"TECHNOLOGY GAPS AND NATIONAL CHAMPIONS: THE COMPUTER INDUSTRY AND GOVERNMENT POLICY IN POST-WAR BRITAIN"

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By the mid 1960s Britain, in common with other western European nations had become increasingly concerned with the widening "technology gap" between Europe and the USA. Perceptions of this gap came on top of, and began to supersede, more general recognition of a productivity gap which had been a feature of the post-war period, as US manufacturing industry in particular forged ahead in world markets.(Tiratsoo and Tomlinson, Geiger, Sebesta). A series of reports by the OECD and an influential book by Servan-Schreiber, in reinforcing these fears, placed the computer industry at the centre of discussion. By the mid-1960s this industry had come to symbolise national modernity and technological competence. In a less graphic, but we would argue more pervasive way, the computer industry, or national computing capability, radiated a very strong appeal in terms of national prestige, parallel with and perhaps stronger than the more commonly recognised aerospace and nuclear sectors. To fall behind in computing, and in the manufacture of computers, would be to drop out of the race for global leadership. This paper will outline the ways in which the British government responded to the perceived challenge which became manifest during the 1960s, and assess the legacy of government intervention in the IT sector. It will be argued that IT policy reflected the priorities and aspirations ascribed to "top nation" status and that the vestiges of imperial/global power played a key role in the developing structure of the IT sector and in the formation of policy in Britain. It will also be argued that in many respects policy was thwarted or stopped, by the very imperial and global legacies which shaped it, most notably Britain's unfolding post-war relationship with the United States.

i) The British Computer Industry and Decline: the Role of the State

The British computer industry seems, at first glance, to be a typical example of the relative decline which has been a feature of the British industrial economy for most of the twentieth century. From positions of leadership, e.g. in the development of some of the early working, stored-programme computers, and in the case of ICL, the establishment of the largest European manufacturer in the 1960s, domestic capability has now been eclipsed by US and Japanese manufacturers. ICL has been owned by Fujitsu since 1990 and the British market is highly dependent on imported information technology.

Debates surrounding the periodisation, nature and causes of the relative decline of the British economy, and manufacturing sector in particular, have been rehearsed for many years. These range from cultural to structural and institutional; from the penalties and legacies of early industrial leadership, to the duality or dichotomy of the British financial and manufacturing economy and social and class formations reflecting "non-industrial" priorities.(Elbaum and Lazonick; Edgerton; Barnet; Weiner; Kirby; Rubenstein) For the purposes of this paper we will focus upon those explanations which touch upon the role of the state. To what extent does the British state bear responsibility, directly or indirectly, for the relative decline of the British computer industry?

At least three episodes in state intervention in the computer industry in Britain have been fairly extensively documented. Firstly there was the attempt by the National Research Development Corporation (NRDC) to foster an early computer industry in the 1950s, through a programme of

R&D funding and advocacy of industry consolidation. Secondly there was a heightened period of government intervention to restructure the industry in the 1960s, through the Industrial Reorganisation Corporation (IRC) and the Ministry of Technology (Mintech), one notable result of which was the formation of ICL as a single national champion, provided with government equity capital and R&D funding.(Coopey, Campbell-Kelly) Thirdly, the Alvey programme in the 1980s, attempted to promote industry and academic coordination in the development of fifth generation computing.(Oakley and Owen)

There are however two general omissions - one of scope and one of strategy. Firstly, in terms of scope, some areas of support or influence have scarcely been touched upon. We nee to be careful in establishing the boundaries of state involvement. Military and related influences, for example, in shaping technologies and markets in Britain have been generally neglected. A cursory glance at the historiography of the US computer industry immediately reveals a wide interest in the role of the National Security Agency (NSA), Defence Advanced Research Projects Agency (DARPA), the US Air Force and so on through programmes such as SAGE and Whirlwind.[1] We need to establish the role played by the Ministry of Supply, the Ministry of Defence or the Atomic Energy Authority in comparison to the comparatively small-scale effort of the NRDC in the British case. Secondly, in terms of strategy we need to fully understand the nature of the interventions in question. General state intervention took many forms ranging from R&D funding, ownership, procurement and regulation policies etc. These can in turn be taken at face value, or explored at a deeper level. Who, for example are the constituent members of networks pushing for change, can we detect particular "cultures" at work - socially shaping technological trajectories, or indeed, can we find competing networks, and if so is it possible to measure stronger and weaker influences in these terms? (MacKenzie; Bijker, Hughes and Pinch)

ii) State Intervention in the Formative Years.

During the 1950s and early 1960s a number of British manufacturers entered the computer market. These can broadly be divided into two groups. Firstly there were the electronics and control firms, notably Ferranti, English Electric, Elliott Brothers and EMI. Computers were ideally suited to their existing business, manufacturing high-cost products such as radio communications and power-generation equipment. Secondly there were office equipment companies, notably BTM and Powers Samas, with a tradition in punched-card machine manufacture. These two companies had both had non-competitive agreements with major US manufacturers, BTM with IBM and Powers-Samas with Remington Rand, but these agreements ceased in 1949 and 1950 respectively, following which competition increased in the British market. Nevertheless punched-card based manufacturers were slower to enter the computer market than electronics manufacturers. In addition to the above there was the ostensibly rather unorthodox diversification of the J. Lyons company, a nationwide catering firm which had been involved in the early years of computing through its need for rapid, large-scale transaction processing. This "pioneering" development reflected Lyons' highly evolved culture of rationalisation and systems management. The firm initially collaborated with Cambridge University in developing a prototype machine, and began manufacturing LEO computers in their own right in 1955.(Caminer et al; Campbell-Kelly)

The first major merger among manufacturers came in 1959 when BTM and Powers-Samas joined together to form International Computers and Tabulators (ICT) - at the time the largest data processing machine manufacturer in Europe with over 19,000 employees. This merger was intended

[1] K. Flamm Targeting the Computer: Government Support and International Competition Brookings, Washington 1987; A. L. Norberg and J. E. O'Neill Transforming Computer Technology: Information Processing for the Pentagon 1962 - 1986 Johns Hopkins 1996; P. N. Edwards The Closed World: Computers and the Politics of Discourse in Cold War America MIT 1996.

to enable ICT to compete more effectively with IBM, not in computer manufacture but rather in the then more important market of punched-card based office machines. The electronics manufacturers continued to produce low-volume, high-cost specialist machines throughout the 1950s. A turning point in the industry also occurred in 1959 as IBM redefined the data-processing industry with the introduction of its 1401 computer. IBM's new machine offered reliable electronic data processing with good software and peripherals (notably its 600 lines per minute printer). The 1401 greatly extended IBM's existing broad customer base, as it began to sell in unexpectedly high volumes. Partly in response to this redefinition of the market a wave of mergers took place in Britain between 1960 and 1963 (see fig. 1). This resulted in consolidation into three manufacturers - ICT, which combined Ferranti electronic data processing interests, and GEC and EMI computer interests; English Electric-Leo-Marconi (EELM); and, still independent, Elliott Automation.

Government intervention had arguably played a key role in the above process, influencing not only company structure but product design and markets at a number of levels. Early government involvement stemmed from the war years. As in the USA developments in computing were accelerated in various ways including the need to enhance cryptanalysis, ballistics calculations, or in the related area of artillery control. Following the war various agencies and institutions sought to consolidate or build upon wartime advances. These included the universities, notably Manchester and Cambridge, the National Physical Laboratory, the Telecommunications Research Establishment. Each of these produced, directly or indirectly, links to manufacturing companies and paths of development in early computing, the Manchester link to Ferranti, for example.

The most highly visible directed state intervention following the war was that undertaken by the National Research Development Corporation (NRDC), formed in 1949. Hendry has described the process by which the NRDC, led by Lord Halsbury, was very prescient in targeting the computer industry.(Hendry, Keith) NRDC policy was originally aimed at realising the potential of inventions, usually from the public sector. It enjoyed early success with the Williams cathode ray tube, a storage device licensed to IBM. The NRDC also employed other strategies however, based on Halsbury's broad interpretation of his remit. These ranged from funding well beyond early stages of development, into production, and attempts, unsuccessful in the event, to foster the merging of British manufacturers, not merely to achieve economies of scale, but more importantly to join the electronics manufacturers with the business machine manufacturers. Such a strategy would have resulted in a pooling of both production and marketing expertise - the latter a very crucial part of the success story of companies such as IBM. NRDC policy was proactive in many ways and it showed signs of trying to pick winners. The Corporation supported Ferranti through R&D funding and purchasing guarantees (having switched support from Elliott Automation) in developing the Star Mark I and the later Pegasus, the latter built to a design partly specified by the NRDC's Christopher Strachey.

The NRDC effort remained small scale however. Budgets were small - £5 million initially and hedged around with restrictions. To be sure Halsbury successfully expanded the envelope of NRDC's activities, nevertheless the Corporation's funding remained cautious - it took five years to spend the first £300,000 of its available £5 million capital. The culture of the NRDC reflected in its operating methods, may also be revealing. Halsbury was appointed on a personal contact basis (he worked with Harold Wilson's wife during the war years - it was Wilson who was President of the Board of Trade when the NRDC was founded in 1949), and this tended to characterise the NRDC modus operandi. As Hendry notes, "If a firm were to be approached by the NRDC, it would very rarely be through a formal letter on NRDC's notepaper. Rather it would be through a luncheon at one of the London clubs, arranged informally either directly by Halsbury or through a mutual

friend."[2] Somewhat ironically, the NRDC, in common with other sectors of government, also had to be careful not to be seen to be bestowing unfair advantage to particular firms, avoiding "bad form"[3].

The scale and style of intervention by the NRDC can perhaps be best judged when viewed in comparison with activities in the USA. During the 1950s, as the foundations for a world lead in computer manufacture were being laid a high level of support was being generated, particularly through the activities of military related organisations.(Norberg, Mowery and Rosenburg, Flamm) Several questions are raised here. What was the level and nature of military support in Britain for example? Secondly, what is the precise effect of military involvement in a particular sector? Thirdly, can we realistically separate the British military experience from US developments, or is a degree of dependency, fostered by post-war geo-political considerations an important factor?

Certainly there were differences in scale of the level of funding devoted to military spending in general, and to computer-related initiatives in particular, reflecting the cold-war stance of the USA from the 1950s onwards. This is not to say that military spending in Britain was not important however, and, as has been noted, Britain continued to devote a disproportionate level of spending to the development and production of weapons during the period.(Kaldor, Walker) The case of institutions like the Atomic Weapons Research Establishment (AWRE) may be instructive here. In the USA the atomic weapons programme features prominently in early support for and use of computing power, form ENIAC onwards. The AWRE - a research and production facility was similarly a heavy user and at the leading edge of computer development in terms of added power, and later computer aided design and development software and hardware. It seems clear that the AWRE followed a path of considerable dependency on US machines, certainly into the 1960s, reflecting the compatibility needs of joint weapons development programmes - in contrast to the official stance of independent deterrence.

There may also be an early point of divergence here, reflecting commercial cultures. In the USA for example the "spin off" of personnel into the private sector was probably greater, as in the case of ERA for example. In contrast British scientists and engineers perhaps remained more firmly tied to government institutions. We can also detect the origins of a strong theme of extra mural R&D in the USA, funded by government, but carried out in industry.(Mowery and Rosenberg) In Britain, though a significant proportion of government funding went towards R&D in industry, a large and important proportion was undertaken in-house, in government owned and managed establishments such as the Royal Aircraft Establishment, the Atomic Weapons Research Establishment, and the Royal Radar Establishment (formerly the TRE).

II. The Mintech Years/ the white heat.

Returning to the civil manufacturing sector, the formal company mergers of the late 1950s did not immediately result in rationalised product lines. ICT for example inherited a range of incompatible machines and, perhaps more importantly, software, as a result of their merger. Long-term plans were made for the stabilisation and harmonisation of production into a single "project set" planned for introduction in 1968. IBM preempted this with the launch of the System 360 in 1964, which had total software compatibility throughout. The announcement of the 360 spurred British manufacturers, ICT and English Electric into accelerating the introduction of new series machines. ICT announced the 1900 series in September 1964 (based on the Canadian Ferranti Packard design) and delivered the first production model a mere four months later in January 1965, stealing a march on the IBM 360, which was not expected to be available in Europe until the following year. The 1900 rapidly gained market share in both Britain and in export markets,

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2. Hendry Innovating for Failure p.21
3. Ibid. p.79

becoming ICT's (and subsequently ICL's) most successful product. ICT's strategy from the outset was to market an alternative system to IBM. This was in contrast to English Electric who chose instead to manufacture a range of IBM compatible machines under an agreement with the American manufacturer, RCA.

The mergers within the computer industry, in the context of still rapidly evolving technologies and product lines, were complicated affairs, generating tensions between both product strategies and corporate cultures. The eventual EELM merger for example involved significant difficulties in combining the expertise, style of English Electric with the culture and ethos of LEO for example (Caminer et al).

The final merger in the British computer industry came in 1968 with the formation of a single national champion, ICL. ICL was formed in July 1968, through the merger of English Electric computer interests and ICT. The largest computer manufacturer outside the USA, ICL employed over 34,000 workers [vertically integrated?]. ICL thus entered the 1970s with a commitment to developing a new range, following the ICT strategy of competing with, rather than seeking compatibility with, the now dominant IBM machines.

Technology and National Champions

The government's role in creating ICL, to which we shall return below, reflected a new intensity of interest in information technology. There had, since the early 1950s been no lack of enthusiasm for supporting the computer industry - certainly Halsbury at the NRDC was vociferous in this respect. These clarion calls were to be considerably amplified in the early 1960s, however, particulary with the accession to power of the Wilson government in 1964. Calling for the modernisation of Britain in the "white heat of the scientific revolution" Wilson established a new Ministry of Technology with progressively wide ranging powers.(Coopey, Coopey) It is frequently noted that Mintech (as the ministry came to be called) engineered the final consolidation of British manufacturers into the single dominant national champion ICL, but less well-documented are the ministry's other attempts to boost both the demand and supply of computers, utilising a wide spectrum of policies.

Mintech's policy was, from the outset almost obsessed with automation - seen as synonymous with computing development. Wilson's famous Scarborough speech was notable for its vivid imagery of a changing workplace and society, dominated by automated processes. "The essence of modern automation is that it replaces the hitherto unique human functions of memory and of judgement. And now the computers have reached the point where they command facilities of memory and judgement far beyond the capacity of any human being or group of human beings who have ever lived".[4] These concerns, fostered by a growing consensus in the early 1960s of a growing "technology gap" (Servan-Schreiber, Shanks), were reflected in the early activities of Mintech. When the ministry's Advisory Council on Technology (ACT) first met in November 1964 item A(i) on the agenda was the "urgent problem" of British computer industry.[5] Both Lord Nelson of Stafford from English Electric and Sir Leon Bagrit of Elliott Automation were members of the ACT at this time. Patrick Blackett, seen by many as one of the principal architects of the Mintech idea, already had a draft paper on the computer industry to hand, nevertheless a working party was set up to examine the industry and make recommendations. The report, when it emerged reflected the interest shown in automation - linked to a belief that the computer industry was a fundamental, strategic area, valuable in itself but also acting as a foundation technology for an increasing number of manufacturing processes and consumer products. Mintech was particularly interested in

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4. Harold Wilson *Purpose in Politics: Selected Speeches*, Weidenfeld and Nicholson, 1964, p.16

5. "Minutes of Informal Inaugural Meeting of ACT", 11 Nov. 1964, Frank Cousins Papers, Modern Records Centre, Warwick (Hereafter FCP), 282.52.

manufacturing.[6] The report, again echoed Wilson in stressing that Britain's role as the "pilot plant" of the world (Wilson 1963), exporting advanced-technology based capital goods was the primary goal of policy. Foreign dependency in this field was rejected almost as an act of faith even though there were those counselling alternative strategies e.g. modernising using either imported or licensed production. [Williams, Carter] Again, the wider geo-political environment informed policy. Restrictions on exports of technology came into play if these were imported from elsewhere, most notably here the COCOM embargo enforced by the USA on export of advanced technology, including computers and related products, to the Soviet Union and its allies.

As the report noted, "it is necessary that mechanical, electrical and electronic design (of capital goods) should be based mainly, if not exclusively on British Technology. Rights to use foreign know-how or equipment often carry with them limitations on exporting , which experience has shown can hamper British companies in competing for export contracts."[7] This problem was to re-emerge later in the 1960s when ICT and English Electric and later ICL, exports of computers or licensing agreements to countries including the Soviet Union, Romania, Czechoslovakia and Bulgaria were blocked by US intervention.[8] Britain continued to view the Soviet Union and Eastern Europe as an trading area in advanced technology, fostered for example by a series of Anglo-Soviet Technological Agreements. Such arrangements continued to rankle with US government policy. Permission was granted by the US for ICL computers to power Gosplan's economic calculations, for example, but a further order for an ICL 4-70 for the Institute of Management Control provoked suspicion. "It was recognised that surveillance of the end use of powerful computers necessarily presented some problems and there had been the additional difficulty in this case posed by the somewhat conflicting role played by this institute in the Soviet economy."[9] US Military Intelligence suspected that the Institute in question was undertaking work in "strategic areas" and continued to veto the export, despite the rather disingenuous attempts by Britain to point out that such export arrangements would give the West valuable intelligence about soviet management methods.[10]

Given that the government was determined to preserve the computer industry in Britain, as a foundation at least for its ambitions to make the British capital goods industry a world leader and the "pioneer" of automation, a series of policies were outlined to the Ministry in 1964. Despite the qualms felt by the US challenge, domestic markets for computers were fairly robust in the 1960s in Britain, partly protected behind a 15 per cent import surcharge. (Britain though lagging behind Germany in computer usage, nevertheless remained the only European country to avoid dominance by US imports.) It was by no means clear that protective tariffs were effective however, since non-price factors were seen to figure increasingly prominently in purchasing decisions.[11] Software support was seen as crucial. ICT, English Electric and Elliott Automation all confirmed a high level of lost orders due to relatively poor software support in comparison to IBM in particular. IBM, it was also noted, had superior sales techniques, and had begun to employ some very effective strategies to tie in customers, ranging from compatibility criteria, leasing facilities and considerable discounts. The latter were reported to be as high as 60-70 percent to educational establishments leading to the danger, as Mintech saw it of "the next generation of scientists and engineers being trained on foreign machines" and thus locked in to IBM culture.

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6. "Proposals for Government Action in Support of Industrial Automation and Computer Development", Ministry of Technology, Report by Officials, undated, FCP 282/52

7. "Proposals for Government Action", p.5

8. T. Benn *Dairies* 7 June 1968, 17 June 1968, 1 August 1968, 5 September 1968; *Financial Times* 25 September 1967.

9. "Minister of Technology's Visit to the USA, April 1970: A Personal Report" Tony Benn Archives (Hereafter TBA) p.18

10. Ibid p30.

11. "Computers in Industry: An Investigation" *British Industry Week* December 6 1968, pp. 8-21.

A range of recommendations emerged from the Mintech ACT deliberations in 1964. In was noted that companies had asked for taxation policies to be designed to aid rental or leasing arrangements by domestic firms. But ACT proposals went much further, notably on three fronts - public sector procurement, an extension of support services and additional R&D funding. Procurement was seen to be one of the most effective methods of intervention, if managed effectively. It was noted that although the public sector wielded considerable purchasing power, this tended to be de-centralised. Within central government there was a Treasury Technical Support Unit, advising on purchasing, but individual departments retained autonomy in decision making. The University Grants Committee took its own advice (Agar, Verdon). The Research Councils, Department of Education and Science, Atomic Energy Authority, Ministry of Aviation, nationalised industries, Post Office, local authorities, etc. all acted more or less independently in deciding computer purchases. New proposals included doubling the size of the Treasury Technical Support Unit, transferring it to the Ministry of Technology where it would promote the centralisation of all public sector purchasing. Departments, such as Education and Science, could still evaluate requirements independently, but final approval would have to be sought from Mintech.

In addition to the centralisation of procurement decision making, criteria for purchasing were also to be fundamentally revised to encompass a pro-active role for government. Traditionally the Treasury, for example, had a requirement that computers should be of a proven design. A different approach, it was felt, would "encourage British companies to tender for sophisticated and novel systems" and, if these were purchased by government initially then commercial and industrial orders would follow. The government sector would thus act as a proving ground for developmental machines - a reverse of the current position.[12] In addition, preference for British machines generally was assumed within the new recommendations. Price criteria was no longer to have primacy and would be assessed in order to judge whether or not imported machines were being unduly discounted. Most importantly policy would be geared to generating a British culture in computing, "ensuring so far as possible that the new generation of scientists and engineers are trained on British machines and in the use of British codes, operating systems and languages."[13]

Centralisation was also seen to be the key to solving, or at least reducing the scale of problems related to software development in Britain, particularly in data processing. At the very least it was hoped that a major advance could be achieved in reducing the levels of duplication of effort. There were a large number different payroll systems alone in the public sector at the time. Proposals thus involved the establishment of a national programming centre to act as a centre for development and as a bureau and clearing house for programmes. ACT proposals were also prescient in suggesting the establishment of a national computer network -"in the nature of a national grid", using telephone (Datel) or telex (5 channel paper-tape) transmission lines. This system echoed the Arpanet developments in the USA, and took direct reference from the MIT MAC project, developed with government funding, which was judged to have the goal of "making computing power available on a public utility basis like electric power".[14] Interestingly, Britain had perhaps held an early lead in this area following efforts by the National Physical Laboratory in Britain to develop the potential of teleprocessing with their Mark 1 system (Abate). The British initiative, providing a network for all data processing applications - "commercial, industrial, legal, medical, administrative and governmental" was to be centred around the AWRE, largest user of powerful computers in the UK at the time, and was envisaged as being operational by 1966.

The third area of government intervention highlighted in 1964 was the level of R&D support for the British computer industry. Companies themselves were seen to spending between £8 million

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12. "Proposals for Government Action" p.20
13. Ibid. p.22
14. Ibid. p.24

and £9 million a year, but this was seen as a burden in terms of restricted cash flow due to high ratios of capital employed to sales[15]. The NRDC was spending £200,000 per year on the ARCH process control system at Elliott, a magnetic card RAM at ICT and a magnetic tape at Decca. The DSIR was spending up to £150,000 on projects including integrated circuits, magnetic stores, and computer aided design at Plessey, ICT, Elliott, Ferranti and Leo-Marconi, as part of an Advanced Computer Techniques Project. This project also involved work at the NPL and Royal Radar Establishment (RRE) worth around £100,000 a year.[16] A further £150,000 per year was being spent by the universities and other Government Research Establishments, though this figure did not include "general programmes of the establishments". In total the effort was deemed to be far too meagre, which indeed it was in comparison to the level of spending by the US government. Recommendations were that the NRDC effort should be at least doubled, the DSIR project, which was absorbed by Mintech, should be trebled and that the university sector should be vastly expanded - to the tune of £2.5 million per annum.

Implementing the Plan

The Ministry of Technology grew progressively between 1964 and 1970, attempted to put into practice many of the reforms suggested by the ACT, some more successfully than others. As the Ministry grew and it gained control, directly of indirectly, over the Ministry of Aviation, Atomic Energy Authority, DRSI, NRDC, and the Research Associations. Centralised procurement was limited to a Computer Advisory Service dealing with the system requirements of the public sector bodies including the nationalised industries, local authorities, research councils, universities and other educational establishments. The CAS handled over 500 consultations per year. Advice was however, even when sought, not compelling. When faced with software, hardware and compatibility problems for example, HMSO preferred IBM over ICT - the former having COBOL up and running, larger storage capacity. (They expected the LEO system on offer to be obsolete rather rapidly)[17] A policy statement from the Treasury the following year effectively rejected a strategy of buying British, insisting that computers selected "were those which by ordinary commercial standards were judged to be the best suited for the jobs to be done and the best value for money."[18] Establishments such as the AWRE continued to buy IBM, following the principle that in defence expenditure the best technology should be used, rather than compromise over cost or national industrial loyalty. (In addition to continued compatibility requirements with the US nuclear weapons programme.)

A National Computing Centre was set up in Manchester, partly funded by the Ministry, to give advice to computer users outside the public sector, act as a library service for existing software and to develop new software. The NCC also offered training for managers and systems analysts. The Advanced Computer Technology Project was extended, so that by 1970 a total of 81 contracts had been placed or completed. Total funding for these projects, which were vetted by the NPL and RRE, exceeded £5 million, of which Mintech provided half. Criteria for projects were that they were novel, engendered long-term commercial prospects and that "the outcome of the work is both in the national interest and in the overall interests of the British computer industry."[19]

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15. Ibid. Annex II, p.2
16. Ibid. Annex IV
17. A. S. Donkin to Appleton, Dec. 1964, FCP 282/52
18. "Computer Programme for Government Offices", Treasury Press Release, 2 Jan 1965.
19. I. Maddock "Stimulating Technological Innovation in Industry: The Role of the Ministry of Technology" Proceedings of the Institute of Mechanical Engineers Vol 182 Pt. 1 No 32 , 1967-8, p. 691; The Ministry of Technology Ministry of Technology May 1970 p.46.

Following the pattern of Wilson's interest in automation, computer aided design and manufacture projects were extensively funded by the Ministry of Technology. Projects related to numerically-controlled machine tools included the pre-production order scheme whereby the government sponsored production and trials of new machine tools in return for reports of performance; a trial purchase scheme underwritten by government; the establishment of a three Numerical Control Advisory and Demonstration Service centres at the Royal Aircraft Establishment, Production Engineering Research Association, and at Airmec/AEI; and AWRE Aldermaston Project for the Application of Computers to Engineering (APACE). (Coopey, Menscher) The APACE project is particularly interesting since it encapsulated some of the most radical aspects of the Mintech project. Not only did it involve the boosting of automation in British industry, but it also involved the transfer of technology and know-how from the military sector to the civil sector, in response to a perceived imbalance in the national effort towards the former. (Jewkes, Maddock, Edgerton, Kirby) Housed "outside the wire" at Blacknest, near Aldermaston, the APACE programme envisaged using the Stretch and Atlas II computers on site. AWRE interest was however increasingly based around the graphic capabilities of its new IBM 360/40 and was focusing effort on writing Fortran programmes for this machine.[20] The APACE project involved contract work for industry, but more importantly was designed to familiarise visitors from British industry with the latest CAD/CAM methods. Other problems arose with the project in terms of the constraints imposed by the Treasury over the cost of the programme, which was envisaged as operating on a profit-making basis after a trial period - though those in charge at Aldermaston saw their role as "evangelical" and in need of extended subsidy.(Coopey) Other Mintech CAD initiatives were undertaken at the National Engineering Laboratory, the NCC and at various universities, including Cambridge and Imperial College.

The formation of ICL a single national champion in 1968 was the most high profile piece of government intervention of the period. As noted above, the NRDC had attempted mergers from the 1950s onwards to no avail. Mintech carried on this policy from 1964, reflecting the dominant belief in both economies of scale and the need to respond to the American challenge in kind. Despite overtures from Technology ministers Frank Cousins (1964-1966) and Tony Benn (1966-1970) ICT and English Electric remained resistant to merger. In 1967 however, in the face of increasing pressure from IBM, which had now captured over 50 per cent of the British market, and in response to the offer of government support for the launch of a new range of machines, the two companies finally entered serious talks. Government support for the new range would be crucial in view of the incompatibility of the existing machines. In the event the merger was delayed and complicated, partly by the intervention of rival electronics manufacturer, Plessey and involving renegotiation of the level of government aid on offer. As the general economic climate worsened around the devaluation crisis of 1967, the original offer of £25 million was reduced to £13.5 million, with additional equity participation by government amounting to £3.5 million. ICL was eventually formed in July 1968, continuing for the time being as the largest computer manufacturer outside the USA.

The formation of ICL, as noted, represented the culmination of a long-term effort by government to rationalise the industry into a company of world class. There were problems with this strategy, however - which itself may have been based on mistaken premises, or which ran into contextual difficulties. In forming a single national champion the government was not in fact emulating the US environment where there were, in addition to IBM, a number of other large scale manufacturers, competing in a limited form, but nevertheless competing. The merger also created a significant degree of dissonance within ICL, as attempts to merge managerial cultures and product lines generated increasing friction. Again, compare this to IBM, whose internal organisational

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[20]. New Technology No. 5 May 1967, p. 6

cohesion and long-term corporate strategic capacity was one of the foundations of its success.(Usselmann) ICL's attempt to continue its product strategy of competing with IBM in producing a non-compatible range, though fitting well with continued images of national independence, was probably a mistaken one. (Similarly the later continuing emphasis on the larger scale main frame market, as opposed to the growing mini-computer market may also have been a mistaken strategy.(Hamilton, Land))

The company may have also suffered initially due to mistaken assumptions relating to the value of the English Electric component. Maurice Dean at Mintech had commissioned Cooper Brothers to report on the value of English Electric prior to the merger. By December 1968 John Wall and Arthur Humphreys were complaining to Tony Benn. Benn recorded in his diary that "The plain truth is they bought a pup. The English Electric computers were in a complete state of confusion. I think that not only was their order book only half as big as they thought but the valuation of their assets exaggerated." If this was the case it highlighted a further problem for government in formulating policy, i.e. its reliance on expert opinion - in this case the independent assessment of the value of English Electric.[21]

Some indication of the realisation that the creation of a national champion was perhaps not the best policy option, is revealed in changes in thought towards the end of the 1960s. Benn, for example, was moving rapidly away from an overtly interventionist approach. He now thought that the computer industry, with its seemingly rapid development cycles, underlined the perils of government trying to second guess the direction of industry. "It kills stone dead the Fabian idea that central Government plans and all else falls into place."[22]

The Ministry of Technology was dismantled in the early 1970s by the in coming Conservative government, and the enthusiasm for the "white heat" of technology was dissipated, at least in a rhetorical sense. When the Labour Party returned to power in 1974 the emphasis was on industrial rationalisation, led in part by the newly created National Enterprise Board (NEB). The NEB, a form of government investment bank, was still persuaded that information technology was a crucial area for intervention, as in the case of the Inmos semiconductor manufacturer for example (McLean and Roland). The almost Svengali like nature of information technology - its continued ability to attract government funding - is later graphically revealed in the Alvey programme. This British response to the Japanese fifth generation computer initiative was able to secure major government funding in the face of Conservative opposition to intervention and advocacy of free market economics.

Conclusions

Intervention by government in Britain, as elsewhere, needs to be understood at a number of levels. In looking at the computer industry in Britain we can see a range of strategies and policies which have affected the pattern of the industry, during its formative years. There were changes of emphasis and tactics by various bodies involved, particularly by Mintech, for example, but there were also structural patterns of development and use which were resistant or inert when it came to change. Government certainly has a close relationship to an industry like computer manufacture, but the extent to which this relationship can manipulated, or shaped in the short- or medium-term (in line with electoral cycles perhaps) may be limited. Intervention in various forms by the US government undoubtedly boosted the US computer industry during this period. Given the fundamental differences across a range of issues - in size and scope of industry, of the nature of the

21. Tony Benn, unpublished Diaries manuscript, 5 December 1968, TBA.

22. Tony Benn reported in *Daily Telegraph*, 5 May 1970

military project, of the relationship between government and industry and so on - perhaps comparisons are somewhat unjust.

On the other hand, if we examine the policy of a country seeking to emulate the USA, or at least avoid a dependent relationship, we can at least note that radical policy directives can seem to have effect. The Japanese government, or at least its agencies, notably in the form of the Ministry for International Trade and Industry (MITI), formulated a general strategy during the early 1960s, aimed at defy the dominance of US producers, notably IBM. Though the general effectiveness of MITI, and its role the Japanese post-war economic "miracle" remain the subject of fierce debate, (Abe, Odagiri) it is clear that in the case of the computer industry policy did have an impact. By a blend of direct and indirect tariffs, compulsion and persuasion in procurement - both in the government sector and amongst those firms upon which MITI could exert pressure - by demand side strategies such as the subsidised purchase and rental orchestrated by the Japan Electronic Computer Company (JECC), by horse-trading with companies like IBM in forcing them to release patents for Japanese to produce IBM designs under licence, or with the US government for tolerance in the operation of tariff systems (again returning to geo-political determinants) - through all these methods Japan was able to come from a position vastly inferior to that of British industry, to a position of near parity with the US manufacturers. It may be necessary, indeed, to understand the structural effects of being a leading nation in terms of technological capabilities of a particular configuration or lineage in order to understand the different experiences of Britain and Japan. Some of the legacies of industrial leadership, the well trodden path of relative decline explanations, may be pertinent in understanding this problem.

In these terms we can identify at this stage, at least some factors where legacies are important. The role the expert scientist or engineer (or indeed the balance between these in British society) in shaping products or policy is crucial for example. In the case of Mintech, for example, how effective was the strategy of recruiting scientists and engineers into the structures of power? The legacy of great nation status also seems important - in shaping policies such as the call for prestigious, national champions; in the dependent policies followed by the AWRE; in the effect of forced compliance with COCOM agreements and so on. "Cultural" legacies may also be important, shaping the priorities given to research programmes, or the allocation of other government resources between commercial or scientific developments for example, or simply in the managerial or operational ethos to be found within a range of government departments and establishments.

This paper has focused primarily on the 1960s, a crucial period in the consolidation of the computer industry in terms of manufacture and usage. The modern global computer industry is a complex network of R&D and manufacturing, with a high degree of interpenetration, defying state intervention in the same ways that it was possible in the 1950s and 1960s.(Flamm) It was still very possible for state intervention to radically affect the shape of the industry in Britain in the 1960s. That the industry declined partly reflects the mistakes of policy, but it more strongly reflects the legacies of corporate structure and cultures, and national political and geo-political influences.

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