The Rise and Sale of the General Electric Computer Department: A Further Look

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This article is a follow-up and extension of the first author's 1995 *Annals* article entitled, "The Rise and Fall of the General Electric Corporation Computer Department." It is divided into three parts: a study of the financial implications of rental versus sales in the larger GE environment, a collection of differing views with respect to the GE management paradigm and its effect on the Computer Department, and a set of corrections to the original article.

In 1994, the General Electric (GE) Computer Department Alumni Association held its triannual meeting in Scottsdale, Arizona. This was the opportunity to interview a number of the pioneers of the Electronic Recording Machine Accounting (ERMA) project and those who continued to embellish GE's capabilities in computer design and manufacture until the merger with Honeywell Information Systems in 1970. From that alumni meeting grew the contents of a special issue of the *Annals* published in 1995. Following that publication, the authors of this report participated in a correspondence that involved several GE alumni. Shortly after the publication of the special issue, Homer (Barney) Oldfield, the originator of the GE Computer Department and ERMA entrepreneur, published a book on the subject.[8]

While there was an excellent correspondence between the two publications based on close cooperation between all the authors, there still remained some differences that were primarily based on perceptions. This article is an attempt to resolve some of those issues or at least to provide the two sides of some issues.

Computer Rental or Sale?

Throughout the lifetime of the GE Computer Department, the annual financial goals that the department proposed and the New York headquarters subsequently approved were often exceeded. Orders received and shipments were consistently higher than projected. This led to problems of managing unplanned growth manifest in inventory imbalances, a lack of trained product service and applications personnel, and a general imbalance of resources. The majority of these increased orders and shipments were for computer systems to be rented to customers rather than purchased, resulting in greatly increased losses as a consequence of GE's method of accounting for such rentals. On the other hand, when the Computer Department was merged into Honeywell Information Systems in 1970, the transaction was profitable to GE, though on paper there was a sizable deficit that had been sheltered by some of the profits from other GE operations. The sale of the Computer Department to Honeywell was structured so that GE did not have to recapture any tax deferrals. If the Computer Department had been an independent corporation, its eventual sale would have been judged to have been successful. Even today, the descendent products of the Computer Department survive.

GE, somewhat like IBM, did not get into the computer business enthusiastically. While IBM chief executive officer Thomas J. Watson, Sr., was concerned about the impact that the creation of a new product line would have on the staple commodity of the corporation—the punched card data processing systems—GE had a greater diversity of products to assuage any initial expenses in setting up a new division. (Watson is imputed to have suggested that the world would not need more than five computers; thus during his tenure, IBM concentrated on the

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Had GE set up a separate organization to be the leasing arm of the computer-marketing activity so that the Computer Department sold the machines to a leasing division, then it is more than likely that the Computer Department would have been profitable on paper.

punched processors as its major product.) Since the end of World War II, GE had added nuclear power, electronics, and jet engines to its repertoire without suffering any major drawbacks.

Two major differences existed between the 1950s computer industry and the practices common throughout GE. In 1951, the computer industry got its first production lines of machines to replace the earlier one-off, specially built machines. Those early machines were generally built under contract or through a government grant and thus became the property of the user. The economic utility of this new generation of computers was not demonstrable, and few users were willing to pay millions of dollars for them. IBM's long-standing policy of renting its products was very attractive to computer users. For the users, it also meant that they would have the opportunity to upgrade their facilities without the necessity of capitalizing their investments or remarketing the machines being replaced. For the vendors, it meant that they could control the secondary market, while at the same time recover their incremental costs within the rental period. On the other hand, the majority of products GE manufactured were for sale—lightbulbs, jet engines, and transformers. Renting was not a common GE approach to distributing its products.

Another significant difference between, say, IBM and GE was in the way that the corporate stock was held (and the expectations of stockholders that, in turn, set strategies for financial planning and budgeting). IBM stock has generally been held as a growth stock, whereas GE stock was (and is) held by "widows and orphans" who sought a dependable dividend with a more-modest expectation of growth. The cash requirements of any GE line of business were not anticipated to have any significant impact on the dividend policy. Leasing or rental did not create cash returns within the same fiscal year that the cost of manufacture was incurred. In fact, the accumulated income from a rental may lag behind the manufacturing costs by several years. Had GE set up a separate organization to be the leasing arm of the computer-marketing activity so that the Computer Department sold the machines to a leasing division, then it is more than likely that the Computer Department would have been profitable on paper. (Many such schemes were proposed but ultimately died on the question of transfer price. See Figure 1, next page.)

In this study, we have created a sample financial statement for a computer of the ilk of the GE 225 (one of the most successful machines during the lifetime of the Computer Department). The two models of financing come from the experience of the second author, who was the manager of budgets and measurements (1956–1962) and then the manager of sales financing (1962–1967) for GE's Computer Department.

Figure 1 summarizes and compares the costs and income from a system that has a basic manufacturing cost of $105,000 plus $110,000 total marketing costs with a sale value of $250,000, resulting in an income before taxes of $35,000 and a net income (profit) of $17,500. This transaction results in a 7 percent return on the sale price.

In the model, the rental price is based on the sale price with an annual return of 7 percent (the same profit as would be expected from the sale).

The market's allegiance to the "price performance" curve established the rental price. Selling prices were strategically established as a multiple of the monthly rental price to effectuate the desired ratio of sales to rental. IBM did not want to sell its equipment and set a high multiple of over 50 times the monthly rental to discourage purchase. The result was approximately 80 percent of its shipments were rented and 20 percent sold. The "seven dwarfs," with the exception of RCA, used a multiple of 44 in an attempt to achieve 65 percent rental and 35 percent sold, but due to the market's bias toward rental, the result was more nearly 70/30. RCA used a much lower multiple and achieved approximately a 60/40 split.

Since rental equipment remains the property of the vendor, it will be subject to property taxes, which may be amortized over the expected lifetime of the machine. In the GE leasing model, the depreciation was front-end loaded (i.e., a greater depreciation is taken in the early years to reduce the property taxes), in contrast to the more-common model in which depreciation is

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EXHIBIT A — **SALES vs RENTALS**

Assumptions	Notes	If Sold	Notes	Rental GE Model	Notes	Rental Common Model	Notes
Sale Price		$ 250,000					
Rental Revenue (Note A)	5 years			$ 337,500		$ 337,500	
TOTAL REVENUE		$ 250,000		$ 337,500		$ 337,500	
Direct Material	30%	$ 75,000					
Direct Labor	6%	$ 15,000					
Direct Factory Overhead	6%	$ 15,000					
Amortization of Rental Asset				$ 105,000		$ 145,000	
Property Taxes			2.5%	$ 3,500		$ 4,788	
Insurance			2.1%	$ 2,190		$ 2,190	
COST OF SALES		$ 105,000		$ 110,690		$ 151,978	
GROSS MARGIN		$ 145,000		$ 226,810		$ 185,523	
Indirect Factory Overhead		$ 15,000		$ 15,000			
Engineering		$ 25,000		$ 25,000			
Other Costs and Expenses		$ 70,000		$ 70,000		$ 70,000	
TOTAL PERIOD COSTS		$ 110,000		$ 110,000		$ 70,000	
INCOME BEFORE TAXES		$ 35,000	14.0%	$ 116,810	35%	$ 115,523	34%
Income Taxes	50%	$ 17,500		$ 58,405		$ 57,761	
NET INCOME		$ 17,500	7.0%	$ 58,405	17%	$ 57,761	17%

Note A: Computed to develop same annual rate of return as a sale price at a simple interest rate

EXHIBIT B — **RENTAL INCOME BASED ON GE MODEL**

	Year 1	2	3	4	5	6	TOTAL
Rental Revenue (Note A)	$33,750	$67,500	$67,500	$67,500	$67,500	$33,750	$337,500
Amortization of Rental Asset	$35,000	$28,000	$21,000	$14,000	$7,000		$105,000
Property Taxes	$1,750	$1,050	$525	$175	$0	$0	$3,500
Insurance	$219	$438	$438	$438	$438	$219	$2,190
COST OF SALES	$36,969	$29,488	$21,963	$14,613	$7,438	$219	$110,690
GROSS MARGIN	($3,219)	$38,012	$45,537	$52,887	$60,062	$33,531	$226,810
Indirect Factory Overhead	$15,000						$15,000
Engineering	$25,000						$25,000
Other Costs and Expenses	$70,000						$70,000
TOTAL PERIOD COSTS	$110,000						$110,000
INCOME BEFORE TAXES	($113,219)	$38,012	$45,537	$52,887	$60,062	$33,531	$116,810
Income Taxes 50%				$11,609	$30,031	$16,766	$58,405
NET INCOME	($113,219)	$38,012	$45,537	$41,279	$30,031	$16,766	$58,405
CUMULATIVE INCOME	($113,219)	($75,207)	($29,670)	$11,609	$41,640	$58,405	

Note A: Beginning and Ending Year assumed at 50%

EXHIBIT C — **RENTAL INCOME BASED ON MORE COMMON MODEL**

	Year 1	2	3	4	5	6	TOTAL
Rental Revenue (Note A)	$33,750	$67,500	$67,500	$67,500	$67,500	$33,750	$337,500
Amortization of Rental Asset	$14,500	$29,000	$29,000	$29,000	$29,000	$14,500	$145,000
Property Taxes	$2,263	$1,538	$813	$88	$88	$0	$4,788
Insurance	$219	$438	$438	$438	$438	$219	$2,190
COST OF SALES	$16,982	$30,976	$30,251	$29,526	$29,526	$14,719	$151,978
GROSS MARGIN	$16,769	$36,525	$37,250	$37,975	$37,975	$19,031	$185,523
Indirect Factory Overhead (Note B)	$0						$0
Engineering (Note B)	$0						$0
Other Costs and Expenses	$70,000						$70,000
TOTAL PERIOD COSTS	$70,000						$70,000
INCOME BEFORE TAXES	($53,232)	$36,525	$37,250	$37,975	$37,975	$19,031	$115,523
Income Taxes 50%	$0	$0	$10,271	$18,987	$18,987	$9,516	$57,761
NET INCOME	($53,232)	$36,525	$26,978	$18,987	$18,987	$9,516	$57,761
CUMULATIVE INCOME	($53,232)	($16,707)	$10,271	$29,259	$48,246	$57,761	

Note A: Beginning and Ending Year assumed at 50%
Note B: Capitalized (added to Amortization)

INCOME OVER 8 YEARS — **GE RENTAL MODEL**

EXHIBIT D

	Year	1	2	3	4	5	6	7	8	
New Units Rented		1	1	1	1	1	1	1	1	
Income before Taxes from shipment year	1	$ (113)	$ 38	$ 46	$ 41	$ 30	$ 17			
(thousands)	2		$ (113)	$ 38	$ 46	$ 41	$ 30	$ 17		
	3			$ (113)	$ 38	$ 46	$ 41	$ 30	$ 17	
	4				$ (113)	$ 38	$ 46	$ 41	$ 30	
	5					$ (113)	$ 38	$ 46	$ 41	
	6						$ (113)	$ 38	$ 46	
	7							$ (113)	$ 38	
	8								$ (113)	
Total Income		$ (113)	$ (75)	$ (30)	$ 12	$ 42	$ 58	$ 58	$ 59	
Income Taxes (at 50%)		$	0	$ 0	$ 0	$ 0	$ 0	$ 0	$ 0	$ 5
NET INCOME		$ (113)	$ (75)	$ (30)	$ 12	$ 42	$ 58	$ 58	$ 53	
CUMULATIVE INCOME		$ (113)	$ (188)	$ (218)	$ (206)	$ (165)	$ (106)	$ (48)	$ 5	

EXHIBIT E

	Year	1	2	3	4	5	6	7	8
New Units Rented		5	10	20	20	10	0	0	0
Income before Taxes from shipment year	1	$ (566)	$ 190	$ 228	$ 206	$ 150	$ 84		
(thousands)	2		$ (1,132)	$ 380	$ 455	$ 413	$ 300	$ 168	
	3			$ (2,264)	$ 760	$ 911	$ 826	$ 601	$ 335
	4				$ (2,264)	$ 760	$ 911	$ 826	$ 601
	5					$ (1,132)	$ 380	$ 455	$ 413
Total Income		$ (566)	$ (942)	$ (1,657)	$ (842)	$ 1,102	$ 2,501	$ 2,049	$ 1,349
Income Taxes (at 50%)		$	0	$ 0	$ 0	$ 0	$ 0	$ 822	$ 674
NET INCOME		$ (566)	$ (942)	$ (1,657)	$ (842)	$ 1,102	$ 2,501	$ 1,227	$ 674
CUMULATIVE INCOME		$ (566)	$ (1,508)	$ (3,165)	$ (4,007)	$ (2,905)	$ (405)	$ 822	$ 1,497

INCOME OVER 8 YEARS — **COMMON RENTAL MODEL**

EXHIBIT F

	Year	1	2	3	4	5	6	7	8
New Units Rented		1	1	1	1	1	1	1	1
Income before Taxes from shipment year	1	$ (53)	$ 37	$ 27	$ 19	$ 19	$ 10		
(thousands)	2		$ (53)	$ 37	$ 27	$ 19	$ 19	$ 10	
	3			$ (53)	$ 37	$ 27	$ 19	$ 19	$ 10
	4				$ (53)	$ 37	$ 27	$ 19	$ 19
	5					$ (53)	$ 37	$ 27	$ 19
	6						$ (53)	$ 37	$ 27
	7							$ (53)	$ 37
	8								$ (53)
Total Income		$ (53)	$ (17)	$ 10	$ 29	$ 48	$ 58	$ 58	$ 58
Income Taxes (at 50%)		$ 0	$ 0	$ 0	$ 0	$ 9	$ 29	$ 29	$ 29
NET INCOME		$ (53)	$ (17)	$ 10	$ 29	$ 39	$ 29	$ 29	$ 29
CUMULATIVE INCOME		$ (53)	$ (70)	$ (60)	$ (30)	$ 9	$ 38	$ 67	$ 96

EXHIBIT G

	Year	1	2	3	4	5	6	7	8
New Units Rented		5	10	20	20	10	0	0	0
Income before Taxes from shipment year	1	$ (266)	$ 183	$ 135	$ 95	$ 95	$ 48		
(thousands)	2		$ (532)	$ 365	$ 270	$ 190	$ 190	$ 95	
	3			$ (1,065)	$ 730	$ 540	$ 380	$ 380	$ 190
	4				$ (1,065)	$ 730	$ 540	$ 380	$ 380
	5					$ (532)	$ 365	$ 270	$ 190
Total Income		$ (266)	$ (350)	$ (564)	$ 31	$ 1,023	$ 1,522	$ 1,124	$ 760
Income Taxes (at 50%)		$ 0	$ 0	$ 0	$ 0	$ 0	$ 697	$ 562	$ 380
NET INCOME		$ (266)	$ (350)	$ (564)	$ 31	$ 1,023	$ 825	$ 562	$ 380
CUMULATIVE INCOME		$ (266)	$ (616)	$ (1,180)	$ (1,150)	$ (127)	$ 697	$ 1,260	$ 1,640

Figure 1. Simulated GE spreadsheet.

evenly distributed over the product's lifetime (straight-line depreciation). Another difference between the GE model and the common model is in the distribution of engineering and indirect factory overhead. In the GE model, these costs are charged to operations as they were incurred (as direct costs), whereas in the common model, these costs were amortized over the product's lifetime. These seemingly minor differences make only a small difference in the accumulated net incomes between the two models. Based on a rental price of $337,500, the net income over five years is about 17 percent; but based on the sale price, the net income is about 23 percent, or less than 5 percent per annum.

We will now discuss theoretical annual returns from the rental of a single system over a calendar period of five years, assuming an impact over six fiscal years. The rental return in each model is the same: $67,500 per annum. The differences in amortization of the indirect factory and engineering costs and the different rates of depreciation result in two differences in the budget sheet. The final bottom lines differ by only $1,288, resulting from differences in property taxes, the GE model having the greater return over the rental period. However, the major difference is in the annual returns that would be reported in annual corporate reports. In the first year, the GE model reports a loss over twice that of the other model. On a cumulative basis, the GE model does not show its first profit until the third year, while the other accounting model is profitable a year earlier.

This delay in profitability is exacerbated as the number of machines delivered increases. Consider the results under the assumption of a steady-state delivery of one machine per year. In the GE model, the annual income levels off in the sixth year (as would be expected with the assumed lifetime of each delivered machine), but it is not until the eighth year that the cumulative income shows a profit. In the case of the common model, the annual return levels off also in the sixth year and with the same amount ($58,000, or $9,500 less than the annual rental fee for one machine), but the first cumulative profit occurs in the fifth year, three years ahead of the GE model. An alternative scenario assumes that 65 machines are delivered in a five-

Table 1. Impact of Rentals on GE Bottom Line

Year	Sale value	Rental income*	Total GE*	Impact %**
1962	150	(68)	581	–11.7
1963	210	(72)	621	–11.6
1964	290	(73)	534	–13.7
1965	410	(70)	760	–9.3
1966	575	(62)	727	–8.6
1967	810	(87)	757	–11.5
1968	1,130	(122)	785	–15.5
1968	1,580	(170)	678	–25.2
1970	2,200	(239)	793	–30.1

* *Before taxes; all amounts are in millions of dollars.*

** *Computer Department losses added back to the GE reported income before taxes.*

Source: Moody's Industrials *for the years indicated.*

year period. This assumes that at the end of this time, the machine would become obsolete or would be replaced by an improved version. In this comparison, the first cumulative profits are still shown a year earlier in the common model than in the GE model, interestingly enough in the year after the last machine was delivered.

These figures correspond closely to the known balance sheets of the Computer Department and GE from 1962 through 1970 (the year of the merger with Honeywell), as shown in Table 1.

Throughout this period, the Computer Department was introducing new computer systems up to and including the 600 series machines that became the backbone of the Honeywell "fleet" of computers, the architecture of which still exists in NEC's 2000 machines. Each year, the front-end load overcomes the residual income from installed systems.

As early as 1959, GE had initiated a company-wide task force to consider the impact of rentals and leases. The task force consisted of a finance person and a marketing person from each affected division, supplemented with staff from corporate headquarters representing accounting and taxation. The Computer Department was represented by Claire Lasher and the second author. The other represented departments were jet engines, dental x-ray, two-way communications, small gas turbines, and locomotives. The task force met monthly for 18 months and produced a two-volume report. The two volumes reflected the views of the lessor and lessee, respectively, and anticipated Internal Revenue Service and Financial Accounting Standards Board rulings and changes by three to four years, especially in those areas where there were no rules applied yet to this new industry. The conservative approach to rentals and leases kept GE out of the taxation and accounting troubles that haunted most other computer companies in later years.

The question clearly arises as to whether the decision to get out of the computer business came too early. Had GE stayed the course beyond 1970, would the annual income have turned around and the cumulative affect become positive? The financial history of Honeywell Information Systems up until the time when it, in turn, sold its assets to Compagnie des Machines Bull is also mixed. The core of the Honeywell stable of systems was the Multics system that had been developed as part of Project MAC. Based on the GE 645, Multics was far advanced in concepts and capabilities and provided time-sharing and security that have not been equaled in 30 years. Honeywell's poor marketing, servicing, and maintenance of Multics systems harmed confidence in the technology, and slowly the strength of the combination of hardware and software declined to the point that Honeywell sold out to Compagnie des Machines Bull. Unlike the GE sellout, Honeywell did not have a time-sharing business to retain and to contribute to the corporate bottom line even after the hardware business was gone. In January 1983, late in the Honeywell period, Honeywell announced the 6180 computer to which Multics was to be ported.

There were many entrepreneurs who tried to salvage Multics from the trash heap after Multics support was canceled in July 1985. However, by 1988, Honeywell transferred all the maintenance of Multics to the University of Calgary, which established a separate corporation named ACTC Technologies Inc. that took on the mission of keeping the last Multics system running. The architecture GE's John Couleur designed in the late 1960s was still running almost 30 years later.

The second author opines that GE got out of the computer business at the most opportune time and in an extremely attractive fashion. To all intents and purposes, the balance sheet was adequately composed of expenditures and the income from the Honeywell sale. The disastrous exit of RCA shortly thereafter demonstrated the delicate timing of the sale.

During the early years of selling ERMA systems to banks, there was a higher ratio of sales, since the banks did not like rentals. One reason was the rental differential in second- and third-shift operations, especially since most banks were third-shift operators.

The GE Management Paradigm

The original paper was critical of GE's management style that did not seem to fit the computer industry paradigm:

> The GE management policy, assiduously supported by Ralph Cordiner and by a long succession of corporate officers, maintained that a professional manager is capable of managing anything—independent of prior experience or preparation. In fact, management trainees were sent to a extremely well organized and documented management course that had been in place since at least the 1930s [according to Lou Rader] to give them not only the "Company spirit" but also to prepare them for a wide variety of management assignments. With one exception [Rader] the Division that contained the computer operation would never have [a] computer literate manager. [The other exception, though not noted in the original article, was the initial department manager, Oldfield.][1,p.29]

John Couleur opined:

> Unfortunately, most of the management had never been associated with electronics, let alone computers, and had no way of evaluating the issues that were being raised.[3,p.59]

Couleur also wrote:

> I guess the secret of making "professional management" work is that the managers Plan, Organize, Integrate, and Measure, while the troops who have been with the business and know the business, do the work. As new managers come in, they get to know the troops and who they can trust and not trust. In this way, the business is actually operated by competent people, managers and troops working as a team.
>
> When so many new managers descended on Phoenix at one time, the new organization destroyed the relationships that had made the business successful and which could have worked to find solutions to the problems. No one knew who to trust. The troops had no reputations with the new managers and with that, lost their influence over the business that they had created. The control was taken by the new managers who made decisions based on their newly granted authority. We all lost our influence. That's when the chaos started.[3,p.60]

Between 1957 and 1970, the computer industry was primarily populated with young scientists and engineers who had little administrative experience. For many companies, it was simply not appropriate to take productive workers from the work floor and train them to be managers. Whether experienced managers could be effective administrators of technically advanced companies was a better bet in the GE milieu.

Bob Johnson remembered (from the Memory Dump session of the GE Computer Department Alumni Reunion, Scottsdale, Arizona, May 1994) the manner in which the Computer Department, like others, made its annual presentations at the New York corporate headquarters:

> The way these things were done then [1962] was there was a little theater at five-seventy [570 Lexington Avenue, New York, GE headquarters], and the team under review was on stage with spotlights on us. The management executive officer sat out in the dark and we couldn't see who was there, but we could hear voices. In my remarks, I made the comment that in ten years I thought half of the computers that we were [manufacturing] would be talking to each other by telephone. And Cordiner's voice boomed out of the dark saying, "On what basis do you make such a preposterous statement?" I made some feeble attempts to defend it, citing for example, all the trouble the bank had in trucking checks around. I failed to persuade them that this was an important subject—data communications.

In any innovative organization, there will be more-worthwhile projects than resources to allocate. Thus for every project that is selected for further development, there will be a cadre of engineers who are upset that their projects were not favored and who will blame their shortcomings on the incompetence of the administrators. While it is apparent that the majority of attendees of the GE Computer Department reunions are from the sales force, many are as critical of the management system as Couleur and Johnson are.

As part of the special issue of the *Annals*, we had hoped to include a reprint of Robert Flaherty's 1967 "Edsel" article from *Forbes* magazine. However, the *Forbes* publishers refused our request. The story was about the appointment of Stanford Smith as vice president and general manager of the Information Systems Division. Flaherty reported:

> While he is no computer man, GE's top executives believe that his broad experience with the company will help in dealing with GE's computer problem. One told *Forbes*: "people who know a business intimately often lack experience in the pursuit of alternative courses of action—of weigh-

> ing the alternatives and coming to a conclusion." In short, top management feels that what GE *has lacked in computers is not technical expertise but overall management vision* [emphasis added].[5]

The second author believes that the forgotten measure of the success of the GE Computer Department was that it was profitably sold in 1970. GE came out of 15 years of computer business with at least a small profit. This may, in fact, prove that if GE had stayed the course, the Computer Department would have turned around. There might be some criticism that those who complained about the capabilities of the long line of managers were engineers whose proposals were rejected. But there were successful managers who felt the same way. A legitimate complaint of many was the additional time it took to persuade their managers of what they felt would have been obvious to technicians and then the inability of the managers to carry those messages up the line to get overall corporate approval. Conversely, some alumni believe it is better to have managers who do not know the business. This fulfilled the axiom, "Good. It is a different business today than it was yesterday, and it will be different tomorrow. We have enough people who know the business as it was yesterday." It is an article of faith among the venture capital community that functionally specialized founders of an enterprise should be replaced by professional managers within two to three years.

Apple Computer brought in a "sugared-water" man (John Scully, former chief executive officer of Pepsi) to share the reins with Steve Jobs in 1984. In the mid 1990s, IBM brought in the "cookie man" (Louis Gerstner, Jr.) to take over the company at an equally difficult time. On the other hand, Watson had enough sense to turn IBM over to his son at the instant the company needed a technologist at the helm (with the help of a large cadre of well-trained scientists such as Cuthbert Hurd).

The subsequent successes in the computer business of some of those who were in management positions within the GE computer operation should not be overlooked either. While they were not totally successful trying to run a computer business under the GE umbrella, they were successful elsewhere. For example, Eugene White, manager of engineering for the 600 line in 1965, went on to take over the ailing Amdahl Corporation from Gene Amdahl and turned it into a success. The alumni list of the Computer Department contains the names of many GE employees who found prosperity in the corporate boardrooms of other computer-related organizations.

Corrections and Refinements

We would like to take this opportunity to correct and refine some points from the first author's earlier article.[1]

Page 24: The question of President Cordiner's aversion to competing against IBM in early 1950 cannot be founded, like our concerns above, on the impact of losing IBM's trade. Cordiner referred to the industry as the "business machines business," populated by well-established companies such as National Cash Register, Underwood, Burroughs, and Remington. IBM was not a competitor in this field, but it was a significant customer of GE in other ways. Metcalf[7] and others have suggested that IBM was purchasing small motors for installation in its punch card data processing systems. The second author has shown (private communication to Oldfield, 15 September 1994) that even if IBM's original equipment manufacturer purchases from GE amounted to 30 percent of its total purchases, this would amount to only 1.38 percent of GE's sales. On the other hand, IBM was receiving 9 percent of its income for the rental of unit record equipment in GE's financial and accounting offices. GE was more important to IBM than the reverse. Thus it is just as likely that Cordiner's instinct, backed up by Watson's protective stance toward his turf, was the rationale for the embargo against getting into the computer business as a common vendor. GE was doing very well in one-off contracts with military agencies. However, the early 1950s was the period when the industry was emerging from the era of custom-built machines into an era when computers were to be built in production lines.

Page 25: The background of W.R.G. "Doc" Baker, one of the early managers of the department, was primarily radio and television, but he was also very familiar with digital techniques.

Page 25: The initial contract for the Bank of America systems called for the capability to process 55,000 transactions per ERMA system per day, or 2 million transactions per day overall. We now know that in March 1959, Johnson and George Trotter reinterpreted the requirements expectation so that some of the 13 processing centers contained multiple ERMA systems with additional sorters and printers than initially forecast to meet the more-general requirement of 2 million transactions per day.

Page 27: There remains a difference in opinion regarding the corporate rules regarding the placement of GE installations and their distance from other installations. The second author opines that a major geographical con-

sideration was the 50-mile "no-overlap" limitation in effect at the corporate level. This policy was established so as to avoid some problems that GE had experienced in the Northeast, where installations, such as Schenectady (New York) and Pittsfield (Massachusetts), competed in the same labor market. Oldfield acknowledges that the rule existed for operating departments but claims it was not applicable to laboratories. The organization that was to take on the ERMA project was not initially intended (or expected by corporate GE) to be an operating department or division, and thus it was categorized as a laboratory. There already existed a GE Atomic Power Department plant in San Jose, California, and the GE Microwave Laboratory at Stanford University (in Palo Alto, California). As an alternative to Palo Alto and its potentially useful proximity to the Stanford Research Institute, Berkeley, across the bay from San Francisco, had been proposed as a potential site for the Computer Department. With an excellent source of engineers from the University of California, and 50 miles distant from San Jose, it met the geographical limitation requirement, but was rejected on the basis of "an arbitrary business climate policy."[8]

Oldfield had visited Phoenix as part of his own search for an appropriate site for the manufacturing facilities and had placed that city on the list of locations to be considered. Phoenix had an excellent labor market and a probusiness climate, as was evident from Motorola's success in establishing its facilities there. Moreover, Motorola's Dan Noble had persuaded Arizona State College (now University) to establish a new technology center, and Motorola was not averse to the arrival of another high-tech company. (The term "high tech" had not been coined at that time.)

Phoenix as a site had the negative factors of too small a population to support a large facility and its remoteness from business centers, but these were overcome. Obviously, in 1964, Rader considered Phoenix too remote from corporate headquarters when he insisted on maintaining his personal headquarters in Charlottesville, Virginia, while keeping his home in nearby Waynesborough. By contrast, his successor, Smith, spent the majority of his time in Phoenix.

The remoteness argument was countered with the prediction that jet airline travel, still at least five years away, would offset that deficiency. Oldfield commissioned, and the Stanford Research Institute undertook, an independent study of Phoenix as a befitting site. The report foresaw the possibility of jet airline travel as a solution to the remoteness counterargument.

Page 28: In the photograph, the identities of the men standing behind the check sorter are (left to right): Jay Lenvinthal (GE), unknown (with back toward machines), George Snively (GE), Owen Lindley (GE), unknown, Lynn Killfoyle (GE), and Claire Lasher (GE).

Page 30: The statement that "there was never an attempt to go head-to-head with IBM in serving banks on the East Coast of the U.S." was simply incorrect. IBM did not make strong inroads in the use of unit record equipment in the banking industry, having unsuccessfully proposed the use of punched cards as an alternative for the Bank of America contract. While there were several sales of ERMA systems on the East Coast, the New York City banks were not a target. The Bank of America was clearly the largest retail bank with numerous branches, whereas the New York City banks were generally largely centralized, wholesale, and lacking branches. The hardware would have been satisfactory, but it would have required a substantial rewriting of the ERMA software to accommodate the relatively few New York City banks.

Page 34: In 1963, Cordiner, serving as chairman of the board, was replaced by Gerald Phillipi, who had served as president up to that time. Fred Borsch replaced Phillipi as president.

Page 38: In the left column, in the first line of the last paragraph, the correct name is George Feeney.

Page 44: The tables at the top of the second column were interpolated from a figure in Flaherty's *Forbes* article.[5] The table has been corrected here (see Table 2).

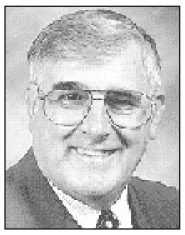
Table 2. Comparison of Revenues and Net Income 1958 and 1964 (in millions of dollars)

		1958	1964
Revenue	GE	$4,121	$4,942
	IBM	$1,172	$3,239
Net income	GE	$243	$237
	IBM	$126	$431

Like so much of our computer history, the memories of the participants differ, and the significance of events varies from person to person. The GE Computer Department story suffers from the lack of involvement of all participants. The corporate view of the history of the Computer Department is totally missing, and several of the more-senior members of the department would prefer to forget their experiences. Having taken a deep breath with the special issue of the *Annals* in 1995 and the subsequent publication of the Oldfield book in 1996, we must now clean up the edges as new information becomes available and as new readers add their recollections.

References

1. J.A.N.Lee, "The Rise and Fall of the General Electric Corporation Computer Department," *Annals of the History of Computing,* vol. 17, no. 4, pp. 24-45, 1995.
2. H.R. Oldfield, "General Electric Enters the Computer Business—Revisited," *Annals of the History of Computing,* vol. 17, no. 4, pp. 46-55, 1995.
3. J. Couleur, "The Core of the Black Canyon Computer Corporation," *Annals of the History of Computing,* vol. 17, no. 4, pp. 56-60, 1995.
4. J.L.McKenney, "Developing a Common Machine Language for Banking: The ABA Technical Subcommittee Story," *Annals of the History of Computing,* vol. 17, no. 4, pp. 61-75, 1995.
5. R.J. Flaherty, "GE's Edsel?" *Forbes*, 1 Apr. 1967, pp. 21-23.
6. J.L. McKenney and A.W. Fisher, "Manufacturing the ERMA Banking System: Lessons from History," *Annals of the History of Computing,* vol. 15, no. 3, pp. 7-26, 1993.
7. G.F. Metcalf, *Making Waves in the Information and Space Age*. Portland, Oregon: Binford and Mort Publ., 1992.
8. H.R. Oldfield, *King of the Seven Dwarfs: General Electric's Ambiguous Challenge to the Computer Industry*. Los Alamitos, Calif.: IEEE CS Press, 1996.
9. G. Snively, "General Electric Enters the Computer Business," *Annals of the History of Computing,* vol. 10, no. 1, pp. 74-78, 1988.



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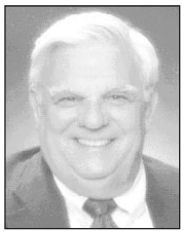

George E. Snively joined GE in 1950 and moved to the Computer Department in May 1956 as the third employee in the payroll and as the manager of budgets and measurements and to manager of sales financing in 1962. He left GE in 1967 to follow his own interests.

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