SCIENTISTS, ENGINEERS AND MARKET FORCES: A STUDY OF FERRANTI AND COMPUTERS, 1949-1993.[1]

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Abstract.

Having been associated with computing virtually from the industry's first days, not to mention its claim to have made the world's first commercially-available computer, Ferranti has a special place in the evolution of this technology. For a variety of reasons, however, by 1963 Ferranti had pulled out of the mainframe computer business, to focus instead on digital systems (largely for defense customers), minicomputers and, later, microprocessors. The principal purpose of this paper is to highlight the major problems Ferranti encountered in exploiting its early technological competitive advantage in computers. Of course, an engineering-led strategy always dominated the Ferranti approach to product development, illustrating how in technical terms the firm was always interested in pioneering on the frontiers of existing knowledge. At the same time, one must remember that a range of exogenous factors influenced the commercial outcome, not least the support provided by government and the small scale of domestic demand. This unhelpful environment also contrasted sharply with the stimuli! prompting American firms like IBM to venture into this field, providing them with such a commercial competitive advantage that Ferranti experienced severe difficulties in dealing with this threat. It is a moot point, though, whether external or internal factors were responsible for the manner in which British mainframe computer manufacturers continued to fall behind their American, and later Japanese, competitors.

It is difficult to capture on paper the excitement and ambition of a period when engineers and scientists embarked on a radical innovation like the computer. There is no doubt that this new machine represented a Schumpeterian leap in man's ability to deal with his environment, especially by enormously increasing the speed with which data could be manipulated and sorted. Politicians and businessmen were also interested in exploiting the commercial benefits of computing, bringing together a coalition of interests which in late-1940s Britain was very much part of the corporatist-collectivist atmosphere of a country determined to build a better world than its peacetime equivalent of the 1930s. As with many of the post-war dreams, however, problems arose from an early stage. While in engineering terms considerable progress was made in producing machines which matched anything else in the world, the long-term benefits in terms of boosting living standards and creating new jobs failed to meet the initiators' expectations.

To many what was at that time the family-run firm of Ferranti represented in microcosm the problems besetting Britain generally over those post-war decades. The de Ferranti family had succeeded in building an organisation dedicated to engineering innovation. While up to the 1930s

[1] I am deeply indebted to Sebastian de Ferranti for sponsoring my research into the firm his family built up. In addition, several people have helped me understand the Ferranti mainframe computer story, especially Harry Johnson, Peter Hall and Peter Dorey of Ferranti, and friends in the academic world like Geoff Tweedale, Martin Campbell-Kelly and John Hendry, For an insight into the relationship between Ferranti and computers, see John F. Wilson, Ten-anti and computing, 1949-93: effecting the balance between commercial reality and technological aspirations', in F. Rodriguez & J. Vignole (eds.), Histoire de L-Informatique, Actes du Ve Coloque, Cepadues-Editions,1998, pp. 151-66. This subject will also be surveyed in greater detail in my forthcoming book. Ferranti. A History, Vol. I, The Emergence of a Family Business. 1882-1963 (Carnegie Press, 1998, approx. pp.450). The company archives are currently being indexed at the North West Museum of Industry, Station Rd., Manchester.

its principal contribution lay in the field of large transformers, meters and domestic appliances, over the following twenty years under the dynamic leadership of Sir Vincent de Ferranti the firm became one of the leading electronics producers, largely as a result of its alliance to the rearmament and wartime drive to modernise the armed forces. While this defense commitment was retained during the post-war years. Sir Vincent also encouraged his managers to venture into exciting, new civil technologies, giving rise to the alliance with University of Manchester scientists in the production of the Mark I computer. As we shall see in this paper, however, Ferranti struggled to convert its undoubted technical prowess in the design and production of mainframe computers into a commercially sound business which could compete effectively with both its British and American rivals. The reasons behind this trend revolve around misdirected government policies, not to mention the small scale of British demand for advanced equipment of this kind which limited commercial opportunities for many other firms in this market. At the same time, it is also important to assess internal factors like the firm's engineering-led strategy and its organisational ethos, producing a more rounded view of the total scene as we attempt to explain why Ferranti had pulled out of mainframe computers by the mid-1960s.

The First Ferranti Computers.

At the time when Vincent de Ferranti was persuaded by Sir Ben Lockspeiser to collaborate with F.C. Williams and Tom Kilburn at the University of Manchester in 'the making of electronic calculating machines',[2] both American and British teams were making significant progress in designing analogue mainframe computers. This story is so well covered in the existing literature that little of the detail needs to be provided here.[3] It is vital to note, though, that by the time the Ferranti-University of Manchester team had installed the Mark I computer (in the university's computer laboratory) in February 1951, they had beaten the American Eckert-Mauchly UNIVAC I by four months to the title of world's first commercial delivery[4]. Over the following decade, at times retaining the link with university scientists, or alternatively developing ideas in the firm's own laboratories, Ferranti succeeded in maintaining an extensive reputation for designing and producing durable mainframes. Although Table 2 reveals that over the period 1950-59 Ferranti accounted for the second largest share (26.4 per cent) of the British computer market, building on the initial contact with Williams and Kilbum the firm had an unrivalled position in sales of the most sophisticated machines.

Before going on to examine this commercial story in greater detail, it is first of all necessary to assess the various influences which prompted the firm's foray into computing. In the first place, while Sir Vincent de Ferranti was encouraging bis managers to build up civil sector businesses, the key agent in this scenario was Sir Ben Lockspeiser, the Ministry of Supply's (MoS) chief scientific advisor, who introduced Ferranti engineers and managers to the Williams-Kilbum team. Indeed, had Lockspeiser not provided Ferranti with an annual sum of £35,000 for five years it is clear that Sir Vincent would have refused to allow his manager (Eric Grundy) to link up with the university scientists. Moreover, as Hendry notes, because there was no competitive tender and no proper specification, the formal agreement between Ferranti and the MoS 'broke many of the rules of

[2] Letter from Sir Ben Lockspeiser to V.Z. de Ferranti, 26 Oct. 1948.

[3] See especially J. Hendry, Innovating for Failure Government Policy and the Early British Computer Industry. Massachusetts Institute of Technology Press (1989), M. Campbell-Kelly, ICL. A Business and Technical History. Oxford University Press (1989), D. Caminer, J. Aris, P. Hermon & F. Land, Leo. The Incredible Story of the World's First Business Computer. McGraw-Hill (1998).

[4] S. Lavington, Early British Computers. The Story of Vintage Computers and the People Who Built Them. Manchester University Press (1980), p. 40.

government contracting'[5]. It was a piece of opportunistic matchmaking by a civil servant committed to providing business with extensive access to the fruits of scientific endeavour.

While Lockspeiser's role was central in forging this relationship, however, it is vital to emphasise that for the remainder of its time as a producer of mainframe computers Ferranti was bound into a relationship with the state which would have serious consequences for the pattern of product development. One might even argue that because the state was more interested in the development of advanced machines capable of contributing to scientific programmes like nuclear or aircraft research, the opportunity to diversify into the production of smaller computers for commercial use were limited to Ferranti. On the other hand, given the relatively paltry financial resources of a family firm like Ferranti, severing its links with state agencies like the MoS and National Research Development Corporation (NRDC) would have been dangerous. Moreover, the Ferranti organisation with its engineering-led ethos was more attuned to working on exciting new projects which were devoted to pushing forward the boundaries of knowledge, rather those which were principally concerned with generating profit. As the Ferranti sales team also reported to the chairman, selling in the 1950s was 'interesting and often exciting, but unrewarding. Time and again we could only report that, after customer visits, that they were showing a keen interest, but no order'[6].

Government Attitudes and Ferranti Product Strategy.

Having noted how the Ferranti computer strategy was significantly influenced by its relationship with certain government agencies, it is now important to outline the pattern of product development over the twelve years which followed the technical success accorded the Mark I in 1951. Table 1 provides basic information on the nine different computers produced at the West Gorton plant acquired by Ferranti for this purpose[7],7 demonstrating how attention moved, constantly to new designs and concepts. One must remember that, as we shall see later, Ferranti also established a computer department at Bracknell during the mid-1950s, where both mainframe design was conducted and the digital systems activities initiated. Nevertheless, it is with the output from West Gorton which we shall be principally concerned, because this represented what at the time was the principal focus of the firm's computer activities.

Source: Swann (1975).

While Ferranti had clearly established a substantial lead over its rivals by 1951 after the launch of the Mark I computer, at the same time it was also faced with two major and complementary problems: how to exploit, and then sustain, this advantage in the market. Crucially important as an immediate problem to Ferranti was the rising development charges involved in continuing the progress made with the Mark I, especially as the University team was considering further improvements. Fortunately, though, although he had moved to the Department of Scientific & Industrial Research (DSIR), Sir Ben Lockspeiser had retained an interest in the Manchester project and he persuaded the MoS to provide another contract, based on the same terms as its predecessor, in order to keep the team together[8]. It was also at this time that the NRDC first started talking to Ferranti about computer production, negotiations which would prove crucial to the future of this embryonic computer department. A detailed analysis of these negotiations will consequently

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[5] Hendry (1989), p. 89.

[6] B.B. Swann, The Ferranti Computer Department, unpublished manuscript (1975), p. 15. See also G. Tweedale, 'Marketing in the Second Industrial Revolution: a case study of the Ferranti computer group', 1949-63, Business History. 34, No.1 (1992), p.101.

[7] West Gorton was not actually acquired until 1956. The first computers were actually made at the firm's Gem Mill plant in Chadderton.

[8] Hendry (1989), p.89-91.

reveal some of the key features of the British computer scene, especially with regard to the nature of government support and the limitations this imposed on firms like Ferranti.

Table 9.1: The Number of Ferranti Computer Sales from the West Gorton computer department. 1951-63

Type and period of production	Scientific Organisations *	Aircraft Co.'s	Other Commercial	Total Sold	Exports
Mark I (1951-2)	2	-	-	2	1
Mark I* (1953-7)	4	1	2	7	2
Pegasusl# (1956-61)	10	5	11	26	3
Pegasus II # (1959-62)	2	2	8	12	1
Mercury (1957-61)	14	-	5	19	6
Perseus (1959)	-	-	-	2	2
Orion (1963-5)	-	-	10	10	1
Sirius (1960-3)	4	-	12	16	6
Atlas (1963-4)	3	-	-	3	-
TOTAL	39	8	48	97	22

* This category includes universities, government research establishments (domestic and overseas), and atomic energy authorities.

Hendry (1989, p. 183-5) claims that sales of twenty-five Pegasus I and thirteen Pegasus II computers were made, but no evidence is produced to say why Swann is incorrect.

Before describing these negotiations, one must remember that two years earlier the head of the NRDC, Lord Halsbury, had failed to raise any support for a joint computer development project from either the punched-card office machinery firms (BTM and Powers-Samas) or major electrical firms like GEC, AEI and EMI. Although an advisory panel on electronic computers was formed by the NRDC in December 1949, on which sat representatives of most electrical firms, because of a widespread suspicion of both computers and backdoor government intervention Halsbury was unable to persuade any to initiate a joint venture. More importantly, while the idea of building partnerships was typical of Halsbury's general strategy, we have already noted how it met with little approval from the industry, where greater interest was expressed in a more focused approach. By the time the Mark I had been commissioned, and further MoS finance had been negotiated for another development stage, Halsbury was consequently in a weak bargaining position when he approached Ferranti about a production contract[9].

This position was also further undermined by the NRDC's refusal to back Halsbury's suggestion that it should finance computer production. Instead, in March 1951 Sir Vincent was offered an interest-bearing loan of £50,000, to cover development costs. Not surprisingly, this was flatly rejected, principally on the grounds that a bank loan was cheaper.[10] Typifying Sir Vincent's general stance when dealing with government agencies, Ferranti wanted the NRDC to underwrite production, thereby minimising any risk involved in making computers for as yet unknown

[9] This story is related in great detail by Hendry (1989), pp.47-59.

[10] These discussions are recorded in a series of letters collected by M.E. Sions in 1957. The most crucial are those from VZF to Lord Halsbury, 22 Nov 1951, and from W.G. Bass (the Ferranti London office manager and head of government contracts) to Lord Halsbury, 22 Nov 1951. See also Hendry (1989), pp.89-91.

customers. However, in view of the established government contracting conventions which prevented the NRDC from giving special preference to one firm, the NRDC was still unwilling to back such a proposal. Negotiations stuttered along over the following months and in fact it was November 1951 before Halsbury finally managed to convince bis board that the most effective way forward was to finance production of an updated Mark I. This indicates how vacillation and hard bargaining took some time to reconcile during the early-1950s, posing substantial obstacles to greater cooperation when the contract was settled. It was a simple matter of Sir Vincent's business mind conflicting with the bureaucratic attitude of Halsbury and the NRDC, setting the tone for over a decade of difficulties.

This first set of negotiations between Ferranti and the NRDC demonstrated two key points: that Halsbury was ready to stimulate private enterprise in computer development and production; and that Sir Vincent was always going to succeed in extracting favourable terms because of the hand dealt to Halsbury. Again, one must remember that little interest had been raised in 1949 from even the largest electrical firms, while Ferranti and the University of Manchester had made such remarkable progress that it had to be sustained if Britain was to establish a position of strength in the world computer industry.

In fact, the NRDC agreed to purchase four of the new computers arising out of the development work on the Mark I, paying Ferranti all the development and production costs plus 7.5 per cent profit, as well as a further five per cent commission on the final selling price in 'using their best endeavours to find customers'[11]. This was quite a coup for Sir Vincent, because all the short-term risks attendant on participating in the project had now been transferred to the NRDC, while at the same time the agreement provided further finance, strengthening the firm's position as Britain's leading computer producer. Of course, while Ferranti carried the longer-term risks associated with keeping its team together and maintaining a factory. Sir Vincent had secured the deal he had been initially wanted.

The end result of this second stage of development was the Mark I*, which represented a substantial improvement in reliability on the Mark I exhibited in 1951, as well as much greater storage capacity and enhanced speed of calculation.[12] It is important to note that the University of Manchester team did not provide much assistance with this product, because they were already beginning to think about what was later known as the Mark II, or MEG (megacycle engine), a computer which by 1957 Ferranti was producing and marketing as the *Mercury.* In the meantime, not only was Ferranti preoccupied with selling the Mark I*, the sales team was also drawing up ambitious plans for additional facilities and development programmes which would further sustain their lead in the market. Inevitably, though, because further development work would involve negotiations with either the NRDC or the DSIR, once again a clash between commercial and functional aims emerged which was to cause even greater problems for both Ferranti and the NRDC.

When Ferranti first approached the DSIR in September 1953 with a proposal for a three-year development programme costing £435,000, only £75,000 of which would come from Ferranti funds, he was greeted with some hostility from an organisation which had already become suspicious of the firm's use of public money.[13] The de Ferranti family was convinced that, because they wanted more support for their *Deuce* computer, executives at English Electric were mounting an anti-Ferranti campaign in government circles. In fact, all computer work at the DSIR was handled by the Brunt Committee, formally the DSIR Advisory Committee on High Speed Calculating Machines, established by Sir Ben Lockspeiser in 1949 and chaired by Sir David Brunt.

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[11] Tweedale (1992), p. 100.

[12] Lavington (1980), pp.118-9.

[13] These negotiations are described in Hendry (1989), pp. 88-104.

While Lord Halsbury and F.C. Williams sat on this committee, it still expressed considerable concern at the lack of control over how its 1951 grants had been spent by Ferranti. No formal accusations were ever made and it seems curious that no investigations were conducted. In effect, though, the comments seemed to have been used as an excuse for refusing the 1953 Ferranti request. Instead, the NRDC was asked to take over the project, especially as the University of Manchester had already approached this body for funding of its Mark II programme. It was a curious affair, but most importantly with regard to computer development it forced Ferranti to negotiate in future only with the NRDC, reviving the debates of 1951.

The preliminary negotiations with the NRDC actually took until March 1954 to complete. Moreover, even though six months had passed since the first approach to the DSIR and the University team was also waiting for an answer to its entreaties. Lord Halsbury still had to settle the details of any deal. It is also important to note that at exactly the same time Ferranti was negotiating another development and production contract on what would eventually become the *Pegasus* computer.[14] Unfortunately, though, the NRDC could never be persuaded to support the Mark II development programme, leading to the rejection of the Ferranti proposal (involving an NRDC purchase of ten Mark II computers at a cost of £500,000), This was extremely frustrating for all concerned, especially as Ferranti went on to develop the Mark II computer and sell eighteen of these machines (marketed as *Mercury).* One can only conclude that the NRDC had missed an opportunity to participate in another successful project.

In view of its previous actions, the NRDC refusal to finance a Mark II project stands out as a rather odd position to take, particularly as two months earlier funds for what became the Pegasus computer had been agreed. In retrospect, though, the hard negotiating stance adopted by Sir Vincent at a meeting with the NRDC in March 1954 could well have been the key factor. Lord Halsbury jotted down some notes after that meeting which provide an interesting insight into his perception of Sir Vincent's negotiating position. He wrote that:

> 'The Ferranti family own the whole of the equity capital in Ferranti Ltd;
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> [they] have all the money they need for personal purposes and money is not an object of interest to them; they are in business for fan and will therefore under no circumstances agree to any proposition whatever that is from their point of view not so fanny; in particular they will not open one crack, cranny or crevice whereby any third party could gain a permanent toehold inside the Ferranti group of enterprises; if Sir Vincent were looking for a new enterprise to invest Ferranti money in, he would not himself pick computers. He has, however, no objection to a Government agency picking computers for him provided that he is fally compensated for the use of Ferranti facilities.[15] '

This is clearly a rather jaundiced view of both Sir Vincent and Ms business, because the firm was much more than a hobby. Crucially, as we saw in chapter seven, one of Sir Vincent's main aims had always been to keep Ms firm in the vanguard of electronics developments, while at the same time ensuring that expensive development contracts would never lead to serious illiquidity problems. Furthermore, even though the NRDC negotiations proved fruitless, Ferranti did develop the University of Manchester's Mark II design into the *Mercury* computer, revealing how Sir Vincent was interested in computers, whether 'fanny' or not.

One might also ask whether the last sentence in Halsbury's notes represents a highly logical and rational stance for a commercial enterprise. Certainly as far as Sir Vincent was concerned, this would have been extremely useful for Ms computer department. The very fact that Ferranti went on to produce Mercury indicates that Sir Vincent was simply attempting to secure the best terms for

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[14] B.Swann to NRDC, 17 Dec. 1953, and NRDC to B.Swann, 2 Feb. 1954.

[15] Quoted in Tweedale (1992), p. 104, and analysed in greater detail by Hendry (1989), pp.95-6.

Ms firm, a position Lord Halsbury misinterpreted. Apart from highlighting the generally unhelpful nature of Halsbury's interventions, when combined with Ms desire to control the industry by splitting up the limited funding between teams of firms one must question whether the NRDC was limiting the prospects of building a successful British computer industry.

Pegasus and Progress.

WMIe Ferranti struggled to extract farther development funding for the Mark I* successor, it is important to emphasise that the NRDC was actually supporting a contemporaneous project wMch was to have even greater implications for general computer technology. TMs project had originally been an Elliott Bros. project, where since 1950 the NRDC had been supporting the work of Elliott Bros.' computing division cMef, confasingly named W.S. (Bill) Elliott. Only because of personnel problems at that firm's Borehamwood research division did Ferranti succeed in acquiring a new approach towards computer circuitry. By 1952, the prototype for what became the Elliott 401 computer was being built, again (after much deliberation) financed by the NRDC. Unfortunately, though, the decision by Elliott Bros. management to move the Borehamwood cMef (John Coales) back to the London headquarters had already precipitated a confidence crisis in the development team, leading Bill Elliott and several others to look for a new employer.[16]

Elliott Bros.'s loss was certainly a considerable gain to Ferranti, because not only had Bill Elliott joined the latter by September 1953, he also brought with him a team of engineers which was to play a major role in developing the southern Ferranti computer activities. In addition, and of much greater immediate importance, Elliott was principally responsible for developing new circuit technology which was to have such a significant impact on the computer world that as a result Ferranti was able to expand its business considerably. Although the NRDC had been reluctant to see the 401 project move from its original home, the Cambridge mathematician Christopher Strachey was able to persuade its computer sub-committee that Ferranti should benefit from the advances made at Borehamwood.[17] Consequently, by early 1954 funds had been provided for what came to be known as the FPC1 (Ferranti packaged computer).[18]

Some delays in implementing this agreement were caused by a major difference of opinion between Bill Elliott and Strachey on the prototype's design. By May, though, a compromise proposal had been tendered by Ferranti which allowed work to start.[19] The contract was also reminiscent of the first agreement in 1951, because it included a promise by the NRDC to purchase at cost plus 7.5 per cent ten FPC1 computers, up to a maximum of £200,000. However, because Ferranti was at that time experiencing some difficulties in its negotiations over NRDC funding for work on Manchester's Mark II project. Sir Vincent proved unwilling to accept all the conditions attached to the first FPC1 agreement. Although Sir Vincent had not been personally involved in negotiating the latter, when he discovered that the NRDC would be given a veto over all design changes, as well as property rights to all patents arising from the development, the Ferranti negotiators were instructed to demand changes.[20]

The FPC1 contract is yet another example of the uneasy relationship between Ferranti and the NRDC. Again, though, the latter was forced to submit to Sir Vincent's stance, waiving the veto over design changes, compromising over property rights and agreeing to raise its liability for the first ten machines to £250,000. Unfortunately, though, this weak approach was later to create grave difficulties when the development stage fell behind schedule. In fact, by May 1956 not only had

[16] See Hendry (1989), pp.74-87 for a detailed history of this project.
[17] Strachey was the most influential member of the NRDC's computer sub-committee. See Hendry (1989), pp. 14-15. For a full review of Strachey's achievements, see Campbell-Kelly (1985), pp. 19-42.
[18] NRDC to Ferranti Ltd. 2 Feb 1954.
[19] Hendry (1989), pp. 80-2.
[20] Hendry (1989), pp.98-100.

costs exceeded by twenty-five per cent the initial budget of £250,000, Ferranti had also sold nine of the computers at prices based on the old estimates. So incensed was the NRDC at this predicament that by November 1956 legal proceedings were being threatened against the company. While little came of this in the next fourteen months, it was important for Sir Vincent to defase the situation.

In fact, typifying bis personalised approach to such negotiations, in February 1958 he took Sir William Black out to lunch at the Savoy Hotel, as a result of which Ferranti made an ex gratia payment of £75,000 ×irecognition of the help the NRDC has given us in getting into the industry'. [21] Of course, because the FPC1 contract had not included any veto over the many design changes which were introduced in the following two years, Ferranti refused to accept in law that they were liable to repay anything to the NRDC. On the other hand, as a gesture of good faith £75,000 helped to ease the losses of over £210,000 made by the NRDC on this contract. It also opened up the possibility that Ferranti might participate in what was at that time being described as Britain's Tast Computer' project, an episode we shall be examining later. Most notably, though, it is clear that the NRDC's inconsistent negotiating stance had created severe problems in the FPC1 development stage, precipitating a major dispute which was only defused by Sir Vincent's diplomacy.

When examining why the FPC1 proved to be so much more expensive than its initial estimates, it is first of all important to understand what was happening in the Ferranti computer department at that time. Of course, there were technical difficulties associated with the FPC1 technology. On the other hand, a factor of great significance was the conflict between the West Gorton manager, Brian Pollard, and Bill Elliott. Sir Vincent had already been warned that Pollard 'lacks the maturity to comprehend and to discharge staff,[22] a point well borne out in his dealings with Elliott. One of the most obvious sources of difficulty with this relationship was the former Elliott Bros. engineer's refusal to move out of London, leading to the establishment of a southern computer department. Interestingly, these premises were at 18 Manchester St., just around the corner from a house formerly occupied by Charles Babbage. Crucially, though, geographical dispersion of this kind was only going to accentuate communication difficulties. More significantly, not only was Elliott a highly independent engineer who would brook few superiors - many said he was quite simply odd - it transpired that he had actually refused Pollard a job at Elliott Bros. during the 1940s.[23] This clearly created an extremely awkward situation, splitting the Ferranti computer effort at a crucial time for the department.

By 1956, the Ferranti computer effort had consequently evolved into two distinct 'empires'. This friction was further intensified when Pollard started to focus more on the Manchester Mark II project, leaving Elliott to work on the FPC1 and mn up significant additional costs. A good example of these difficulties was the confusion over the FPC1 prototype, which by January 1956 had been installed in a new Ferranti sales centre in London, because while Pollard claimed that it lacked a main drum store, Elliott was convinced that his machine was ready to start work as a demonstration model.[24]

Of course, it is easy to exaggerate the degree of conflict between Pollard and Elliott. Problems often arise when extremely bright people work together, while because with specific regard to computer engineering there was considerable debate in this pioneering phase over the direction of development, inevitably there would be disagreements. Eventually, sales of both Mercury and Pegasus were also reasonably successful. In fact, when at the end of 1956 the London development team eventually moved into new facilities, at Lily House in Bracknell, Sir Vincent persuaded Grundy to sack Elliott. Although he had been careful to wait until the FPC1 technology had been satisfactorily transferred to the Bracknell laboratories. Sir Vincent was just not prepared to

[21] Hendry (1989), p. 102.
[22] V.Bowdento VZF, 15 July 1953.
[23] I am indebted to Harry Johnson for this information.
[24] Hendry (1989), p. 101, claims that no drum store had been developed by early1956, but Elliott claims otherwise.

see two of his senior managers arguing over crucial decisions. On the other hand, it was unfortunate that not only did Elliott leave to establish the UK research centre of the major American computer firm of IBM (at Winchester), he also took with him several key members of the Ferranti team in London. The whole story was not only an object lesson in organisational dynamics, it is also clear that this created too much antagonism within the computer department, limiting the extent to which Ferranti was capable of sustaining the progress of the early-1950s.

Market Difficulties and Atlas.

It is clear from what we have seen so far that a combination of internal personal rivalries and inept government policies were two of the key reasons why computer progress at Ferranti in the 1950s was perhaps not as startling as one might have expected. Of course, as Table 2 reveals, this did not prevent the firm from taking the second largest share on 1950s British computer sales, not to mention maintaining its reputation through the Pegasus and Mercury machines as a highly innovative organisation. However, it is vital at this stage to introduce another factor into this scenario, because while Ferranti succeeded in developing highly advanced computers it is significant that Elliott Brothers took a larger share of the market with its smaller machines which sold in significant numbers to commercial customers. As one can see from scanning Table 1, the majority of Ferranti computer sales went either to scientific customers or to aircraft companies for research purposes, reflecting the influence the DSIR and NRDC had on the direction of computer development at that time. In contrast, the firm's attempts to develop commercial computers like Perseus (designed specifically for insurance companies) failed commercially.

Table 2: The Share of Computer Sales in the UK. 1950-59.

	%of total sales
Elliott Brothers	32.4
Ferranti	26.4
Leo Computers	16.5
English Electric	15.5
ICT	7.1
IBM	2.0

Source: Campbell-Kelly (1989), p.215.

Of course, one could well blame Ferranti for following a highly defensive strategy of relying on government funds for projects which were intended to support the major research programmes associated with nuclear power or aircraft development. On the other hand, as we noted earlier, in view of the limited nature of demand for computers, especially in the early-1950s when Ferranti was considering which direction to follow, it is difficult to see how the firm could have been more aggressive. Those firms which did succeed in developing commercial computer businesses, like Elliott's and Leo, were obliged to focus on a narrow product range, given the nature of British demand for such advanced products. The Leo case, of course, is also unusual, given its origins as the solution to internal organisational problems perceived by J. Lyons & Co., the well-established tea and cake company.[25] This gave the venture a captive market on which to base a successful strategy aimed at selling computers to organisations with similar organisational challenges. While the existence of such a venture reflects the overall strength of the British computer effort during the 1950s, the limited market base meant that too many firms were chasing too little business at what were clearly unremunerative prices. It was a scenario which IBM was able to exploit effectively by

[25] See Caminer, Aris, Hermon & Land (1998).

moving into the British market and offering systems on a leasing basis which was competitively priced as a result of the support it had received from a booming American market.

By 1960, while 240 computers had been installed in the UK, when one compares this with the 5,400 purchased by American customers it is clear that the two markets were very much different in size.[26] Taking a more objective measurement, in 1965 there were 105 computers per million inhabitants in the USA, while in the UK there were just twenty-one.[27] By that time, 1,582 computers had been installed in the UK, compared to 24,700 across the Atlantic, revealing how American firms were provided with an extremely conducive environment, encouraging the expansion of development programmes and production facilities. As Lord Halsbury conceded as early as 1953, 'the enthusiasm of the American user was a big factor in determining the rate at which progress can be made by a manufacturing and development centre. In England potential users are not enthusiastic'.[28] In this context, one can only wonder at how a firm like Ferranti could have stimulated more interest in computers, because as far as the UK was concerned there seems to have been a general reluctance to buy such advanced equipment, while in the USA especially attitudes were very much different. Table 1 reveals that while forty-eight computers were sold to commercial customers (other than to defence-minded aircraft companies), in fact ten of these sales were to Ferranti divisions,[29] illustrating how in the 1950s this market was extremely difficult.

While firms like Elliott Brothers and Leo were experiencing some success exploiting the small computer market during the late-1950s, it is interesting to see how Ferranti was sucked into the 'Fast Computer' project to build a rival to the 'Stretch' computer advancing at IBM. The early British work had been initiated in 1953 by Tom Kilburn at the University of Manchester, where they had built an experimental transistor computer which Lavington claims was the world's first of its type to work successfully.[30] Unfortunately, though, the NRDC vacillated over which company to invite to assist Kilbum in the construction of what by 1956 had become known as MUSE, resulting in the available funds being divided between Ferranti (£300,000) and EMI (£250,000). [31] Not only did this reduce the amount of work either team could fund, the decision took three years to reach, by which time American and French super computers were nearing completion. While progress at Ferranti was speedier thereafter, particularly once Pollard had been replaced by Peter Hall as the computer department manager, MUSE proved to be a commercial cul-de-sac for the firm.

It is important to emphasise that MUSE, or what was marketed as *Atlas*, proved to be a technological success. Although its peripherals might well have been poorer than those built into the American machines,[32] on the machine's inauguration in December 1962 *Atlas* was described as the most powerful and flexible computer in the world. The most notable advantages associated with *Atlas*, apart from the extensive use of transistor technology, was the pioneering work on virtual storage and paging which contemporaries regarded as being years ahead of developments in the USA.[33] Just to indicate some of the speeds available on *Atlas*, the access time to the main store was just 2 microseconds and to the fast store 0.3 microseconds, while time-sharing (or, multi-programming) was controlled by supervisory routines in the fixed store to prevent interference from other users.[34] By the end of 1963 an *Atlas* II had also been developed in association with the

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[26] Hendry (1989), p. 196. As a further point of contrast, by 1960 165 computers had been installed in France and 300 in West Germany.

[27] C. Freeman, The Economics of Industrial Innovation. Frances Pinter (1982), p.45.

[28] Quoted by Tweedale (1992), p. 118.

[29] In fact, only one of the computers used by Ferranti was employed in product design (a Pegasus I for the transformer department), while the rest were part of the company's marketing and sales effort.

[30] Lavington (1980), p.50.

[31] This section is based on Hendry (1989), pp. 120-3 5.

[32] Hendry (1989), p. 136.

[33] Campbell-Kelly (1989), p.219.

[34] Swann (1974), pp.82-5.

Cambridge University Mathematical Laboratory, partly because the latter would not accept a design originating in Manchester. Whatever the variant, though. Atlas was generally regarded as 'the world's fastest computer'.[35] In effect, it was said to have out-stretched 'Stretch', reinforcing the reputation Ferranti had already built up as one of the most innovative firms in the industry.

Irrespective of this technological success story, it is fair to claim that, in effect, *Atlas* put Ferranti out of the mainframe computer industry. A crucial point of importance here is that, while the NRDC provided £300,000 in development funds, by February 1959 Ferranti had already spent £375,000 on the first prototype, while by October 1962 expenditure amounted to £930,000 [36] Furthermore, as Ferranti was obliged to repay all the NRDC funds, this forced Ferranti to price *Atlas* at £2 million. At the same time, as the American firms preferred to rent their machines on a monthly basis - IBM charged $2,500 for its 1401, Univac charged $135,000 for the LARC, and CDC $85,000 for the 6600[37] - sales were difficult to achieve. One should also note that American peripherals were much more advanced than those installed on Atlas, emphasising how they had paid much closer attention to the needs of customers when designing what were still regarded in the early-1960s as sources of great mystery. In fact, as Table 1 reveals, apart from the University of Manchester order, only two Atlas computers had been sold by 1963, to London University and to the UKAEA. In the summer of 1962 Ferranti even made a major effort to market Atlas in the USA, sending their leading programmer. Dr. S. Gill, and Dr. D.G. White (a former Plessey engineer) to visit potential customers like government departments, atomic energy establishments and aircraft companies. Unfortunately, though, little interest was shown in this British product, partly because of nationalistic attitudes in the USA, but mainly because Ferranti could not promise early delivery of a computer which was still being perfected.[38]

Conclusions.

It is clear that in spite of, or perhaps because of, the technological lead established by Ferranti with the Mark I and sustained through *Pegasus, Mercury, Sirius, Orion* and *Atlas*, the computer department's financial performance was miserable. Characteristically, Ferranti was in at the start of computer development, committing both its own and public funds to a technology which looked both exciting and potentially rewarding. As Sebastian de Ferranti said in an interview with the Sunday Times: 'We go for the difficult things, where we can build up a technical edge'.[39] Ultimately, though, because businesses require a positive cash flow to survive, the huge rise in development expenditure committed by Ferranti to the computer department had to be funded.

In this context, one must note that while the Mark I, Mark I* and *Pegasus* projects were profitable, partly because government support was forthcoming for both their development and production, Ferranti only made a profit on one of its in-house projects. *Mercury*. In contrast, losses on *Perseus, Sirius* and *Orion* by 1962-3 amounted to over £920,000, three-quarters of which was attributable to the latter's production difficulties.[40] Furthermore, losses of nearly £385,000 were made on the NRDC's high-speed computer project, *Atlas*, because while £300,000 of public money was provided for this project, Ferranti actually invested £820,000. Government development funding had also dried up by 1962, leaving the firm to provide all the capital required for new projects. Although Ferranti was fully committed to the development of civil computers which had only a limited commercial appeal, the heavy financial commitments created such difficulties that by the early-1960s drastic actions were being considered.

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[35] Electronics. 16 August 1963. At Cambridge, Atlas II was known as Titan.
[36] Lavington (1975), p.32.
[37] Hendry (1989), pp. 187-92.
[38] Tweedale (1992), p. 114.
[39] Sunday Times, 4 Feb.1962
[40] Losses of £684,043 had been made on Orion by 1964. Ferranti Management Accounts, 1950-64.

While emphasising the importance of internal factors, one might also mention Peter Hall's argument that the reason why Ferranti decided to sell its mainframe computer department arose out of a realisation that ' success in the computer business depended on a marketing operation and a base of data-processing users that Ferranti did not have and ICT did'.[41] Clearly, with regard to the need for a customer base, contemporaries agreed that the company 'lacks the sales organisation to break into the mass market'.[42] Tweedale has also argued that, when compared to the American giant IBM, the Ferranti marketing effort was weak. At ÞÌ, its founder, Thomas Watson, 'endowed marketing with an almost spiritual significance',[43] an approach which had clearly rubbed off on its British counterparts, BTM and Powers-Samas.

Of course, one might regard such a comparison as extremely misleading, because ÞÌ, BTM and Powers-Samas were slow to enter the computer market, leaving others with the expensive task of developing the technology. Notwithstanding these points, above all one must stress the concentration on large, expensive machines which characterised the Ferranti computer effort throughout this period. The whole venture was essentially technology-led, typifying the approach Ferranti adopted in most markets. In failing to develop effective product planning for the mass market, the company was saddled with a department which was based on low-volume sales. This was the main reason why Peter Hall encouraged Sebastian de Ferranti to sell West Gorton to ICT, seeing this as a more effective long-term future for the engineering and production staff at West Gorton. Finally, in July 1963 it was announced that West Gorton and its team was being purchased for £8.4 million.[44] The Economist described the move as 'a welcome farther rationalisation of the still irrational computer industry',[45] indicating how the internal problems at Ferranti were not the only reason why the merger was a sound idea.

Of course, the atomistic stmcture of the British computer industry was by no means the only external reason why Ferranti had been forced out of the mainframe computer business. The key factors revolved around an external environment which simply did not provide the incentives for firms willing to risk substantial sums on ambitious development programmes. In the first place, Halsbury's strategy for the computer industry and the NRDC's paltry level of funding failed to deal effectively with the problems associated with building a competitive range of products, especially when contrasted to the American government's efforts in this field. The insistence that any available funding should be divided amongst a group of firms, compounded by the antagonostic relationship between Lord Halsbury and Ferranti, undermined any benefits the firm might have derived from the ***loans*** provided. In contrast, ØÌ was nurtured as the principal computer supplier of American government agencies like NASA and the US Air Force, receiving enormous ***grants*** to support its R & D programmes, as well as guaranteed markets for its products at the beginning of each product cycle. While Halsbury might well have described the NRDC's relationship with Ferranti as 'Pushing Mules Uphill',[46] in any case a commercial company has a better perspective on what type of products ought to be developed and which markets targeted.

The second key feature of the external environment was the failure of what Lavington describes as 'the "computerised society" [to] get under way in Britain until about 1966'.[47] While as early as 1954 the market for computers in the USA was described as 'tremendous',[48] providing a substantial incentive for American computer firms, British suppliers were faced with ignorance and

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[41] Interview with Peter Hall. Also quoted in Tweedale (1992), p. 116.
[42] Financial Times. 8 August 1963.
[43] Tweedale (1992), p.96-7.
[44] ICT paid Ferranti £1.5 million in cash and 1.9 million ordinary shares, of which 625,000 were to rank with the existing ICT ordinary stock. This gave Ferranti a 10.6 per cent stake in ICT. Ferranti Board Minute 5395, 18 Oct 1963.
[45] Economist. 10 August 1963.
[46] Hendry (1989), pp. 165-8.
[47] Lavington (1980), ð.85.
[48] Report by E. Grundy of a tour of the USA and Canada, 21 April to 2 June 1954.

an acute level of conservatism. Using the buoyant home market as a base, American firms were consequently able to infiltrate the British market with ease when demand started to grow more significantly in the 1960s, intensifying the problems associated with the industry's atomistic structure. Given their undoubted technological prowess, with the same level and type of government support, matched by an earlier surge in demand from all types of customer, one can only speculate on what firms like Leo, Elliott Brothers and Ferranti could have achieved in the 1950s and 1960s. Instead, forced to compete for paltry government resources and marginal numbers of orders, the British computer industry was slowly squeezed by the mighty American giants like ÞÌ, and later Japanese competitors like Fujitsu. The study of firms like Ferranti provides lessons which policy-makers and businessmen might follow if greater success is to be achieved in high technology sectors. Certainly, Ferranti would have benefited enormously from more supportive domestic conditions, especially if a more effective marriage between technological and marketing skills could have been achieved within a firm which was far too committed to the former.