WH had routinely included in its reactor construction contracts clauses committing it to supply uranium fuel – at prices averaging about \$10 per pound. WH expected them to remain stagnant throughout the 1980s. However, uranium prices exploded. In 1975 it reached \$26 per pound and \$40 in 1979. In 1975, WH decided to notify the 27 utilities involved that it was cancelling the fuel delivery contracts. In response, the utilities brought suits against WH, which faced a prospective loss of about \$1.184 billion in 1975. Such losses rose to about \$2.6 billion in 1979 equalling or exceeding WH's entire shareholders' equity (refer to figure 4¹⁰⁸).

¹⁰⁶ GE's 1972 Annual Report showed a graphical representation of GE's technologies in a wheel's blades.

¹⁰⁷ **WH's four "companies" in 1971 (Source: WH's 1971 Annual Report)**

Power Systems: Nuclear and power plants; Platform-mounted, floating nuclear power plants; Gas-turbine: combined gas and steam turbine plant; Transmission and distribution equipment; Environmental services – recommends action programs to meet environmental regulations, runs the School for Environmental Management, and manufactures an environmental monitoring system (air and water quality).

Industry and Defense: Construction group – water and wastewater treatment; Housing – building house units in existing and newly formed cities; Computer controlled production systems; Components and Materials – new industrial plastics and chemical coatings, wiring services, self-grounding receptacles for maximum safety in home and industry, lines of appliance motors, TV picture tubes, and distribution subsidiary; Transportation – rubber-tires vehicles (horizontal elevator); Apply defense technology to civilian tasks: weather sensors, planning a new generation of hospitals, and isotopo-powered-heart-pump engine.

Broadcasting, Learning and Leisure: Communication business – radio and TV broadcasting; WH Learning – new school systems; Leisure time – mail-order, Longines-Wittnauer watches, and time pieces; Econo-car leasing and rental; Soft drink distribution.

Consumer Products: Homeology products – water purifiers, room air cleaners, safer ranges; Standard products – bulbs, space-saving refrigerators, and laundry equipment; Consumer service; New businesses – home security (electronic home protection system against intruders, fire smoke, and other emergency conditions), and interior systems for industrialized housing (prepackaged kitchens, bathrooms, heating, and air conditioning).

¹⁰⁸ Figure 4 plots a proxy for overall performance of a firm – annual profits as a percentage of US GNP. Refer to Fleck (20X1).

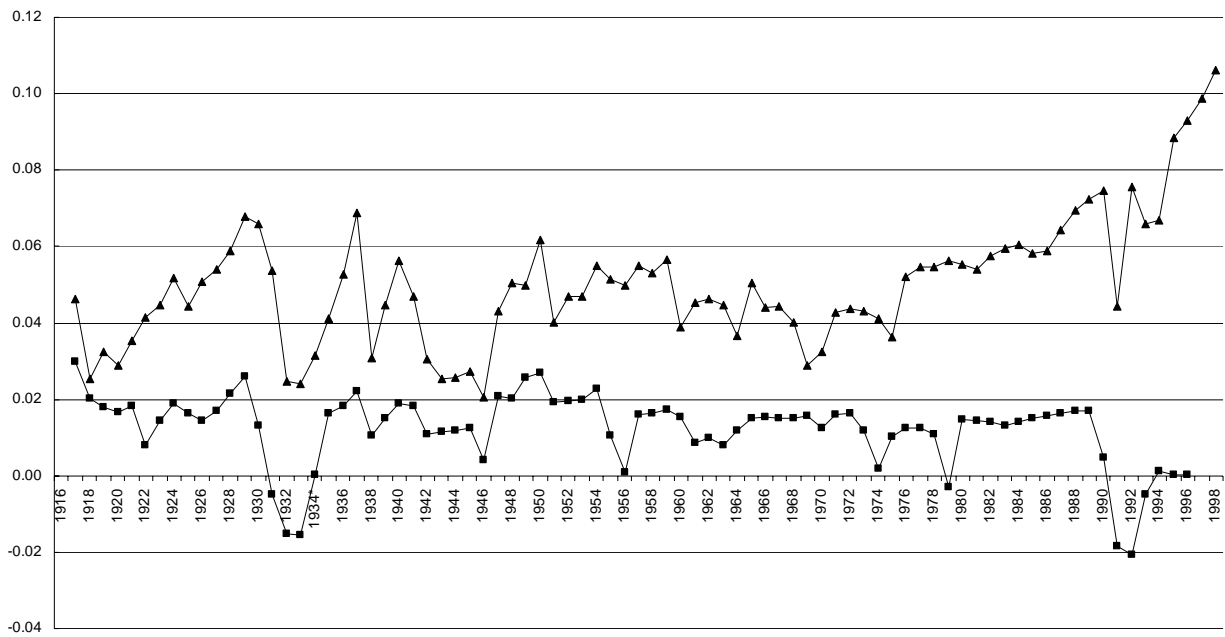


Figure 4 – Financial performance of General Electric and Westinghouse

Following the many changes the business landscape went through after the end of WWII, two dynasties – Ralph Cordiner and Fred Borch at GE, and Gwilym Price and Donald Burnham at WH – had failed to redirect their companies towards new continuing growth ventures. In 1972, Reginald H. Jones replaced Borch at GE, and two years later, Robert E. Kirby replaced Burnham at WH. Although the two companies faced a number of common problems – inflation, uranium prices hike, labor strikes, and increasing foreign competition – they fought ever less against each other.

In 1972, Reginald Jones, who had made a career as GE auditor, replaced Borch at GE. He not only carried forward Borch’s business portfolio rationalization, but he would also develop further the main policies in place. A case in point is Crotonville. The Management Development Institute Cordiner had inaugurated in 1956 was intensively used to homogenize managers’ skills, knowledge and values. One of GE’s accomplishments mentioned in its 1974 Annual Report was a new executive workshop, “Managing in an Inflationary Economy”. Long-established procedures were kept and developed further. For example, Swope’s yearly reviews of personnel records at promotion time came to encompass the identification of talented and promotable managers, the planning and development of such executives, and contingency plans for succession. Jones introduced a new committee structure of GE’s Board. Five new committees were

formed in mid-1972¹⁰⁹. These were: operations, public issues, management development and compensation, audit and finance, technology and science. In addition, Jones would increase corporate scrutinizing and controls to ensure effective strategic planning and resource allocation.

The oil crises disturbed the world’s economy during the 1970s. Throughout the decade, inflation escalated and most large firms followed the widespread business portfolio view. This view prescribed the building of balanced counter-cyclical portfolios of diversified businesses. A case in point is WH, which was diversifying its portfolio since the late 1960s. Yet, a large number of these acquisitions proved unprofitable were divested. Like many other poorly screened acquisitions, the French elevator company that had been acquired to improve WH’s competitive position in the European elevator business did not live up to expectations and was sold in 1974. Throughout 1975, the home-building subsidiary, named Urban Systems Development Corp., was discontinued and all the segments of the mail-order business terminated or sold off. WH lost more than \$120 million in these three businesses.

Table 3 summarizes similarities and differences between GE and WH from the late 1950s to the mid-1970s.

Similarities	Differences
<ul style="list-style-type: none"> . Both companies were involved in the electrical conspiracy . Both companies lost cash cow businesses after the dismantling of the umbrella structure . Both were unprepared to manage volume production after the umbrella dismantling and were caught short of capacity in lamps and appliances . Both entered several minor unprofitable ventures in high-tech and in non high-tech businesses . Both faced an unfavorable environment: increasing foreign competition, labor strikes, and high inflation . Both lost ground in electronics . Both engaged in the defense business, which accounted for 20-25% of their sales . Both entered the nuclear field . Both R&D labs developed several innovations . Both companies decided to re-establish their foreign operations after WWII 	<ul style="list-style-type: none"> . WH took a piecemeal expansion approach both domestically and internationally, while GE did not . WH took major non high-tech initiatives: land development, auto rental, home building, mail order, while GE took minor non high-tech initiatives . GE took major high-tech initiatives in addition to the defense field: computers, aircraft turbines, plastics, while WH’s high-tech initiatives were mainly in the defense field . GE hedged against uranium prices hike, while WH did not

Table 3 – Similarities and Differences between GE and WH (late 1950s – mid-1970s)

¹⁰⁹ The committees aimed at “insuring optimum utilization of Directors’ time and abilities in reviewing matters of greatest importance to General Electric” (1972 GE Annual Report, p. 6).

From the mid-1970s on, with one noteworthy exception – their financial subsidiaries – GE and WH would take ever more distinct paths. In fact, both GE Credit and WH Credit would experience enormous profitable growth during the 1980s, which led each to occupy prominent positions in its company's portfolio. Interestingly, both subsidiaries would face scandals later on. Apart from this similarity, the companies diverged in several respects: while GE was fine tuning its business portfolio in search of growth ventures, WH underwent continuous divestment and contraction; while GE acquired Utah International, a mining company with coal, oil and gas, uranium, iron ore, and copper operations in several countries, WH was facing bankruptcy threat due to its price fixed uranium delivery commitments; while GE's inflation studies would provide its corporate strategy with major directions, WH's strategic planning process would address portfolio planning on a micro-basis.

In 1974, the 56 years old Robert E. Kirby would replace Burnham at WH. Kirby, joined WH in 1946, and was the first fully home-grown WH executive to become the company's CEO. He established a prudent management style: he established limits of authority and had auditors check operations to make sure guidelines were being observed. In acquisitions, for example, he discontinued the former procedure that had three-page proposals hurriedly handed to the vice-chairman for approval. Moreover, he did not allow any unit to initiate negotiation until the proposed acquisition got tentative approval from the Major Projects Review Committee. Shortly after he took office, the uranium issue came to light, initially as a concern and later on as a major problematic issue¹¹⁰.

Reestablishing a strong top coordination was one of the most important changes Kirby introduced. A Management Committee formed by Kirby and the companies' presidents was established to make key decisions¹¹¹. This committee dealt with every major issue, such as capital budgeting, long-range planning, key appointments, as well as, the latest developments in uranium.

¹¹⁰ In early 1973, WH's president in charge of nuclear businesses had told security analysts "we have firm commitments [for uranium] that match our requirements throughout the term of all our contracts". See Fortune, August 1976, p. 154. In WH's 1975 Annual Report, Kirby reviewed WH's performance, and stated that "apart from our concern over uranium ... the year 1975 was one of accomplishment for Westinghouse" (p. 1). In the Annual Report's Financial Section, a potential severe financial impact was conjectured, while also stating that "in light of many uncertainties, probable or potential loss cannot reasonably be estimated" (p. 34). The uranium affair had aken WH's management by surprise. Unawareness of the firm's commitments was a result of Burnham's reorganization. In fact, fuel obligations had been taken on in a piecemeal, uncoordinated way, leaving top management unaware of the extent of such obligations. By 1977, in his letter to stockholders, Kirby would declare that "resolving the uranium problem remains one of our primary objectives". See WH's 1977 Annual Report, p. 3.

¹¹¹ As Fortune reported in August 1976, "Company presidents, who formerly were preoccupied with their own parochial interests – and who even feuded over products and markets – now find themselves "looking over all of Westinghouse" at these meetings and helping to deal with problems in their sister companies" (p. 156).

In 1976, GE acquired Utah International. Having diversified into the natural resources area, GE added a totally new field to its previous five businesses – consumer, industrial components and systems, industrial power equipment, aerospace, and international. At that time Utah was a \$1 billion business that contributed 6% of General Electric’s total sales in 1976 and 17% of total earnings¹¹². Commenting on Utah’s acquisition, Jones stated that “the favorable impact of Utah International on our 1976 results underscores the short-term benefits of this merger. But the greater importance is long-term”¹¹³. Utah was a “growth opportunity”¹¹⁴ identified through strategic planning”, whose potential for profitable growth was expected to “exceed those of our historic product lines”¹¹⁵.

In July 1978, Kirby appointed Douglas D. Danforth WH’s chief operating officer. Danforth had joined WH as a general manager of the Mexican subsidiary in 1955 and had later overseen WH’s Canadian operations. After his appointment as chief operating officer, Danforth travelled abroad extensively. In an interview to *Fortune* he stated that “our own people were telling me we could do better. We were turning down projects, because the job needed six of our business units and only three were interested”¹¹⁶. Customers also complained¹¹⁷.

Kirby and Danforth assigned John C. Marous to do a study on WH’s international operations. Marous, joined WH at the age of 24, and had been for thirty years with the company. A ninety-day deadline was set and Marous assembled a team that would provide a fresh look on the company’s international operations. The findings astounded team members. For one, WH did not know precisely how much money it made abroad, because business units never separated their domestic and export business¹¹⁸. In addition, each unit had its full complement of support services – legal, accounting, financial – in each country¹¹⁹. Only a few units had developed an international orientation and operating method. Those were the nuclear and the defense-equipment businesses, whose

¹¹² GE 1976 Annual Report, p. 6.

¹¹³ GE 1976 Annual Report, p. 5.

¹¹⁴ At the time of its acquisition, Utah had achieved “its twelfth straight year of record earnings”. See GE 1976 Annual Report, p. 6.

¹¹⁵ GE 1976 Annual Report, p. 5.

¹¹⁶ *Fortune*, January 14, 1980, p. 50.

¹¹⁷ *Fortune* reported the following incident: “not long ago, a company salesman called on a Saudi business man. After the preliminaries, the Saudi reached into his desk drawer and drew out the business cards of twenty-four other Westinghouse salesmen. Spreading the out in his desk, the Saudi exasperatedly inquired: ‘Who speaks for Westinghouse?’ ” See *Fortune*, January 14, 1980, p. 50.

¹¹⁸ As a result, they were able to allocate overhead as they saw fit, sometimes piling it all on their domestic sales to avoid the appearance of a loss abroad. See *Fortune*, January 14, 1980.

¹¹⁹ According to *Fortune*, “This led to such ludicrous situations as one subsidiary sitting with surplus cash, while another in the same country was borrowing at exorbitant rates”. See *Fortune*, January 14, 1980.

products had a competitive edge in world markets. As for the others, the effort to compete internationally was far too demanding¹²⁰.

Intent on raising GE's earnings, GE's studies indicated that, in an inflationary economy, unless real costs were known, prices would mistakenly be set low, reducing therefore the company's profits¹²¹. In 1979, GE launched a management-education program, COIN, "Effectively COping with INflation". In two years, the program trained around 3,000 GE managers, and representatives of about 50 other large companies. GE shared its insights with corporate visitors, believing that to the extent that all of American industry knew its real costs, pricing would be more realistic, and all firms would benefit.

Inflation studies produced insights that were incorporated into GE's corporate policy. For instance, since services businesses were lean in inventories and fixed assets, not only they would not require large inflation adjustments, but all competitors in a service industry would be more likely to understand their real costs. Pricing would consequently allow for real profits in the industry. As a result, expansion into services would be a sound strategy in inflationary times. Another insight concerned the effects of inflation adjustments. Those were believed to be much bigger on low-margin businesses than on high-margin ones. Expansion into high-tech ventures would, therefore, fit well an inflationary economy. As a result, GE's formulated strategies emphasized expansion into services, for example, computer programming, and into high-tech, such as, manufacturing of advanced integrated circuits.

In the late 1970s and early 1980s, aiming at recovering lost ground and meeting the increasing challenge of the Japanese, WH concluded it had to increase productivity much faster than the 2-3% American industry used to achieve¹²². As a result, Westinghouse invested a record \$446 million in capital improvements in 1980, an increase of 41% over 1979¹²³. In 1979, WH established the Westinghouse Productivity and Quality Center. In

¹²⁰ Most of the business units enjoyed no international competitive edge and readily fell back on the big, unified, steadily expanding domestic market. If an easy foreign sale or obvious acquisition appeared, they snapped it up. Otherwise, the world looked too complex, fragmented, and competitive to be worth the effort. See *Fortune*, January 14, 1980.

¹²¹ Those studies were meant to better understand the effects of inflation on business and to derive growth strategies in a high inflation environment. GE's studies on this matter suggested the need to "raise the balance-sheet values of inventories and fixed assets from historical to current cost, and then use these values to set the inventory and depreciation costs that flow through the income statement". See *Fortune*, May 4, 1981, p. 121-122.

¹²² In the words of a WH executive: "Our operating margins didn't look as good as we hoped for the future and we agonized a lot over this. The significant and delightful development came when we freed ourselves from trying to solve the problem by changing the mix, forgetting the volume or raising prices. We said, realistically, these things are not fully, and sometimes not at all, under our control. Maybe we had better concentrate on things we can influence. We are going to have more with less – fewer people, less money, less time, less space, fewer resources in general – and I think that's probably a pretty good definition of productivity". See *Fortune*, June 15, 1981, p. 74.

¹²³ According to WH's 1980 Annual Report, "A substantial portion of this investment was made as part of our corporate-wide quality and productivity effort. This effort includes modernizing existing facilities, building new plants, introducing advanced manufacturing processes and focusing on human motivational factors" (p. 1).

addition, WH engaged in participative management¹²⁴. As of 1981, more than 600 quality circles had been formed and three new ones were added each day¹²⁵. Notwithstanding these proclaimed productivity enhancing efforts, WH's overall productivity remained virtually unchanged (refer to figure 6).

While GE was fine-tuning performance measurements to account for inflation effects, the uranium issue was unquestionably WH's greatest concern. In 1975 WH realized that the fulfilment of its uranium delivery commitments might cause its bankruptcy. As a result, the company declared itself legally excused from the fuel contracts because of the drastically changed market conditions. As of December 1979, settling the utilities suits had cost in excess of \$1 billion before taxes, and a provision of \$405 million was made for estimated future costs. In 1983 WH won \$85 million from uranium producers against whom it had filed suit. As of 1992, the nuclear contracts had cost WH in excess of \$1.3 billion. Throughout Kirby's tenure, WH's performance improved to the point of having the medium-term revolving credits cancelled. Some old-time businesses such as circuit breakers and related control equipment were extremely profitable¹²⁶. Yet, the on-going suits that utilities had filed against WH created a sort of dilemma to WH's management. Should they acknowledge the firm's recovery and its better earnings prospects, they might worsen the settlement conditions the company was negotiating. All in all, despite a few investments made during Kirby's tenure, the outstanding bill of previous strategic errors led WH towards a continuing contraction path (refer to figure 1). GE, on the other hand, had avoided liability in its long-term, fixed-price uranium supply contracts, because it had contracted for enough uranium among suppliers to cover its much more limited commitments – a precaution WH had not taken.

In 1981, Jack Welch took over from Reginald Jones a slightly larger GE. In 1983 Douglas D. Dunforth replaced Robert Kirby at a considerably smaller WH (refer to figure 1). In line with GE's corporate expansion strategies that emerged from inflation studies, Welch was intent on renewing and growing the company's businesses. He conceptualized the company's portfolio as those businesses falling into three circles – core, services, and high-tech – and those falling outside the circles – mobile communications, housewares, TV and audio, and consumer electronics. These latter were divestiture candidates. For four years, Welch carried out deliberate contraction to foster continuing growth. GE's portfolio of about 100, sometimes marginal, businesses was reduced to 14 major ones, occupying first or second positions in their industries. Well over 100,000 jobs were eliminated in this

¹²⁴ Ouchi's Theory Z and his consulting services were utilized. Moreover, Ouchi became chairman of an outside committee of three consulting academics. See W. Ouchi, *Theory Z*, (New York, NY, 1981).

¹²⁵ See *Fortune*, June 15, 1981, p. 84.

¹²⁶ So profitable were those businesses that officials felt "almost embarrassed to talk about it". See *Fortune*, August, 1976, p. 156.

process. Several businesses were sold, such as central air-conditioning (1982), houseware small appliances (1984), semiconductors (1988). Most of Utah International was also sold in 1984. Having faced cyclically depressed prices for its products, Utah had not turned out to be the growth business anticipated at its acquisition.

Unlike Burnham, Kirby stepped down at 65 in 1983. His succession happened in a quite unusual way: Dunforth, then 61 years old was to replace Kirby up to 1987, when Marous would replaced him. Because Marous would be 62 in 1987, as of Danforth's succession, WH named the 57 years old Paul E. Lego president and chief operating officer and announced that he would replace Marous by the end of 1990. Kirby's policies were basically continued over the Dunforth-Marous-Lego period. Then in 1991, WH Credit led WH to a \$1.6 billion quarterly loss. Once more, WH had failed to keep business deals under close scrutiny. WH Credit collapsed in 1992 after billions of dollars in loan losses. Lego left WH shortly after. In the words of a securities analyst: "the crisis at Westinghouse began as a hangnail and turned into gangrene"¹²⁷. This time, however, the amputation procedures in use for the last 3 decades did not succeed in keeping WH alive, and WH split apart a few years later.

In contrast to Reginald Jones, a finance man who had climbed GE's hierarchy as an auditor, Jack Welch had been a business manager. He developed the plastics business, positioning GE's Lexan thermoplastic as a replacement for glass. Unlike most GE managers, the entrepreneurial and performance-deliverer Welch did not rotate through new jobs during the first 17 years of his career. He viewed bureaucracy as evil making people look inward. He once told a group of GE's top managers: "this internal focus has wasted out energy, and frustrated us"¹²⁸. Welch would fight the bureaucracy that grew enormously during Jones' tenure. Feeling that nobody ever got all the information s/he would like, Jones had added more complex financial reporting to the point of having GE's computers produce seven daily reports, each 12 feet high.

Much like Swope, Jones picked up a successor that in many respects differed from himself. While Jones had emphasized control, Welch preached entrepreneurship. Rather than an organizational change, Welch saw the need for a change. Much like Swope, he would aim at communicating directly with employees. He would meet subordinates face to face as often as possible, showing up at GE's management training institute to present his ideas and debate them with the managers there. He would discuss issues ranging from corporate strategy to attitude and best practices – being number one or number two,

¹²⁷ See Fortune, November 4, 1991, p. 99.

¹²⁸ See Fortune, March 27, 1989, p. 46.

boundarylessness, work-out, six sigma, and becoming the most competitive firm in the world.

Described as a revolutionary by many, Welch however confessed he was “afraid of breaking it”, as he had been handed “one of the treasures of American enterprise”¹²⁹. On several occasions, he would put forward concepts such as *cohesiveness*¹³⁰, *integration*¹³¹, *boundarylessness*¹³², *size and speed*¹³³, and *hybrid enterprise*¹³⁴. Those ideas had in common the notion that GE should conciliate its huge size and diversity with high needs for speed and integration.

In 1985, Welch’s administration made its first major acquisition. RCA, the first joint venture associating GE and WH, was brought back into GE to strengthen GE’s aerospace and defense business. Interestingly, GE exited the aerospace and defense business in 1992-93 by selling it out to Martin Marietta. In the process GE kept RCA’s highly profitable television network, NBC. In 1986, GE acquired Kidder Peabody to reinforce GE’s financial subsidiary. In 1987, GE traded its consumer electronics business for Thomson’s medical equipment business, and the nuclear business was restructured, so as to focus its activities on refueling and servicing installed boiled-water reactors.

¹²⁹ See Fortune, November 22, 1999, p. 186.

¹³⁰ According to GE’s 1984 Annual Report, this meant “successfully implementing a strategy to become the world’s most competitive enterprise demands a special culture – one that’s strongly cohesive” (p. 5).

¹³¹ The notion of integration was advanced in several instances. GE’s 1985 Annual Report, for example, stated that, “At GE today, they’re run by entrepreneurs with their own boards – but with all the technological and financial resources that come with being part of a larger company” (p. 3). GE’s 1989 Annual Report commented on GE’s corporate strategy, “Are we a conglomerate? No. Not that there’s anything wrong with being a conglomerate. We simply aren’t one. We’re not a collection of stand-alone enterprises, and this label misses the very essence of what makes this Company work so well. We know what we are: **an integrated, diversified company**” (p. 3).

¹³² According to GE’s 1990 Annual Report, boundaryless vision meant: “in a boundaryless company, suppliers aren’t ‘outsiders’... Customers are seen for what they are – the lifeblood of a company... internal functions begin to blur. Engineering doesn’t design a product and then ‘hand it off’ to manufacturing. They form a team, along with marketing and sales, finance and the rest” (p. 2). GE’s 1991 Annual Report mentioned that “GE’s diversity creates a huge laboratory of innovation and ideas that reside in each of the businesses, and mining them is both our challenge and an awesome opportunity. Boundaryless behavior is what integrates us and turns this opportunity into reality, creating the real value of a multibusiness company – the big competitive advantage we call Integrated Diversity. Boundary-busting does something else for us. It makes us faster... ‘We versus them’ is increasingly coming to mean GE versus the competition” (p. 3, 4).

¹³³ According to GE’s 1992 Annual Report, “Size gives us staying power through market cycles in big, promising businesses... Size gives us the resources to invest over a half-billion dollars a year on education... What we are trying relentlessly to do is get that small-company soul – and small-company speed – inside our big-company body” (p. 2, 3).

¹³⁴ GE’s 1995 Annual Report explains the idea: “The hottest trend in business in 1994 – and the one that hit closest to home – was the rush toward breaking up multi-business companies and ‘spinning-off’ their components, under the theory that their size and diversity inhibited their competitiveness. The obvious question to General Electric, as the world’s largest multi-business company, was ‘When are you going to do it?’ The short answer is that we’re not. We’ve spent more than a decade getting bigger and faster and more competitive, and we intend to continue. Breaking up is the right answer for some big companies. For us it is the wrong answer... Our dream, and our plan, well over a decade ago, was simple. We set to shape a global enterprise that preserved the classic big-company advantages – while eliminating the classic big-company drawbacks. What we wanted to build was a hybrid, an enterprise with the reach and resources of a big company – the body of a big company – but the thirst to learn, the compulsion to share and the bias for action – the soul – of a small company” (p. 1, 2).

Under Welch, GE globalized, expanding into Europe first and into Asia next. To counter the expected cultures clash as of GE's acquisitions abroad, the company developed an integration model, which began even before a deal was made. The due diligence team, which examined not just financial but also human resources and general management issues, would draft a plan to take effect immediately after the deal was formalized. Believing that there are no mergers of equal, in its acquisitions, GE sought to inspire change rather than compel it, while keeping clear that GE was the boss. Integration time was reduced to about 100 days in 1999, despite the particular challenges of managing in Europe – such as dealing with unions¹³⁵.

At WH, Dunforth continued the reshaping of WH's portfolio¹³⁶. Between 1985 and 1987 WH made 70 divestitures and 55 acquisitions, and experienced some internal growth. Upon Dunforth's retirement in 1987, the 62 years old Marous replaced him up until 1990, when Lego took over. Marous and Lego continued the restructuring of WH's portfolio. Internally developed VABASTRAM (for VALue-BASed STRAtegic Management) was the planning tool that, according to Lego was "the most sophisticated strategic planning process of any company in the United States" and that helped WH "to portfolio-plan on a micro-basis"¹³⁷. According to WH's management, this tool helped to perform a shareholder-value test on acquisitions, which were required to complement existing lines of business. In addition, WH was heavily applying productivity and quality enhancement techniques to improve all the companies businesses.

Welch viewed a rigorous allocation of available resources as a crucial managerial task. Like in his predecessors' tenures, succession at all organizational levels was carefully reviewed. A board committee was closely involved in a continual evaluation of the company's 130 highest-rank executives. The exhaustive assessment, in place even before Welch took over, probed the managers' strengths and weaknesses, contributing suggestions for their development. He believed that developing human resources was crucial for GE to become the most competitive enterprise in the world. As a result, not only ever-higher standards were set in the recruitment of top talent, but innovative professional training programs were developed.

¹³⁵ According to Johnston, GE's European CEO, who had come to France from GE Appliances in Kentucky, "I'd dealt with the union in Louisville, but here it's something else. The three unions are the communists, the socialists, and the anarchists". As Fortune reported, "GE prevailed by being as punctilious about workrules as the strikers were, having a notary record questionable union behavior, storing finished goods at the airport to keep shipments going, and hiding parts onsite so that work went on when deliveries couldn't get through. And by talking: Johnston never let a day go by without meeting with the strikers to tell GE's side of the story". See Fortune, September 27, 1999, p. 130.

¹³⁶ Fortune reported that Dunforth "moved factories offshore, bought back stock, took a couple of restructuring hits, and channeled capital away from sluggish businesses and into fast-moving ones. Light bulbs, cable television, and many others were cut away." See Fortune, July 3, 1989, p. 93.

¹³⁷ See Fortune, July 3, 1989, p. 93.

In the mid-1990s GE launched a Six Sigma program to help establish a common quantitative language throughout its many businesses world-wide. Targeting increased productivity and quality, the program aimed at reaching standards of excellence in any kind of process – manufacturing, billing, loan processing. Welch stimulated both collaboration and competition within GE. Diffusion speed of ideas, methods, and practices became as usual as top managers' pursuit of top people and best talents worldwide. In Welch's view, GE had reached the third stage of globalization – globalizing intellect after having globalized markets and sources¹³⁸.

The finance subsidiary of both companies – WH Credit and GE Credit, later on renamed GE Capital – experienced remarkable profitable growth. Due to its astonishing performance throughout the 1980s, WH's subsidiary was widely praised inside and around WH. As of 1987, WH Credit profits accounted for 16% of WH's total profits. It was the financial subsidiary that generated growth to support the unrelenting search for the perfect, counter-cyclical portfolio that led Dunforth and Marous to sell and buy several dozens of businesses throughout the 1980s. GE Capital (GEC) was formed in the 1930s as a captive finance subsidiary to bankroll GE's washing machines and other household appliances. Over time, it made a number of acquisitions and launched a number of internal ventures in the financial services. By 1997, its businesses included among others specialty insurance, store-sponsored credit cards, commercial loans, residential mortgage, computer services, and equipment leasing – airplanes, railcars, cars, trucks, satellites.

Here is how GE Capital's top manager, Gary Wendt, saw the integrated, diversified, globalized GE: "The most important part of the GE value to us is its management structure. Jack Welch is not only a heroic form of CEO, there's also a long history of building management practices here"¹³⁹. Besides, the reciprocal relationship linking GEC and the other GE units was mutually fruitful. GE's long-time knowledge of a number of industries provided GEC with valuable information on potential clients for its financial products. For instance, GE's centennial familiarity with utilities enabled GEC's managers to learn firsthand of the utilities eagerness to get rid of ancillary activities such as billing, and collections. As a result, GEC's retailer financial services, which already did billing and collections for 75 million store-brand credit cards, expanded into a new market. The intelligence network has also helped to point out hazards. For example, GE's internal sources signalled a likely instability in the utilities industry due to deregulation. This led GEC to withdraw from insuring utility bonds. On the other hand, GEC has given GE a

¹³⁸ "Globalizing the intellect of the company... It means using Russian engineering and Indian software – not to arbitrage labor costs, but because these are the best people you can find". See Fortune, September 27, 1999, p. 136.

¹³⁹ See Fortune, November 10, 1997, p. 188.

competitive advantage by providing large contracts financing for the customers of GE businesses, such as aircraft, power systems, and automotive.

GE's managerial expertise in running businesses was also helpful in avoiding the write-off of a bad loan or a leasing loss. In 1983, for example, GEC became a railroad leasing company, when its loans to Tiger International became potential losses. On another occasion, GEC launched Polar Air, an independent air cargo line, by converting passenger planes into cargo carriers, when those passenger planes came off lease in a period of weak demand for passenger airplanes. In sum, GEC and GE's other businesses kept a synergistic relationship.

GEC would seek to eliminate, or at least reduce, all risks that did not carry a big potential payoff (like insuring utility bonds) and to save its risk-taking for the few that did. Moreover, the broad mix of businesses helped to minimize the risks posed by one particular venture. However, GEC's protection went beyond simple diversification, encompassing plenty of collateral. By employing a team of highly qualified asset managers, GEC aimed at knowing exactly what each collateral was worth. This enabled GEC to buy problem loans and properties, which others would not dare to acquire, and reap capital gains from such assets. Risk management was deeply incorporated in the management of GEC's diversified portfolio of businesses. Business managers would closely work with risk management experts¹⁴⁰. In addition, GEC has also used quantitatively triggered danger signals – smoke detectors – to alert it in case of trouble¹⁴¹. Besides collateral and smoke detectors, GEC performed a real-time financial X-ray of its clients, which helped to keep track of GE's exposure to every client across all lines of business. Finally, GEC's customers were usually assigned a \$50 million credit ceiling. Any credit extension required review and signature from GEC's top management. A credit extension beyond \$100 million would go to GEC's board, where Welch sat¹⁴².

As of 1997, GEC's profits accounted for 39% of GE's earnings. Welch was reported to view GE full of slower-growing money makers like plastics, lighting, and aircraft engines, which together threw off most of what was needed to pay dividends, buy

¹⁴⁰ According to GEC's chief risk manager, "Part of the assessment our business leaders make on a new piece of business is whether or not we'll get paid. That's why we put risk managers down in trenches with them". See *Fortune*, November 10, 1977, p. 134.

¹⁴¹ To produce these smoke detectors, in each business, its risk manager identified the main factors, usually four or five, which contribute to potential profitability. This involved studying the business history to understand how GEC made money in the financial product sold. Once the profit drivers were determined, smoke detectors were set to alert business managers to any substantial change.

¹⁴² In GEC's view, "the limits don't hinder growth, but they do make it more thoughtful and greatly reduce the odds of a nasty surprise". See *Fortune*, November 10, 1997, p. 134.

back shares, and fetch that triple-A credit rating¹⁴³. On the other hand, the opportunistic, entrepreneurial, fast growing GEC was producing the necessary fuel to foster GE's growth.

Still, both the successful GEC and WH Credit underwent major problems in the 1990s. Notwithstanding GE's acquisition expertise, GE Capital's acquisition of Kidder Peabody turned into a fiasco reducing GEC's 1994 earnings by \$1.2 billion. This acquisition became a nightmare for two reasons. First, a controversial issue involving an inside trader turned into a major financial scandal¹⁴⁴. Second, an organizational issue affected Kidder Peabody's risk assessment efficacy. Kidder's head, Welch's good friend Michael Carpenter, did not get along with GEC's head, Gary Wendt. Welch allowed Carpenter to report directly to him. Welch kept Kidder under intense pressure to grow, and allowed it to operate entirely detached from GEC's sophisticated, financial and risk management controls. Not only did the American government force GE to oust Kidder Peabody's management, but the firm also suffered a huge loss of talented people thereafter. Other costly scandals in the defense business also emerged throughout Welch's tenure¹⁴⁵.

WH Credit problems popped up just a few months after Lego took over the chairmanship. In 1990, the subsidiary had to look for \$665 million in revolving credit, and in 1991, WH was forced to make a \$1.68 billion provision against earnings. Out of a \$10 billion portfolio, WH had to write-down \$2.7 billion. Growth had been pursued so intensively, that "nearly every deal that went to a loan committee got approved"¹⁴⁶. When accounts started to fall delinquent, renegotiation resulted in reduced interest payments in return for equity in the financed projects.

At the end of January 1993, Lego was forced into retirement, stepping down two years ahead of schedule. WH's eroding stock price undermined his credibility with shareholders, leading WH's board to oust him. Up until a new CEO was brought in, one of WH's executive vice presidents, Gary M. Clark, became the acting CEO. Five months later, in June 1993, an external manager, Michael H. Jordan, was brought in. At that point, WH Broadcasting was not only the most profitable but also the most promising business in WH's portfolio. During Jordan's first two years, WH's stock price stayed at the

¹⁴³ See *Fortune*, November 10, 1997, p. 118.

¹⁴⁴ See J. Jett, *Broken Bonds*, (New York, NY, 2004).

¹⁴⁵ In 1985, GE pleaded guilty to fraud charges for overcharging the Air Force. GE agreed to pay \$2 million in criminal and civil penalties; in 1989, GE settled four civil suits brought by whistle blowers who alleged that GE cheated the government by issuing faulty timecards. GE paid \$3.5 million; in 1990, GE was convicted of defrauding the Defense Department by overcharging the Army for a battlefield computer system. GE paid \$30 million; in 1992, GE pleaded guilty to defrauding the Pentagon in the sale of military jet engines. GE paid \$69 million in fines; in 1993, GE's NBC unit issued an on-air apology to General Motors for staging a misleading simulated crash test, and agreed to pay \$1 million legal and investigation expenses. See *Fortune*, September 5, 1994, p. 46.

¹⁴⁶ See *Fortune*, November 4, 1991, p. 94.

same low level it was when he took office. Aiming at fortifying WH Broadcasting, whose 1995 earnings were \$203 million on sales of \$870 million, Jordan purchased for a big premium CBS television network. From then on, Jordan restructured WH's portfolio repositioning WH as a media business. Industrial businesses were to be spun off. As a result, in 1997, after more than almost three decades of restructuring experiments, WH's several businesses were split up or sold out and the company ceased to exist.

Interestingly, despite the large amount of activity in reshaping GE's portfolio in the last two decades of the 20th century, out of the 12 businesses reported in 1997 GE's annual report, only one – broadcasting – was new to GE¹⁴⁷. In fact, broadcasting, which had been included in GE's portfolio as a divestiture candidate, ended up showing a superb profitability and was kept, while the businesses that had motivated RCA's acquisition – aerospace and defense – ended up being divested in the course of time. Ironically, in Welch's highly praised "New GE"¹⁴⁸ all but one business were "old", having started in the late 19th or early 20th century.

CONCLUSION

This paper describes the emergence and development, up to the late 1990s, of the American electrical industry and of its top two companies – General Electric and Westinghouse. It shows that even though these companies led the electrical schumpeterian revolution in America, they ended up having very different destinies. While GE still thrives as a highly diversified high-tech company, WH progressively deemphasized its high-tech orientation, and therefore lost a distinctive capability that it had cultivated for decades. Historical data suggest that value creation through innovation and value capture from innovating activities have consistently been central to GE, while to WH value creation and value capture from innovation became accessory.

¹⁴⁷ Aircraft engines (1903 – first gas driven turbine wheel in the US); Appliances (1905 – electric iron); Capital Services (1880s – financing central stations); Lighting (1879 – first incandescent lamp); Medical Services (1896 – X-ray apparatus); NBC (acquisition); Plastics (1900 – chemical research to develop new filament materials); Power Stations (1880s – central stations); Electrical distribution and control (1886 – Sprague acquisition); Information Services (late 1950s – time-sharing systems); Transportation Services (1904 – locomotives).

¹⁴⁸ See R. Slater, *The New GE - How Jack Welch Revived an American Institution*, (Homewood, Ill., 1993).

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