SEWPS
SPRU Electronic Working Paper Series

Paper No. 121

Sustained Innovation: Career Engineers, Stock Markets, and the Theory of the Innovative Enterprise

William Lazonick* and Andrea Prencipe
(*INSEAD and University of Massachusetts Lowell, **University G. D'Annunzio and SPRU)

August 2004

The Freeman Centre, University of Sussex,
Falmer, Brighton BN1 9QE, UK
Tel: +44 (0) 1273 678936
E-mail: a.prencipe@sussex.ac.uk
http://www.sussex.ac.uk/spru/

SPRU
Science and Technology
Policy Research

Sustained Innovation:
Career Engineers, Stock Markets, and
the Theory of the Innovative Enterprise

William Lazonick♣ and **Andrea Prencipe**♦

♣ The European Institute of Business Administration, INSEAD and University of Massachusetts Lowell, Lowell, MA 01854, Email: william.lazonick@insead.edu

♦ Faculty of Economics, University G. D'Annunzio, and SPRU, University of Sussex, UK
Email: a.prencipe@sussex.ac.uk

Acknowledgements
We would like to thank Joe Lampel for comments on an earlier draft of the chapter. This research was funded by the Targeted Socio-Economic Research (TSER) Program of the European Commission (DGXII) under the Fourth Framework Program, European Commission (Contract no.: SOE1-CT98-1114; Project no: 053) and by INSEAD Association for Research. The section 'Introduction' has been jointly written. The sections 'Research Method', 'The origin of the RB211 and the bankruptcy of Rolls Royce', and 'The era of nationalization' can be attributed to Andrea Prencipe. The sections 'Corporate control and financial markets' and 'Conclusions: is Rolls Royce a success story?' can be attributed to William Lazonick.

Abstract

The aim of this paper is to document the role that career engineers played in the investment strategies and eventual survival of an organization producing large high technology capital goods. Using the theory of innovative enterprise developed by Lazonick and O'Sullivan (2000), we analyze the locus of strategic control and its interactions with the cognitive and behavioral dimensions of Rolls-Royce, nowadays a successful industrial firm. The company has been analyzed during an intense period of radical changes in the ownership structure of the company that followed the firm's misdemeanors. Analysis of the role of engineers is paralleled with an analysis of what influence the firm's exposure to the stock market had on its innovative activities. The case analyzed shows that there was a clear lead by the engineering-related functions, while other functions had little say in important investment decisions. Company decisions were driven by the creed of engineering excellence transmitted from generation to generation of engineers via the recruitment and apprentice systems that were at the basis of the company's internal training policy.

Introduction

Literature on the economics and management of innovation has pointed out that the introduction of new technologies requires a number of conditions to be met in order to be successful in the market (Freeman and Soete, 1997). Top management support, financial commitment, functional integration, project championing, and a clear market target, have been identified as key enabling factors for the successful introduction of new technologies (Clark and Fujimoto, 1991; Rothwell, 1992). Research on innovation has greatly increased our understanding of the relevant organizational and technological dimensions of the innovation process. Empirical studies on innovation have fed the promising literature on the evolutionary theory of the firm (Nelson and Winter, 1982) and the resource-based view of the firm (Penrose, 1959). These two research traditions have put back history into the account of firm behavior and given appropriate weight and role to the internal workings of firms. Specific weight is given to firm capabilities in identifying new opportunities and meeting them by integrating internal and external resources (Teece et al., 1997).

Building on the resource-based view of firms, Teece et al. (1997), have put forward the *dynamic capability* approach. They argued that the *dynamic capability* approach extends the resource-based approach since it adds the dynamic perspective that was partly neglected. Teece et al. contended that firms not only accumulate capabilities but also need to continuously reconfigure and integrate internal and external resources to compete effectively in an ever-changing environment. Thus, a *dynamic capability* is the firm's ability to reconfigure, redirect, transform, and integrate internal capabilities with external factors of production and resources to meet environmental challenges. Defined in this way, a dynamic capability represents a super-order capability that pertains to strategic top management. Teece et al. argued that an analysis of dynamic capabilities must focus on a firm's position, its managerial and organizational processes, and paths available to it.

This research tradition of the theory of the firm, however, said little or nothing on the locus of strategic control of resource allocation. Specifically, the dynamic capabilities perspective said nothing on who sets the positions and therefore who controls the firms and what sustains the paths. Reviewing Teece et al. (1997), Lazonick (2002: 15) argued "… they have nothing to say about who within the organization's hierarchical and functional division of labor should make decisions to maintain the integration of strategy and learning and thereby sustaining the innovation process". The aim of this paper is to document the role that career engineers played in the investment strategies and eventual survival of an organization producing large high technology capital goods. The theory of innovative enterprise developed by Lazonick and O'Sullivan (2000) constitutes a good conceptual framework for an empirical analysis of the locus of strategic control and specifically of its interactions with the cognitive and behavioral dimensions (see also O'Sullivan, 2000; Lazonick, 2002; Carpenter et al., 2003). Our analysis is focused on Rolls-Royce, nowadays a successful industrial firm that has produced aircraft engines since its inception and was driven out of the market precisely because of the not entirely appropriate timing of a technological bet. The company has been analyzed during an intense period of radical changes in the ownership structure of the company that followed the firm's wrongdoings.

Analysis of the engineers' role is paralleled with analysis of the influence of the firm's exposure to the stock market on its innovative activities. The idea we pursued was to create two rival explanations to enlighten the success of Rolls-Royce. We therefore employed the pattern-matching tactic (Yin, 1994) to assess, compare and then ponder the role of engineers against that of the stock exchange. This tactic has permitted us not to become too one-dimensional in finding explanations for the successful and unsuccessful decisions taken by the company.

The case analyzed shows that there was a clear lead by the engineering-related functions, while other functions had little say in important investment decisions. Company decisions were driven by the creed of engineering excellence transmitted from generation to generation of engineers via the recruitment and apprentice systems that are at the basis of the company's internal training policy. In fact, most if not all of Rolls-Royce's top managers had extensive engineering background and therefore "had intimate knowledge of the problems and possibilities of the enterprise's investment strategies" (Lazonick and O'Sullivan, 2001, p. 10). On the other hand, whatever else Rolls-Royce has been doing since privatization, the company clearly has not been creating value for shareholders.

The paper is organized as follows. The next section describes how Rolls-Royce's attempt to develop the three-shaft engine for Lockheed at the end of the 1960s resulted in bankruptcy. Then we detail how, as a nationalized company from February 1971 to May 1987, Rolls-Royce continued to develop the three shaft-engine, first as an add-on to its military efforts and then in the 1980s as a critical capability in preparation for privatization. The use of financial markets in general and the stock market in particular to sustain the development of such an engine is also detailed. The final section considers the implications of the Rolls-Royce case for understanding the impact of communities of practitioners on the control of resource allocation for development of innovative capabilities and eventually on a firm's survival.

Research method

This single case study draws on qualitative and quantitative data. Data were gathered through research in both primary and secondary sources. These distinct types of data were employed in this study to establish *construct validity* (Yin, 1994). Multiple data sources enabled us to obtain stronger substantiation of constructs by triangulating evidence across cases (Yin, 1994).

The first type of information was gathered from a systematic review of the technical literature, trade publications, specialized engineering journals, and databases on financial data. Specific attention was paid to the analysis of Rolls-Royce's annual reports and publications. This first type of data was used to provide background information and to sketch an overall picture of the historical evolution of the company through the development of the firm's technological capabilities in the RB211 engine program. The second type of information came from interviews carried out with industry experts and company engineers.

The analysis of the combination of these two types of data enabled us to scrutinize the resource allocation process in relation to the development of technological capabilities in Rolls-Royce. We employed the pattern-matching tactic to analyze the data using two rival explanations (Yin, 1994). According to Yin, this tactic "requires the development of rival theoretical propositions…The important characteristic of these rival explanations is that each involves a

pattern of independent variables that is mutually exclusive: if one explanation is to be valid, the others cannot be. This means that the presence of certain independent variables (predicted by one explanation) precludes the presence of other independent variables (predicted by a rival explanation)" (1994, p. 108). The first explanation we developed was based on the role of career engineers, while the other was based on the role of the stock exchange.

As discussed in the literature on research methods, single case studies do have a number of limitations. Specifically, the generalizability of the findings of case studies is largely impaired by the fact that cases are selected and not sampled. The Rolls-Royce case was selected in the same way that a laboratory investigator selects experiments (Yin, 1994). As Yin (1994, p. 31) suggested, the method of generalization from case studies is analytic generalization, "in which a previously developed theory is used as a template with which to compare the empirical results of the case study". This method of generalization differs from statistical generalization, where data related to a sample form the basis for inferences about a population.

On the other hand, case studies play a significant role in a theory building exercise (Eisenhardt, 1989) that ought to be tested using other methods: the development of evolutionary theory in biology was in fact based on a case study. Also, this case study is part of a larger study which using the same analytical framework, analyzed a larger number of case studies. Hence, we followed a comparative case-study research approach, often employed in the strategic management and innovation literature (Eisenhardt, 1989; Leonard-Barton, 1990; Doz, 1996). This approach builds an analysis of the process to be studied by comparing new cases, added sequentially rather than simultaneously, to an initial model case – that is, one that exemplifies the success (or failure) of a company in the particular phenomenon that is the focus of study. In effect, through the discovery of critical exceptions to the explanation of success (or failure) to what, before the addition of the last case study, had been seen to be the rule, the model that we develop to explain the phenomenon under investigation gains analytical sophistication.

The origins of the RB211 and the bankruptcy of Rolls-Royce

The British national context

Already in the mid-1940s Rolls-Royce had proved to be the most successful and competent British aircraft engine firm. Unlike vertically integrated competitors such as de Havilland and Siddeley Armstrong Motors, Rolls-Royce was an independent engine supplier that could seek orders from any of the airframers. Rationalization of the industry occurred between the end of the 1950s and the beginning of the 1960s. A series of combinations reduced the number of airframers to three -- Hawker Siddeley Group, British Aircraft Corporation, and Westland Aircraft – and engine manufacturers to two -- Rolls-Royce and Bristol Siddeley Engines. Then in 1966, when it appeared that Bristol Siddeley would join with SNECMA to build the Pratt & Whitney JT9D engine for the Airbus, Rolls-Royce acquired Bristol-Siddeley, and thus became the only British aircraft engine company that could contemplate competing in global markets (Pugh, 2001, 94-102). Both Bristol Siddeley Engines and the government (which had recommended the merger of the two companies in the Plowden Report) welcomed the take-over.

The three-shaft engine architecture

The development of Rolls-Royce's civil business rested on two important decisions: (1) to develop a large turbofan aircraft engine, and (2) to break into the United States market. In 1965 a study indicated an expanding future market for engines rated over 30,000lb. At Rolls-Royce the first program for a larger turbofan engine was based on the two-shaft Conway turbofan engine. The engine, labelled RB178, was rated at 28,500lb and had a relatively low by-pass ratio. The company's view was that the fuel consumption benefits of a high by-pass ratio would be more than offset by the fuel consumption costs attributable to the larger size of the fan, the greater weight of the engine, and the higher installed drag that a high by-pass ratio would entail (Cownie, 1989; Pugh, 2001).

Such a view changed, however, when "tests in the US demonstrated that the installed drag penalty of the nacelle was less than half that assumed in European studies" (Ruffles, 1992, 3). As a result, the by-pass ratio of the RB178 was increased up to 8, which in turn led Rolls-Royce's engineers to choose "a three-shaft configuration as the best for both aerodynamic and mechanical reasons" (Ruffles, 1992, 4). This design layout, labeled RB178-51, would provide much higher thrust than the previous RB178. A demonstrator program was launched to test the new technological solution, with the first engine test run taking place in July 1966 (Cownie, 1989). The tests revealed a number of mechanical defects related to the revolutionary character of the three-shaft architecture. A shortage of finance meant that the demonstrator program was dropped. Meanwhile, Rolls-Royce started a smaller three-shaft engine program, the Trent, which permitted the company to gain some experience on a lower-rated version of a three-shaft engine. The Trent program was, however, cancelled in 1968. As reported by Cownie (1989, 232), "many believed that some of the problems later experienced in RB211 development could have been solved earlier if running had continued with the RB178 demonstrator".

When Boeing launched the 747 in 1968, Rolls-Royce submitted an engine proposal (the RB178-51) to power the widebody aircraft (Ruffles, 1992). Boeing selected the Pratt & Whitney JT9D, however, mainly because of its larger size. After failing to sell the RB178-51 to Boeing, Rolls-Royce became even more convinced that the future of its aircraft engine business depended on the development of large turbofan engines. Forecast studies showed that sales of Rolls-Royce's existing engines would fall from £58.9 million in 1969 to £3.5 million in 1975, and revenues from the aftermarket from £36.5 to £31.9 million (Cownie, 1989). Towards the end of the 1960s, Rolls-Royce had in place two large three-shaft engine projects, namely the RB207 and the RB211. The RB207 was the larger one, rated at over 50,000lb and proposed for the twin-engined European Airbus, US jumbo jets, and the BAC Two-eleven projects. The RB211 was relatively smaller, rated at 30,000lb, and proposed for three-engined airliners.

Development of the RB211

In June 1967, Rolls-Royce entered into negotiations with Lockheed to manufacture the RB211, rated at 33,260lb, for its projected L-1011 three-engined widebody aircraft (Pugh, 2001, ch. 4). The Rolls-Royce marketing team (led by David Huddie) focused its campaign on technological superiority and lower prices. Technological superiority was supposed to derive from not only the revolutionary three-shaft architecture but also the all-composite (Hyfil) fan blade. These technological advances would result in an engine that was "lighter, cheaper to run, simpler in construction (with 40 per cent fewer component parts) and easier to maintain than existing turbo-fan engines" (Gray, 1971, 84). Also, given lower wages in Britain and the further devaluation of

the British pound against the US dollar, the RB211 engine was offered at £203,000 compared with £250,000 for the General Electric engine and £280,000 for the Pratt & Whitney engine. Pratt & Whitney pulled out of the race, while General Electric cut its price to £240,000. After tough and intense negotiations, Rolls-Royce won the contract by cutting its price to just under £200,000 (Reed, 1973). Lockheed announced the launch order for the RB211 in March 1968. Lockheed ordered 150 'ship sets' of RB211 engines (totalling 450 engines), with TWA and Eastern Air Lines as launch airline customers. Air Holding of the United Kingdom ordered 50 Lockheed aircraft, which was politically advantageous for Rolls-Royce because it offset the offshore purchase of British engines and therefore helped the US balance of payments (Cownie, 1989).

The news of the Lockheed deal was very well received in Britain. Anthony Wedgwood Benn, Minister of Technology in the Labour government, stated that the contract was "a terrific boost to British technology and its export potential" (quoted in Gray, 1971, 86). Also the City welcomed the deal, and Rolls-Royce's share prices moved up from £2.225 to £2.35, adding £30 million to Rolls-Royce's market value (Reed, 1973). As pointed out by Gray (1971, 86), however, the optimism was based on the mistaken assumption that, through the company's newly developed computer centre, "Rolls-Royce's success was due to the careful control of costs". In fact, Rolls-Royce's success in securing the contract was based on price cutting, a strategy that, as Gray (1971, 86), put it, "did not require a computer".

The development of the RB211 was unique for Rolls-Royce. As Harker (1976, 176) summed it up: "This was a mammoth task; the engine itself was much bigger in overall dimension than anything the company had produced before; it was a different shape and the diameter of the fan was eighty-six inches, which necessitated large machinery to cut metal and required new techniques in welding" (see also Cownie, 1989, 234). The task became even more complex when the design specifications of the engine were modified to accommodate changes in the design of the aircraft. By the time the engine was ordered, aircraft performance requirements had increased, with the thrust required from the RB211 rising to 40,600lb. In 1972, the thrust requirement climbed again to 42,000lb because of increased weight of both aircraft and engine. This thrust was twice that of the largest engine that Rolls-Royce had previously produced.

The government's initial contribution was 70% of the launching costs of the RB211, totalling around £47 million. It was an exceptional contribution since the government had set a limit to launching aid at "normally not more than 50%" of the launching costs (Department of Trade and Industry, 1972, Annex A).[i] To make things worse, the initial launching costs had been seriously underestimated. The yet unproven technologies being introduced in the RB211 resulted in soaring development costs. First, the Hyfil carbon fiber that made up the fan blades failed the so-called 'bird strike test'. The fiber was reinforced to strengthen the leading edge of the blades, but this solution caused stresses at the root of the blade (Gray, 1971). As a result, the all-composite fan blade was abandoned, and the 'old' solid titanium blades with snubbers were reintroduced. This change, however, added 300lb to the weight of the engine, thus necessitating expensive redesign work. The sheer size of the engine also required the construction of new testing facilities. As a result, the progress of the program was delayed, and it became highly likely that Rolls-Royce would incur the heavy late-delivery penalties that the Lockheed contract mandated.

Rolls-Royce's bankruptcy

Rolls-Royce financial situation started deteriorating towards the end of 1969. In May 1970, Rolls-Royce asked the Industrial Reorganization Corporation for a loan of £10 million. Changes in management were made: first Lord Beeching and Ian Morrow joined the board; then Sir David Huddie, one of the architects of the successful RB211 campaign, stepped down and Hugh Conway (from the Bristol division) replaced him. Also, 3,500 men were made redundant and a small factory (employing 100 men) was closed down. In November 1970, in the face of Rolls-Royce's mounting financial difficulties and a revised estimate of the launching costs of the RB211 to £135 million, the government increased its launching aid by a further £42 million, its total contribution of £89 million representing 66 % of the revised cost estimate. In addition, the Bank of England agreed to lend £8 million to Rolls-Royce, while Midland Bank and Lloyds Bank each lent £5 million with the stipulation that they would each have a representative on the Rolls-Royce board (Department of Trade and Industry 1972, 7–8; Bowden, 2002, 50). This £60 million financial package was, however, subject to a reassessment of the development program (Department of Trade and Industry 1972). A further change was made to the Rolls-Royce management. Sir Denning Pearson, Rolls-Royce Chairman and another architect of the RB211 campaign, stepped down and was replaced by Lord Cole, who had just retired from Unilever.

Notwithstanding changes in management, redundancies and augmented financial aid from the British Government, Rolls-Royce was not able to overcome the problems with the RB211 development program. Rolls-Royce internal assessments (reported to the Ministry of Aviation Supply) showed that due to a number of design modifications and subsequent changes in the production process, development and production targets could not be met. These delays meant a postponement of at least six months for engine deliveries (Department of Trade and Industry, 1972). The Department of Trade and Industry estimated that "a further £110 million cash flow would be required, as compared with the £60 million estimated in September 1970" (Department of Trade and Industry, 1972, 11). The incoming Conservative government that, while in opposition, "had adopted a policy of 'disengagement' from industry with references to the need to end public support for 'lame ducks'" (Hayward, 1989, 138), had to decide whether to continue to support Rolls-Royce financially or allow it to go bankrupt. They opted for the second alternative and on 4th February 1971, Rolls-Royce went into receivership.

What went wrong? The problems were technical, financial, managerial, and contractual. The use of Hyfil carbon fiber for fan blades turned out to be a failure. Also, the technological viability of the RB211's revolutionary three-shaft architecture had yet to be demonstrated. As mentioned earlier, the RB178 demonstrator program had been cancelled due to financial shortage, leaving the design team dependent on parametric studies of the Spey and smaller turbo-fan engines. Worse still, the premature death of Adrian Lombard deprived Rolls-Royce of one of the finest 'trouble shooting' engineers in the industry (Hayward, 1989, 137).

At the time that the RB211 program was launched, Rolls-Royce was involved in the development of the larger RB207 engine for the European Airbus as well as in a number of military programs (Harker, 1976). Although the two civil engines shared a common architecture and several design features, "development of two large engines, and especially the RB211 to Lockheed's stringent contract terms, was straining [Rolls-Royce's] resources" (Hayward, 1989,

136). Also, the acquisition of Bristol Siddeley Engines absorbed financial resources; Rolls-Royce's purchase of Bristol cost £63.6 million, £26.6 million of which was paid in cash to Hawker Siddeley Aircraft (Hayward, 1989, 123). The valuation included about £20 million in 'goodwill' and shares in British Aircraft Corporation and Westland, which Rolls-Royce later sought unsuccessfully to sell. The Bristol acquisition placed considerable demands upon managerial resources for rationalizing the engine divisions. In fact, Rolls-Royce would have to provide additional capital to support the Bristol side of the business at a time when its own liquidity was under pressure from its fateful contract with Lockheed. Hayward (1989, 123) stated that "[w]ith hindsight, it is evident that the determination to prevent P&W [Pratt & Whitney] obtaining a European foothold led Rolls into a precipitated and ill-judged act. Although the merger [with Bristol Siddeley] was not the main cause of Rolls' later problems, it would be a significant contributory factor."

As for the Lockheed contract, the main problem was that Rolls-Royce had agreed to a relatively low fixed price with, as Hayward (1989, 136) put it, "strict and onerous penalties for delay, giving Rolls very little leeway in the event of serious technical or financial problems." Similarly, Harker (1976, 186) emphasized that "[s]ix hundred engines were contracted, but the price did not make sufficient allowance for the unexpected inflation that ensued in the economy or the unanticipated development costs that arose."

Engineer control: a two-edged sword

"A basic engineering training is a good training for management and for top engineering decisions" (quoted in Gray, 1971, 75). This statement, attributed to Sir Denning Pearson summarizes Rolls-Royce's management philosophy. Several commentators underlined the fact that Rolls-Royce was an engineering company run by engineers who were devoted to engineering excellence. This value informed every single allocative decision taken within the firm. Engineering excellence was pursued strenuously, sometimes irrespective of time and cost constraints. As mentioned by an industry expert, allegedly, having laid their hands on a Pratt & Whitney engine, Rolls-Royce engineers were appalled by the crudity of the engineering solutions embedded in the engine. They were also appalled, however, by the fact that the competitor's engine worked.

Rolls-Royce was a paternalistic company that was run by and for its long-time employees, especially its engineers. To get a job in Rolls-Royce was made easier if the applicant had a relative already working for the company. Employees tended to stay with the company for their entire working lives. This attachment occurred not only at the top management level, but also on the shop floor. As underlined by Gray (1971, 75): "Before Rolls-Royce merged with Bristol Siddeley in 1966 only one of their eight directors had been with them for less than twenty-five years. Such links with the past were to be found on every level: in 1964 over a third of the workers in the Derby factory had been employed there since before the Second World War." Also, Rolls-Royce did not adopt job rotation policies, so that engineers tended to stay within the same department for years, and sometimes decades, with the likelihood that they would become experts in a specific component and/or subsystem of the aircraft engine.

Inspired by the culture of engineering excellence, Rolls-Royce's engineers maintained a solid grip on the resource allocation process during the early stage of the development of the RB211.

This grip, however, started being questioned when Rolls-Royce went bankrupt and later during the nationalization era.

The era of nationalization

Emergence from bankruptcy

On the same day that the Rolls-Royce Receiver was appointed, Frederick Corfield, the Ministry of Aviation Supply stated: "To ensure continuity of those activities of Rolls-Royce which are important to our national defence, to our collaborative programs with other countries and to many air forces and civil airlines all over the world, the Government has decided to acquire such assets of the aero-engine and marine and industrial gas turbine engine divisions of the company as they may be essential for these purposes" (quoted in Department of Trade and Industry, 1972, 14). A new company, Rolls-Royce (1971) Limited was therefore formed that took control of the assets of Rolls-Royce acquired by the government (Department of Trade and Industry 1972).

At that point the development of the RB211 was almost cancelled. But Lord Carrington, the Minister of Defence, commissioned a technical and cost study that involved veteran Rolls-Royce engineers Fred Morley, Stanley Hooker, and Arthur Rubbra and that gave an optimistic assessment of the RB211 (Pugh, 2001, 230). The study argued that the RB211's development problems could be overcome with a six-month delay and a cash flow injection of a further £120 million (Department of Trade and Industry, 1972). According to Gunston (1997, 195), the nationalized company took "the RB211 on board, funded on a cheeseparing daily basis." The British government entered talks with Lockheed to renegotiate the RB211 contract. After a lengthy negotiation involving the British and the US governments, Rolls-Royce (1971) Limited and Lockheed signed a new contract for the completion of the RB211 program. Under this new agreement, Lockheed agreed to buy RB211 engines at increased prices. Meanwhile, the US Senate had authorized a Federal rescue package for Lockheed, and the British government provided the necessary cash to complete the RB211 program.

According to the 1971 Memorandum of Understanding that outlined the relationship between the British government and Rolls-Royce, the government, as the sole shareholder, maintained ultimate control over strategic planning and financial issues related to the launch of new engine development programs (Hayward, 1989). In particular, "any investment decisions over £25 million (US$41 million) had to be referred back to the government for approval" (Verchère, 1992, 33). The government was, however, not involved in the company's day-to-day management, although the Rolls-Royce board agreed to keep it informed about its operations (Hayward, 1989).

A number of the Government appointees to the new board of Rolls-Royce (1971) Limited were clearly supporters of the RB211 program. They included Sir William Cook, a former scientific advisor to the Ministry of Defence, and Sir St John Elstub, Chairman of Imperial Metal Industries, both of whom had already advised the Heath government on the viability of the RB211 (Pugh, 2001, 234-235). Yet, as summed up by Hayward (1989, 140), the bankruptcy and bailout entailed a dramatic challenge to engineer control:

> [I]t was soon evident that Rolls required a long period of convalescence and a sharp taste of internal reform. Pearson, Huddie and the Rolls board took the full brunt of the post

> mortem. There had been fatal flaws in Rolls' management structure and the dominance of engineers at the top of the company was singled out for particular criticism. As one Rolls man would later put it, "the first thing we had to learn was that the company was not just a playground for engineers to amuse themselves".

Rolls-Royce had to be rebuilt and Sir Kenneth Keith's appointment as chairman in September 1972 marked the start of the process. According to Sir Stanley Hooker, Sir Kenneth found a lack of discipline which appalled him and took on a seven-year stint which would lay the conditions for Rolls' revival.

Engineer control and bureaucratic interference

With government and board support for the RB211 program, engineers regained complete control over the evolution of the program itself. In the aftermath of the bankruptcy, a number of Rolls-Royce's most illustrious engineers had come out of retirement. Among them was Sir Stanley Hooker, who, among other things, had led the development of the engine for Concorde while working at Bristol Aero Engines (Pugh, 2001, 90-92). Hooker became both Technical Director and a member of the Rolls-Royce board of directors with the charge of getting the RB211 program back on track. Cyril Lovesey and Arthur Rubbra, both well over 70 years old, worked with Hooker as what he called "a kind of Chief of Staff committee" (Pugh, 2001, 235, quoting from Hooker 1984).

When the Labour government took office in 1974, however, the spectre of bureaucratic interference reappeared. Rolls-Royce was put under the control of the National Enterprise Board (NEB) whose role was to overlook the company's operations. Indeed Rolls-Royce was the main holding of NEB, which in turn came to symbolise Labour's foray into industrial policy. Rolls-Royce management disliked this intrusion; Sir Kenneth Keith, its chairman believed that the National Enterprise Board added a redundant bureaucratic layer between Rolls-Royce and the government (Hayward, 1989, 159).[ii] Tony Benn, as Minister of Trade and Industry after Labour returned to power in February 1974, had his first meeting with the Rolls-Royce Chairman in March of that year. Keith told Benn that when he had accepted the Rolls-Royce position in 1972 he had told the Prime Minister, Edward Heath, that he would "take it on so long as I am not buggered about by junior Ministers and civil servants and officials." Benn responded that "while I am in charge I will not accept chairmen of nationalized industries indicating to me that they won't be mucked about by junior Ministers and civil servants: Rolls-Royce is a nationalized company and must be accountable for what it does."

During 1979, over a period that included the election of the Thatcher government in May, there was open hostility between Sir Kenneth Keith and the NEB Chairman, Sir Leslie Murphy. In late 1979 Murphy told Sir Keith Joseph, Thatcher's Minister of Industry, that the Rolls-Royce Chairman should be sacked in the light of the company's poor financial performance.[iii] In the event, Sir Kenneth retired as chairman, while Sir Keith took control of Rolls-Royce away from the NEB (resulting in the resignation of the entire NEB board), and placed the company in the hands of the Department of Industry.[iv]

Worsening financial performance and the GE deal

In 1980 Rolls-Royce's 1000th RB211 went into production. But from 1979 the company's financial situation worsened. With uncovered foreign exchange as the value of the pound appreciated under the first Thatcher government as well as a prolonged strike, Rolls-Royce recorded losses of £58 million in 1979 (Pugh, 2001, 299). A severe recession in the civilian aerospace industry in the early 1980s meant persistent losses for Rolls-Royce. In 1983 Rolls-Royce lost £193 million, and in 1983 and 1984 delivered only 126 new RB211s, even though the "worst-case" scenario in the company's 1982 plan had been 350 engines (Pugh 2001, 297, 304). Between 1980 and 1984 Rolls-Royce cut its labour force from 62,000 to 41,000, mainly through voluntary severance and with no industrial disputes (Pugh, 2001, 300, 321, 325).

From 1971 to 1979, Rolls-Royce reportedly had received £425m in state aid.[v] From 1979 through 1988 successive governments provided Rolls-Royce with £437 million in launch aid, of which £118 million was repaid from sales levies (Hayward, 1989). The new chairman, Sir Frank McFadzean, appointed at the end of 1979, stated, however, that "as a chairman of this company I have no intentions of going and clearing everything with civil servants; otherwise I would never run the company. You would never run a business on that basis" (quoted in Hayward, 1989, 160).

In 1984, however, in the aftermath of a string of unprofitable years stretching back to 1979, Rolls-Royce entered into two risk-and-revenue-sharing partner agreements with General Electric (GE) whereby GE took a 15 % stake in the development of the medium-sized RB535E4 engine to power the Boeing 757, while Rolls took a 15 % stake in the development of a GE engine designed to exceed 60,000lb (Pugh, 2001, 311-319). As reported in an article entitled "Rolls faces up to reality" that appeared in the *Financial Times* the day after the agreement was announced: "By swapping a share in one of its new engine's for a stake in one of General Electric's, Rolls has finally moved away from the course which it has followed in the civil engine market for the past 20 years – a course which has taken this proud engineering company into bankruptcy, and which more recently has left it with an increasingly weak position in the market for high thrust commercial engines" (Lambert and Makinson, 1984, 16). The article cites Ralph Robins, who was at the time Director – Civil Engines, as saying (in the words of the journalists) "that to develop the RB-211 series up to the [60,000lb+] size range would have effectively required the designers to start with a clean sheet of paper. On this basis the project could have cost $1-1/2bn or more".

As a journalist was to write from the vantage point of 1990 on the eve of the first test of the Trent engine, the 1984 RRSP deal had been made because the company's new Chairman, Sir William Duncan, "believed that any attempt by Rolls to go it alone in developing high-thrust engines would threaten a repetition of the 1971 RB211 crisis. His answer was for Rolls to stay in the game by opting for minority partnership with one of it American rivals" (Lorenz, 1990). Or as another journalist, also writing in 1990, remarked, looking back at the Duncan agreement, "implicit in the deal was the understanding that Rolls would stay out of the big engine end of the market – shutting it out of the highest growth area and limiting it to a subordinate role" (Crooks, 1990, 10).

The reversal of strategy: the RB211 thrust growth capability

By 1986, however, some two years after agreeing to the high-thrust RRSP with GE, Rolls-Royce was marketing its own high-thrust engine, the RB211-524D4D in direct competition with not only Pratt and Whitney's PW-4000 but also GE's CF6-80C2, in which Rolls-Royce still had a 15 % stake. In August 1986, much to the displeasure of General Electric, the RB211-524 secured a £600 million order from British Airways for its new long-range jumbo jets. GE claimed that its pact with Rolls-Royce precluded its "partner" from bidding for the BA order. Rolls-Royce disagreed (Donne and Cassell, 1986). Subsequently the GE-Rolls high-thrust RRSP fell apart, with the collaboration being terminated in November 1986 (Crooks, 1990; Pugh. 2001, 314-319).

Why the reversal of strategy? The improvement in the market for turbofan engines from 1985 clearly had much to do with it; in 1986 Rolls-Royce had pretax profits of £120 million and outstanding orders worth £3.1 billion (Pugh, 2001, 323). Rolls-Royce's engineers also found, over the course of 1984 and 1985, that, because of the modularity embedded in the three-shaft architecture, they could upgrade the RB211 for the big-engine market without increasing the fan diameter, with dramatic savings in development costs compared with Robins' earlier estimate (Pugh 2001, 314). Whether or not a change in the top management of Rolls-Royce was a factor in the reversal of strategy is difficult to say. In late October 1984, some eight months after the high-thrust RRSP, Duncan, the Rolls-Royce architect of the agreement, announced that, as of December 1, Ralph Robins would become Managing Director of the company, the number two position. A week after the announcement, Duncan suddenly died at the age of 61. He was replaced as Chairman by Sir Francis Tombs, who had been appointed to the Rolls-Royce board as a non-executive director in 1982, and hence was involved in the direction of the company when the pact with GE had been made. From the perspective of 1990, Tombs was able to argue that the agreement with GE "was leading us nowhere. The decision to pull out was a watershed" (quoted in Lorenz, 1990). As a result of the reversal of the decision to take a subordinate role to GE in the development of the high-thrust engine, Rolls-Royce increased its market share of the world civil engine market from 5 % at the time of its 1987 privatization to 20 % in 1990. The basis of the company's success was, as Crooks (1990) put it, "Rolls' massive advantage in having the RB211 engine." As Lorenz (1990) summarised these advantages that, by 1990, had resulted in the Trent engine:

> "… the RB211 engine core, whose development costs put the company into receivership, has become the key to its survival and success. Its revolutionary design, using three shafts rather than Pratt and GE's two, has proved so flexible that in successive upgradings since 1971 the engine power has been doubled without incurring the huge expense of significant design changes."

The three-shaft is shorter than two-shaft engines, more rigid and therefore more durable. It wears less in service, preserving its outstanding fuel economy over its full life. Along the way Rolls developed a new, wide fan blade, the "wide-chord" fan, which needs fewer blades to produce the same, or more, power, and is quieter and more fuel-efficient than conventional fans. Only with the Trent did the original RB211 fan diameter have to be increased, but no other fundamental change has been made. As a result, the Trent development is likely to cost about £400 (with about 25% being funded by Rolls' partners in

the project, including BMW and two Japanese companies). By contrast, industry estimates suggest the GE90 project will cost more than £1 billion.

Corporate control and financial markets

Privatization, restructuring, and reorganization

From 1979 Thatcher administration had wanted to privatise Rolls-Royce as part of the Tory policy "to reduce government intervention in industry and to spread 'popular capitalism' through wider share ownership" (Hayward, 1989, 160). As one minister put it, "the business of aerospace must pay its way. Defence considerations apart, there is no reason why aerospace should not be subject to the financial disciplines and opportunities of the marketplace". Or in the words of Norman Tebbit, the Minister of Industry who succeeded Keith Joseph, "the aerospace industry is for making profits, it is not a form of occupational therapy" (both quoted in Hayward, 1989, 160).

With losses piling up in the early 1980s, Rolls-Royce was not yet ready to throw away the protection of government ownership. But in late 1984 a recovery in the civil aerospace markets began, and in 1985 and 1986 Rolls-Royce posted substantial profits. In May 1987 Rolls-Royce was privatized with the flotation raising £1.36 billion for the government for the sale of its shares to the public. In addition, at the request of Sir Francis Tombs, Rolls-Royce's newly appointed Chairman, the government authorised an additional share issue that injected £283 million. Notwithstanding the privatization, the British government retained in perpetuity a 'golden share' of Rolls-Royce that gave it the power to veto any takeover attempt. In an effort to limit the possibility of such a situation arising, the privatization limited foreign ownership of Rolls-Royce to 15 % of its outstanding shares on a first come, first served basis (Hayward 1989). This limitation on foreign ownership was challenged by the European Commission, and was subsequently increased to 29.5 % in 1989 and then to 49.5 % in 1998.[vi]

Once privatized, Rolls-Royce searched for productivity gains through significant organizational restructuring that entailed focusing on core businesses, outsourcing, downsizing, and cost-cutting schemes. This restructuring was pursued with the aim of making the customer, especially civil airlines, central to the strategy of the company. Restructuring also involved an increasing involvement of suppliers and universities as partners in development and research programs. Organizational restructuring was pursued also via several internal programs informed by lean manufacturing, total quality control, and business process re-engineering principles. The aims of these programs were to improve the efficiency of business processes throughout the company and to modify the management structure to improve accountability. At the beginning of the 1990s, Rolls-Royce embarked on an internal quality-enhancing program, labeled *Project 2000*. The program was clearly inspired by the Japanese quality movement and aimed at identifying and eliminating the firm's business processes that did not add value (Verchère, 1992).

The supplier base was also rationalised through the reduction of the number of first-tier suppliers and the introduction of a supplier ranking system. Also, in 1998 Rolls-Royce reorganised itself into two types of business units: (a) customer-facing business units with responsibility for identifying and meeting customer needs, and (b) operating business units with responsibility for delivering sub-systems on time, to cost and to specification. It was expected that this flatter

structure would enable clear accountability of the business units (*Rolls-Royce Annual Report,* 1998).

This intense and profound restructuring resulted in job-cutting throughout the 1990s. The average number of Rolls-Royce's employees steadily declined throughout the decade. In ten years there was a net reduction of about 20,000 employees, accounting for about a third of the work force in 1990. Nevertheless, Rolls-Royce has recognised the importance of a committed and trained labour force. For example, the 1996 Annual Report contended that "[ultimately] our competitive edge lies not in hardware but in the quality of our people" (*Rolls-Royce Annual Report, 1996*, 17). The 2000 Annual Report put it more concretely: "Rolls-Royce is fortunate to have extremely talented and dedicated employees. In the UK, the average length of service is approaching 20 years. This is important in an industry where development and production programs may have lives of more than 50 years and in which the customer relationship with an individual product may be 25 years or more" (*Rolls-Royce Annual Report, 2000*, 16).

Over the 1990s the absolute amount of spending on R&D increased constantly, with net R&D as a % of sales in the 6-7 % range. Much of this spending (as we shall see in the next section) was aimed at the further development of the RB211. Over the past few years, the emphasis has been on the generation of technologies that can be exploited across the company's different businesses. Technologies originally developed for aerospace applications are being exploited for energy applications and more recently in the marine business (in particular, computational fluid dynamics tools are being applied to marine propulsion design). New technologies are being researched to reduce the adverse environmental impacts (in terms of noise and emissions) of products. New technologies are also being used to support the more recent move towards the provision of customer support and service.

Corporate strategy and the stock market

As a nationalized company, Rolls-Royce prepared a corporate strategic plan for government approval every year, and relied on corporate revenues, short-term and long-term borrowing, and government support in the form of defence contracts and "launch aid" (in effect interest-free loans from the government) to maintain its organization and fund expansion. With the privatization of the company in May 1987, Rolls-Royce still had access to these sources of funds, although launch aid would only be forthcoming if other sources were unavailable. The main difference was that, as a publicly traded company, the management of Rolls-Royce was now accountable to the corporation's public shareholders, the vast majority of whom had a purely financial interest in the company.

According to Verchère (1992), after privatization senior managers felt more under public scrutiny by the investment community and private shareholders. As a Rolls-Royce senior manager stated: "We're becoming much more of a financial and accountability culture than before" (quoted in Verchère, 1992, 34). From the beginning of the 1990s Rolls-Royce engaged in "a three-tier planning discipline comprising a ten-year review of market trends backed by five-year financial and strategic plans" (Verchère, 1992, 34). The third tier was a two-year operating plan and budget that is, in turn, informed by quarterly and four-week financial budgets that, according to Verchère (1992, 34) have had "the net effect of tightening financial controls at all levels, including the shop floor."

Yet throughout the 1990s, Rolls-Royce underperformed in the FTSE100, with the gap in stock prices increasing perceptibly in the late 1990s (see Figure 1). But how did Rolls-Royce's exposure to the stock market actually affect strategic decision-making and the allocation of resources at the company? Lazonick and O'Sullivan (2002) provide a framework for analyzing the four functions that the stock market can perform in the industrial corporation. Firstly, it can structure the relation between owners and managers in exercising strategic *control* over corporate allocation decisions. Secondly, it can provide the corporation with *cash* that can be used to restructure the corporate balance sheet, fund operations (including R&D), invest in plant and equipment, or acquire existing physical and intangible assets. Thirdly, it can provide the corporation with its own *combination* currency that can be used instead of or in addition to cash in mergers and acquisitions. Fourthly, it can provide the corporation with its own *compensation* currency that it can use, instead of or in addition to cash, to reward employees and other stakeholders.[vii] As we shall see in the following account of the relation between Rolls-Royce's corporate strategy and the financial markets, the stock market has played all four roles at Rolls-Royce during the past sixteen years.

Insert Figure 1 about here

Ownership and control

Privatization of the company in 1987 transferred ownership of the Rolls-Royce shares from the British government to institutional investors and households. Table 1 shows the size distribution of holdings of ordinary shares on December 31, 1988 and December 31, 2001. It is worth noting that on December 31, 1968, on the eve of the difficulties that had plunged Rolls-Royce into bankruptcy, Rolls-Royce had 59,712 shareholders of which 50,742 were individuals (who held 46 % of the number of shares outstanding), while 218 were insurance companies, 948 banks, and 134 pension funds (Bowden, 2002: 41-42). Twenty years later, as a reprivatized company, Rolls-Royce had a vastly increased number of small shareholders, but a smaller number of large institutional shareholders held a much larger proportion of the shares outstanding.

As can be seen from Table 1, from 1988 to 2002 the number of small shareholders declined, while the concentration of shareholdings among the largest shareholders – all institutional investors – increased dramatically. Whereas in 1988 the 115 holders of more than one million shares had 48 % of Rolls-Royce's shares, in 2002 the 166 largest shareholders had 80 % of the shares. As of March 6, 2002 the largest shareholder, with holdings of 12.08 % of the outstanding ordinary shares, was Franklin Resources, Inc., a major US-based institutional investor that manages the Franklin-Templeton investment funds. The second largest shareholder was BMW AG with holdings of 9.89 %. The German automobile company had acquired these shares because of Rolls-Royce's purchase of BMW's stake in a joint aircraft engine venture.

Insert table 1 about here

Notwithstanding the growing concentration of shareholding at Rolls-Royce, throughout the period 1987-2003 Rolls-Royce's management was dominated by insiders who -- protected from takeover by the British government's 'golden share' -- remained firmly in control of corporate

allocation decisions. The key executive over this period was Sir Ralph Robins. Upon graduating from Imperial College in 1955, Robins, aged 23, had joined the company as an apprentice engineer. He became Managing Director in 1984, Chief Executive in 1991, and Chairman in 1992. A 1999 profile of Robins in *The Financial Times* noted that "Sir Ralph . . . has been in charge throughout the glory years." The article went on to say that, while the City remains unimpressed with Rolls-Royce's stock market performance, "no one in the City has a bad word to say about the slim, pinstriped, impeccably courteous Sir Ralph." The profile went on to quote one unnamed City analyst who remarked: "He's everybody's favourite uncle. But his priority is to maintain Rolls as an independent British company. Shareholder value is secondary to him" (Shapinker 1997). Or more recently, as stated in a newspaper report in March 2002 that followed Robins' announcement of his retirement: "Sir Ralph Robins, chairman of Rolls-Royce, is no great fan of the City or it of him by the look of the 7 per cent surge in the Rolls-Royce share price that greeted news of his retirement."

Like Robins, most of the other top executives at Rolls-Royce in the fifteen years after privatization had built their careers with the company. In October 2001, the person who Michael Howse replaced as Director – Engineering and Technology was Philip Ruffles, an engineer who had joined the company in 1961 at the age of 23. In addition, Ruffles' predecessor as Director – Engineering and Technology was Stewart Miller, an engineer who had joined Rolls-Royce in 1954 at the age of 21 and had been appointed to the Board in 1984 before retiring after 41 years of service in 1996. Counting Robins and Ruffles, of the nine executive directors who were with the company in 2001, six had joined the company in 1969 or before at an average age of 22.5 years and had on average 37 years of service with the company. Five of these six were engineers. Of the other three, John Rose and Paul Heiden, who joined Rolls-Royce in their 30s, both had finance backgrounds, while James Guyette joined the company subsequent to the Allison acquisition. These executives, who effectively control Rolls-Royce's resource allocation decisions, are long-term career managers, and most of them have spent their entire careers with Rolls-Royce.

Stock as a source of cash

Table 2 shows the most important items in Rolls-Royce's sources and uses of funds since it was privatized. In addition, we have shown the company's annual net expenditures on R&D, which are deducted as an expense on the profit-and-loss statement, thus reducing the "funds from operations" figure but which represent in reality an ongoing "capital" expenditure that the company must be able to fund if it is to stay in business. Based on the data in Table 2, Figure 2 illustrates that for most of the 1990s the company's funds from operations plus depreciation charges were just covering capital expenditures (including acquisition costs) plus dividends. Since the late 1990s, however, these sources of funds have been significantly greater than these uses, without sacrificing either R&D expenditures or dividend distributions.

Insert table 2 about here

Figure 3 shows Rolls-Royce's main financing activities and external fund raising under privatization. As discussed below, the two public share issues (categorized as PSI in Table 2) that Rolls-Royce did in 1993 and 1995 were directly related to technological investments – the first case to fund R&D without taking on more debt, and in the second case to fund the

acquisition of the Allison Engine. By the late 1990s, when Rolls-Royce carried out the major acquisition of Vickers, it turned to the bond market rather than to the stock market for financing.

Insert Figures 2 and 3 about here

Rolls-Royce made substantial profits from 1987 through 1990. As a result, as can be seen in Table 2, from 1987 through 1990 the company's funds from operations totalled £732 million, almost double its total capital expenditures of £372 million. In addition, internal funds also covered the company's expenditures on net R&D, which totalled £734 million during the years 1987-1990.

After the boom years of the late 1980s, a slowdown hit both the military and civil segments of the aerospace industry. After suffering an operating loss of £172 million in 1992, Rolls-Royce found itself facing the high costs of both sustaining the development of the high-thrust wide body Trent and rationalizing its existing activities. The first Trent 700 engines for the Airbus 330 were to be delivered in the winter of 1994, and the higher-thrust Trent 800 that was being developed for the Boeing 777 would be tested in September 1993.[viii] The rationalization program, which was announced in March 1993, entailed the closing of six of twelve of the company's main manufacturing sites and layoffs of 2900 people, a 6% workforce reduction (Tieman, 1993).

The company had taken on considerable debt in the lean years of the early 1990s (see Table 2). But the company still needed to raise funds from the markets. According to the report in *Extel Examiner*, "[Sir Ralph] Robins [the Chairman of Rolls-Royce] said that it was expected that the rationalisation program alone will result in a cash outflow of £130 million over this year and next. Against this background Robins said the board had decided to increase the equity base thereby restoring it to a level which, in its opinion, is more appropriate to the sales and activity of the Group."[ix] Instead of taking on more debt, in September 1993 Rolls-Royce announced a rights issue which would raise £307 million net of expenses. One new share would be offered to the company's existing shareholders for each four shares that they currently held. A Rolls-Royce press release explained why the company was going to shareholders for more equity capital:

> In July this year the financial resources of the Group were strengthened by a successful $300 million bond issue. However the Board of Rolls-Royce does not wish to place undue reliance on bank and other forms of debt financing. The Board believes it appropriate to finance the Group's long term activities predominantly through equity capital rather than debt. This approach was adopted in the Group's capital structure at the time of privatization in 1987 when the Group came to the stock market with no net debt. The requirement for a rights issue should be seen in the context of turnover which has risen from £1973 million in 1988, when shareholders' funds were £949 million, to £3562 million in 1992 on a similar equity base.[x]

Rolls-Royce had seen its market share of civil aircraft engines rise from 22 % in 1992 to 28 % in the first half of 1993 – placing it just ahead of Pratt & Whitney, and even with General Electric – but market conditions, intense competition, and the imperative to sustain R&D raised concerns among shareholders about when they would see a resurgence of Rolls-Royce's share price to its

post-privatization levels (Tieman, 1993).[xi] *The Times* editorial on the rights-issue announcement observed that "Rolls-Royce asks a great deal from its shareholders". In *The Times* full report on the condition of Rolls-Royce, reporter Ross Tieman (1993) observed that "the last time Rolls-Royce needed more cash to develop a new aero-engine, it went bust. This time it is asking shareholders to contribute." But Tieman continued:

> The need for money is fundamentally different to that which existed 22 years ago, when Edward Heath's government was obliged to bail the company out of its cost over-runs on the development of the RB211 airliner engine. Today, the problem is one of success. But ironically, the RB211 is still at the root of Rolls's financial embarrassment.

Ideally, the prices that Rolls-Royce could secure from the airlines in the new engine market would reflect the improvements in reliability that would save on future servicing and replacement costs. But the generally depressed market conditions since 1989 had led airlines to ground older planes with "spares-hungry" engines while creating intense competition among the Big Three for new orders, including engines for the Boeing 777, in a multisourcing world (Tieman, 1993). It was under such economic conditions that, in 1993, Rolls-Royce went to its shareholders for cash.

On the announcement of the rights issue, the price of Rolls-Royce shares fell by almost seven % to 152-1/2p. The rights issue was offered at 130p, a 20.5 % discount from the market price on the announcement date. Those British shareholders who did not want to take up the rights issue had a window of opportunity to sell the rights to those who did. At the same time, foreign holdings had reached the maximum of 29.5 %, thus restricting foreign sales (Rudd 1993, 17).[xii] In the event, the deep discount on the rights issue meant that 87.2 % of the 211.6 million new ordinary shares offered were taken up by existing shareholders, with the broker underwriting the rest of the issue and offloading the shares at 145p, mainly to two large institutional investors (Kibazo et al., 1993, 50). In the process, the proportion of shares that were foreign-owned dropped to 25 % (Pain, 1993, 22).

In January 1995 Rolls-Royce paid $525 million, equivalent to £328 million, to acquire Allison Engine Company, a US military engine supplier that had been founded in 1915 and that from 1929 to 1993 had been a subsidiary of General Motors. Rolls-Royce had made a previous bid for Allison in 1993, but GM had sold the company to a management buyout team for $370 million.[xiii] When Rolls-Royce had announced its plan to buy Allison Engine on November 21, 1994, the news was, according to *Investors Chronicle*, "welcomed by the City, with Rolls-Royce's share price moving up 2p to 185p.[xiv] Financial analysts apparently believed the Allison acquisition would be done in Rolls-Royce shares, whose price had risen substantially over the past year and which were listed on the New York Stock Exchange in the form of American Depository Receipts.[xv] Allison's current owners were not, however, interested in accepting Rolls-Royce's shares in payment. To finance the acquisition, therefore, in March 1995 Rolls-Royce did a £331 million rights issue (net of expenses) – after having raised £307 million from shareholders in a rights issue just 18 months earlier – this time offering one ordinary share at 154p for every 5.4 ordinary shares held on March 16, 1995.

The March 1995 rights issue differed significantly from that of September 1993. Instead of offering new shares directly to existing shareholders, Rolls-Royce, through its sole underwriter N M Rothschild & Sons, offered the 227.3 million shares to City institutional investors at 154p, which was a discount of just over 5 % on the opening price of 164p – and hence less than one-fourth of the discount that the 1993 rights issue had imposed on the company's shares (Rodgers 1995, 17).

Stock as an acquisition currency

In late October 1988 Rolls-Royce secretly purchased a 4.7 % stake in Northern Engineering Industries (NEI), a power station equipment and heavy engineering group based in Newcastle (Garnett, 1988, 33). Rolls-Royce then entered into talks with NEI concerning a friendly bid for the company that would total £360 and be paid mainly in cash, to be covered by Rolls-Royce's cash balances and the proceeds from the Eurobond issue.

Subsequent merger talks between the two companies appeared to have come to an end in late December (Gibben, 1988, 19). When the merger was agreed in April 1989, however, no cash was involved. Between the aborted discussions in December and the merger agreement in April, Rolls-Royce's share price rose from 128p to 185p, an increase of 45 %, that, compared with the FTSE100, enabled it to outperform the rising stock market by 29 %.[xvi] Instead of cash, seven new Rolls-Royce shares were exchanged for every ten NEI shares, thus valuing NEI at £306 million.[xvii] In using its shares for the merger, Rolls-Royce was able to maintain control over its cash flow.

The NEI purchase price represented a 23 % premium over the price of NEI shares on the date before the disclosure of Rolls-Royce's 4.7 % holding in NEI. The new shares issued by Rolls-Royce entailed a 16.7 % increase in its issued ordinary share capital, thus placing a substantial burden on the NEI acquisition to generate sufficient earnings to maintain existing earnings per share. In 1988 NEI had reported pre-tax profits of £38.5 million, equivalent to 22.9 % of Rolls-Royce's level of pre-tax profits in that year.[xviii] Thus, the NEI acquisition promised to pay its own way. More importantly, the NEI acquisition started the company on a diversification strategy that, as already described, became focused in the last half of the 1990s around the application of gas turbine technology to energy and marine uses as well as aerospace.

Alongside Rolls-Royce, Vickers was the other major British engineering company to survive the pressures of competition and consolidation over the course of the twentieth century. Indeed the relation between Rolls-Royce and Vickers went back to 1919 when the first non-stop transatlantic flight was made in a Vickers Vimy aircraft powered by Rolls-Royce Eagle engines (Lister, 1999). In September 1999, Rolls-Royce announced its proposal to acquire Vickers for £576 million in cash -- a premium of 53 % over Vickers' market capitalization at the time -- in order to gain access to its capabilities in marine power systems.[xix] As Sir Ralph Robins told reporters: "Our strategy is to get to No. 1 or 2 in the various markets in which we operate. We are there in aerospace, this will put us there in marine" (Cowell, 1999). Vickers shareholders were also given the option of receiving, in lieu of cash, Loan Notes issued by Rolls-Royce, redeemable at the holder's option in whole or in part at six-month intervals directly from Rolls-Royce, but not listed or traded on a stock exchange.[xx] With revenues strong in 2000, the company was able to reduce substantially the debt taken on to acquire Vickers.

In 1999 Rolls-Royce made three other acquisitions. To build capabilities in the energy sector, it acquired the rotating compression business of Cooper Cameron, named Cooper Rolls, for £132 million in cash. It acquired National Airmotive, a service and repair facility in Oakland California, for £47 million in cash. Finally on December 31, 1999 Rolls-Royce purchased the 50.5 % shareholding that BMW AG held in BMW Rolls-Royce GmbH for 33.3 million shares and the waiver of a £180 million loan that BMW owed to Rolls-Royce, for a total acquisition value of £289 million. The business was renamed Rolls-Royce Deutschland GmbH. (Rolls-Royce Annual Report, 1999). It was because of this deal that BMW acquired a 10 % stake in Rolls-Royce and was, as we have seen, its second largest shareholder as of March 2002.

Stock as a compensation currency

After its privatization, Rolls-Royce had two stock-based compensation schemes: a) an Employee Sharesave Plan that, for example in 1995, was available to about 40 % of the company's UK employees and 30 % of all employees; and b) an Executive Stock Option Plan that covered 46 senior executives in 1987 and 124 in 1999, but was extended to 363 senior executives in 2000 (Rolls-Royce Annual Reports, 1988-2001). Under the executive plan, the vesting period was three years with expiration after ten years, and certain company performance criteria had to be met before stock options could be exercised. As stated in the 2000 Annual Report:

> Depending on performance, executives are eligible to receive options on an annual basis. Options are granted at the mid-market price on the day before the day of issue and normally have to be held for a minimum of three years before they are capable of exercise. They expire after ten years. In line with the [remuneration] committee's view that an increasing proportion of remuneration should be performance related, the exercise of options is subject to a performance condition that the Group's growth in earnings per share (EPS) must exceed the UK retail price index by three % per annum, over a three-year period.

The annual reports provide information on the stock option awards to executive directors, including the number of awards in a particular year, exercise prices, and the number of options exercised. From this information it is possible to derive fairly accurate estimates of the extent to which executive directors were able to augment their salaried income (which included bonuses) through the exercise of stock options. For example, Sir Ralph Robins was able to increase his income over the period 1987-2002 by 7.48 % through the exercise of stock options, while John Rose increased his income as an executive director (1991-2002) by 3.48 %. In fact, most options awarded in the early years expired without being exercised. Nevertheless, at the end of 2002, Robins had over one million options outstanding and Rose over 2.3 million.

Over the period 1987-2002, executive directors received increasingly generous pay even without gains from the exercise of stock options, as Table 3 shows. In 1987 the pay of the highest paid Rolls-Royce executive was 9.0 times that of the average pay of all Rolls-Royce employees, while the average pay of all executive directors was 6.1 times that of all employees. By 2002 these figures had risen to 28.9 and 18.2. In addition, in 2001, and in certain cases for 2000, executive directors began receiving quantities of stock option awards that were far in excess of what they had received previously. For example, perhaps as a retirement bonus, Robins received

1,025,618 option awards in 2001, up from 172,674 in 2000 and a previous high of 694,618 in 1995. Rose received 1,680,702 option awards in 2001, up from 408,276 in 2000 and a previous high of 355,392 in 1995 (Rolls-Royce Annual Reports). In 2002, Rose received 638,298 more options.

Insert table 3 about here

Conclusions: is Rolls-Royce a success story?

This case study shows that despite dramatic changes in the forms of enterprise ownership from the 1960s through the 1990s, Rolls-Royce was able to remain one of the Big Three in the turbofan industry. Because of continuous investments in the three-shaft RB211 program from the mid-1960s through the 1990s, the company was able to emerge as the industry's technological leader in widebody engines, notwithstanding the fact that it was Rolls-Royce's initial investments in this program that helped to drive the company into bankruptcy at the beginning of the 1970s.

We argue that the continuity of this development effort can only be understood in terms of the influence of the company's engineers, as strategic decision-makers, over the allocation of the company's resources. As salaried employees, their own careers depended on the success of the company in developing jet engines. In pursuing this developmental strategy, they made use of government financial support, especially during the period of nationalization, but not at the cost of surrendering their positions of strategic control. Subsequent to the company's 1987 privatization, Rolls-Royce's executives have made astute use of financial markets to fund acquisitions and further technological development while avoiding both loss of strategic control and the threat of bankruptcy. Indeed, it would appear that the career advancement of the current CEO, John Rose, who joined Rolls-Royce in 1984 at the age of 32 with a background in finance, was bound up with the successful financial engineering of the 1990s, and in particular the two rights issues of 1993 and 1995. Fundamentally, however, the success of the company over the last decade and a half derives from the sustained development of the RB211, a process that was begun in the last half of the 1960s and continued through the end of the century.

While Rolls-Royce is an exceptional case in the British context, from a comparative-historical perspective on the role of salaried managers in exercising strategic control over corporate resource allocation in high fixed cost, knowledge-intensive industries, Rolls-Royce's history is by no means unique (see Chandler et al., 1997). It is career managers, not public shareholders or government bureaucrats, who have the understanding of the technologies, markets, and competitors in a complex-product industry required to make strategic allocation decisions that stand any chance of generating successful outcomes. At the outset, investments in innovation in such industries are inherently uncertain. The role of strategic managers is not only to make investments in the face of uncertainty but also to immerse themselves in an ongoing learning process about developing technologies, accessing markets, and confronting competitors that can transform uncertainty into economic success.

As outsiders to the industrial corporation, public shareholders are ill-positioned to be involved in these strategic decision-making processes, and indeed if they were obliged to be so involved they would probably rather sell their shares. In this regard, Rolls-Royce's shareholders, both

before the bankruptcy and after privatization, were no exception. The question for them has always been when, not whether, to buy and sell "ownership" stakes in the company, and in this activity different shareholders of the same company often take very different actions. Bowden (2002, 44), for example, shows that from 1968 to 1969, as Rolls-Royce's seemingly strong financial condition eroded, four major institutional shareholders (including the largest, Prudential Insurance, with holdings in 1968 that were greater than those of the next seven largest shareholders combined) sold their entire holdings while ten others increased the size of their holdings, in many cases substantially. Bowden (2002, 49-51) also recounts how, as Rolls-Royce's financial difficulties deepened in 1970, it was the banks, not the shareholders, who became involved in the affairs of the company.

Since privatization, as we have seen, shareholding in Rolls-Royce has become increasingly concentrated in the hands of large institutional investors. What have they gained? From 1988 through 2002, the average real dividend yield on Rolls-Royce's shares was –1.3 %, ranging from –6.6 % in 1990 to 2.0 % in 2001. In 2001-2002, dividends per share were 64 % higher than they were in 1992-1995. But with the company's dismal stock-price performance since 1997, the real annual total yield (dividend yield plus price yield adjusted for inflation) on Rolls-Royce's stock has averaged –13.2 % for 1997-2002 compared with an average of 6.8 % for 1988-1996. For 1988-2002, the average annual real total yield on Rolls-Royce's shares was –3.2 %. Whatever else it has been doing since privatization, the company clearly has not been creating value for shareholders. Particularly for the most recent period, therefore, a proponent of agency theory might argue that in fact Rolls-Royce's competitive success – it raised its market share of the civil engine market from eight % in 1987 to about 30 % in 2002 -- represents a case of entrenched management squandering resources that could have been used more productively elsewhere in the economy.

The problem with such a view is that, whatever its stock market performance, Rolls-Royce is a company that, because of sustained investment in its productive resources, has a technological capability that took decades to develop and that no other company in the world can replicate. The company has been persistently profitable with underlying real earnings per share being somewhat higher in 1997-2002 (when stock price performance has been poor) than in 1988-1996. The company provides productive employment to over 39,000 people, of whom the 24,000 in Britain would have by no means been certain of finding another employer in the UK that could have provided them with equivalent career opportunities. The average real annual earnings of these employees were over 50 % higher in 2000-02 than they were in 1990-92. While beyond the scope of this paper, the development of Rolls-Royce's capability clearly has had spillover effects that, especially through their effects on resources available in the British university system, have been beneficial to the training of engineers outside Rolls-Royce as well as to the technological capabilities of other engineering companies. It may well be that in the future, Rolls-Royce's top management may become more concerned with their own emoluments (as the British say) than with generating returns on the company's human and physical resources – and in this regard the tripling of average executive director pay in relation to average employee pay from 1987 to 2002 may be a cause of concern. But there is little doubt that over the past several decades the entrenched control of Rolls-Royce's managers over the strategic allocation of the company's resources has resulted in the creation of valuable and unique productive capabilities that certainly the British economy would not otherwise have possessed.

References

AFX News (1998), 'BAe, Rolls-Royce foreign ownership limit raised to 49.5 % from 29.5', March 12.

Bowden, S. (2002), 'Ownership Responsibilities and Corporate Governance: The Crisis at Rolls-Royce, 1968-71,' *Business History*, 44, 3: 31-62.

Carpenter, M., W. Lazonick, and M. O'Sullivan (2003) 'The Stock Market and Innovative Capability in the New Economy: The Optical Networking Industry,' *Industrial and Corporate Change*, 12, 5: 963-1034.

Chandler, A, F. Amatori, and T. Hikino (eds.) (1997), *Big Business and the Wealth of Nations,* Cambridge: Cambridge University Press.

Clark, K. B. and T. Fujimoto (1991), *Product Development Performance*, Boston, MA: Harvard Business School Press.

Cowell, A. (1999), 'Rolls-Royce to buy Vickers for $933 million,' *New York Times*, September 21.

Cownie, J. (1989), 'Success Through Perseverance: the Rolls-Royce RB211 Engine', *The Putnam Aeronautical Review*, 4, December: 230-238.

Crooks, E. (1990), 'Aero-Engines: Rolls revs up for new Aero-engine Battle,' *Investors Chronicle*, August 24.

Department of Trade and Industry (1972), 'Rolls-Royce Ltd and the RB211 Aero-Engine', presented to Parliament by the Secretary of Sate for Trade and Industry by Command of Her Majesty, January.

Donne, M., and M. Cassell (1986), 'Rolls-Royce wins Engine Order for 16 BA Jumbo Jets," *Financial Times*, April 16: 1.

Doz, Y. (1996). 'The Evolution of Cooperation in Strategic Alliances: Initial Conditions or Learning Processes.' *Strategic Management Journal*, 17: 55-83.

Eisenhardt, K. M. (1989), 'Building Theories from Case Study Research', *Academy of Management Review*, 14, 4: 532-550.

The Economist (1975), 'Rolls-Royce: Middle-man or Medler?', December 27: 42.

The Economist (1978) 'National Enterprise Board: Rolls-Royce of a Problem,' February 11: 112.

The Economist (1979), 'NEB and Rolls-Royce: Who needs a Lame-duck Hospital?' November 17: 108.

The Economist (1979), 'Industrial Policy: Mrs Thatcher's Awkward Inheritance,' May 5: 120.

The Economist (1979), 'Rolls under Whitehall's Wing,', November 24: 83.

The Economist (1979), 'The Real Problem is Money,' November 17: 108.

Extel Examiner (1993), 'Royce-Royce 1 – Right Issue Offsets Rationalisation Costs,' September 2.

Extel Examiner (1993), 'Official Correction: Rolls-Royce – Rights Issue,' September 2.

Extel Examiner (1993) 'Extel Financial Exclusive: Rolls-Royce to Fund "R&D at Highest level Ever" – Chairman,' September 2.

European Information Service (1995), 'Rolls-Royce Buys Allison Engine.' January 5.

Freeman C. and L. Soete (1997), *The Economics of Industrial Innovation*, London: Pinter.

Garnett, N. (1988), 'Rolls-Royce takes 4.7 % of Northern Engineering,' *Financial Times*, November 1.

Garnett, N. (1989), 'Rolls-Royce to But NEI in Deal Worth £300 Million,' *Financial Times*, April 11: 1.

Gibben, R. (1988), 'Rolls and NEI end Talks,' *Daily Telegraph*, December 22.

Global News Wire (1999), 'Rolls-Royce plc: Proposed Recommended Offer for Vickers plc from Company for £576m,' September 20.

Gray, R. (1971), *Rolls on the Rocks: The Story of Rolls-Royce,* Salisbury: Compton Press.

Gunston, B. (1997), *The Development of Jet and Turbine Aero Engines*, second edition, Sparkford: Patrick Stephens Limited.

Harker, R. W. (1976) *Rolls-Royce: From the Wings 1925-1971 Military Aviation*, Oxford: Oxford Illustrated.

Hayward, K. (1989), *The British Aircraft Industry*, Manchester: Manchester University Press.

Hooker, Sir Stanley (1984), *Not Much of an Engineer*, London: Airlife.

The Independent (1989), 'View from City Road: NEI an "Add-on" for Rolls-Royce,' April 11, 25.

Investors Chronicle (1995), 'Popular Shares: R-R ahead of Allison OK,' February 10, 54.

Kibazo, J., C. Price, and S. Qureshi (1993), 'London Stock Exchange: Rolls-Royce Rises,' Financial Times, 30 September: 50.

Lambert R., and J. Makinson, (1984) 'Rolls faces up to Reality,' *Financial Times*, February 4.

Lazonick, W. (2002), 'The Theory of Innovative Enterprise,' in M. Warner, ed., *International Encyclopedia of Business and Management*, Thomson Learning: 3055-3076.

Lazonick, W., and M. O'Sullivan, (2000) 'Perspectives on Corporate Governance, Innovation, and Economic Performance', Report to the European Commission (DGXII) under the TSER Program (see http://www.insead.edu/cgep).

Lazonick, W., and M. O'Sullivan (2002) 'Corporate Governance, Innovation, and Economic Performance in the EU: Project Policy Report', Report to the European Commission (DGXII) under the TSER Program (see http://www.insead.edu/cgep).

Leonard-Barton, D. (1990), 'A Dual Methodology for Case Studies,' *Organization Science*, 1, 3.

Lister, D. (1999), 'Vickers consigned to History as Rolls rides to the Rescue,' *The Times*, September 21.

Lorenz, A. (1990), 'Rolls turns on Maximum Power,' *Sunday Times*, July 15.

Nakamoto, M. (1997), 'Japan abandons Hope of Flying Solo', *Financial Times*, January 10.

Nelson, R.R. and S. Winter (1982), *An Evolutionary Theory of Economic Change*, Cambridge, MA: Belknap Press of Harvard University.

New York Times (1989), 'Investor Limit Up at Rolls-Royce,' July 20, D5.

O'Sullivan, M. (2000), 'The Innovative Enterprise and Corporate Governance,' *Cambridge Journal of Economics*, 24, 4: 393-416.

Pain, D. (1993), 'Market Report: Rolls Aero Shares fly High as Horizon Brightens,' *The Independent*, November 13.

Penrose, E. (1959), *The Theory of the Growth of the Firm*, London: Basil Blackwell.

PR Newswire European (1993), 'Rolls-Royce plc Interim Results 1993,' September 2.

PR Newswire European (1995), 'Clayton, Dubilier & Rice Completes Sale of Allison Engine Company to Rolls-Royce, March 24.

PR Newswire European (1989) 'Rolls-Royce and NEI to Merge, April 10.

Pugh, P. (2001), *The Magic of a Name: The Rolls-Royce Story, Part Two: The Power Behind the Jets, 1945-1987*, Icon Books.

Reed, A. (1973), *Britain's Aircraft Industry: What went right? What went wrong?*, J. M. Dent & Sons.

Regulatory News Service (1999), 'Vickers plc – Recommended Cash Offer – Part 1,' September 20.

Rodgers, P. (1995), 'Rolls Placing raises £330m,' *The Independent*, March 25.

Rolls-Royce *Annual Reports* (1988-2002)

Rothwell, R. (1992), 'Developments Towards the Fifth Generation Model of Innovation', *Technology Analysis & Strategic Management*, 1, 4: 73-75.

Rudd, R. (1993), 'Rolls-Royce issues £307M Cash Call,' *Financial Times*, September 3.

Ruffles, P. (1992), 'The RB211: The First 25 Years,' 31st Short Brothers Commemorative Lecture.

Shapinker, M. (1997), 'Flight of Fancy is over for Boeing', Financial Times, 22nd January, p. 4.

Teece, D.J., G. Pisano, A. Shuen (1997), 'Dynamic capabilities and Strategic Management,' *Strategic Management Journal*, 18: 509-533.

Tieman, R. (1993), 'Rolls-Royce asks Investors for Mid-flight Refuelling,' *The Times*, September 3.

Verchère, I. (1992), 'Rolls-Royce Runs Leaner and Meaner'*, Interavia Aerospace Review*, January: 33-37.

Yin, R.K. (1994), *Case Study Research: Design and Methods*, London and New Delhi: Sage Publications.

Table 1. Size Distribution of Ordinary Shareholdings
31 Dec. 1988, 31 Dec. 1991, and 31 Dec. 2002

	December 31, 1988			December 31, 1991			December 31, 2002		
Size of holding*	Number of holders	% of total holdings	% of total shares	Number of holders	% of total holdings	% of total shares	Number of holders	% of total holdings	% of total shares
1-150	612,545	72.32	11.43	345,974	58.21	5.26	119,263	37.06	0.94
151-500				200,769	33.78	4.63	155,370	48.27	2.48
151-1,000	210,226	24.82	8.28						
501-10,000				45,521	7.66	8.66	45,157	14.03	5.07
1,001-10,000	22,491	2.66	6.88						
10,001-100,000	1,099	0.13	5.00	1,348	0.23	4.71	1,457	0.45	2.49
100,001-1,000,000	474	0.06	20.34	574	0.10	21.34	463	0.14	9.25
1,000,001 and over	115	0.01	48.07	149	0.02	55.96	166	0.05	79.77
TOTAL	846,950	100.00	100.00	594,335	100.0	100.0	321,876	100.00	100.00

* The 1988-1990 annual reports provide data on shareholding for those with 151-1,000 shares and 1,001-10,000 while the 1991-2002 annual reports provide data on shareholding for those with 151-500 shares and 501-10,000 shares.

Sources: Rolls-Royce Annual Report 1988, 34; Rolls-Royce Annual Report 2001, 72.

Table 2. Rolls-Royce plc, Sources and uses of funds, 1987-2002 (selected items)

£ millions

SOURCES	2002	2001	2000	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989	1988	1987
FFO	611	418	479	392	395	311	182	193	41	37	124	100	254	278	217	191
DEP	236	198	238	110	113	92	103	116	109	105	104	64	69	55	43	41
LTB	151	69	510	734	177	2	69	4	0	208	181	335	161	162	155	9
ΔLTD	103	67	-223	530	162	-5	59	-150	-76	48	3	174	-1	-38	146	-70
ΔSTD	-155	39	-146	91	-19	65	0	17	6	-29	214	57	48	-62	-2	-163
SS0	1	16	10	4	14	4	18	15	4	8	0	4	1	0	0	0
PSI	0	0	0	0	0	0	0	332	0	317	0	0	0	0	0	274
DFA	41	168	46	187	213	89	52	153	40	38	12	15	19	8	4	2
USES																
CPX	314	211	292	381	387	222	142	94	105	130	126	119	112	113	65	82
AOA	28	1	45	653	0	9	3	217	0	0	0	0	0	0	0	0
RLTD	48	2	733	204	15	7	10	154	76	160	178	161	162	200	9	79
CDS	109	84	74	88	65	78	69	57	51	44	64	45	69	55	45	14
Net R&D*	***297***	***358***	***371***	***337***	***310***	***268***	***217***	***206***	***218***	***253***	***229***	***216***	***237***	***161***	***149***	***187***

FFO = Funds from operations; DEP = Depreciation; LTB = Long-term borrowing;
ΔLTD = Change in long-term debt (=LTB-RLTD); ΔSTD=Change in short-term debt;
SS0 = Sale of ordinary shares to employees exercising options;
PSI = issue of ordinary shares to the public (net of expenses);
DFA = Disposal fixed assets; CPX - Capital expenditures; AOA = Acquisition of assets;
RLTD = Reduction of long-term debt; CDS = Cash dividends

** As an operations expense, the cost of net R&D is covered by revenues that are deducted in arriving at the "funds from operations" figure, and is not an item in the cash flow (i.e., "sources and uses of funds") accounts. Given its importance to the company, however, the net R&D figures are included in Table 9 so that they can be compared with the cash flow items that are in the sources and uses accounts.*
NA = not available
Sources: Rolls-Royce Annual Reports, 1988-2002.

Table 3. The Relative Pay of Rolls-Royce Executives and Rolls-Royce Employees, 1987-2001.

Year	Pay of Highest-Paid Executive to Average Pay of All Employees	Average Pay of Executive Directors to Average Pay of All Employees
1987	9.0	6.1
1988	11.2	6.9
1989	12.5	6.6
1990	14.8	9.5
1991	14.3	7.7
1992	14.4	9.7
1993	14.5	10.6
1994	16.6	11.0
1995	13.3	9.3
1996	14.4	10.7
1997	19.2	12.7
1998	18.5	13.0
1999	18.9	14.9
2000	20.1	13.2
2001	25.0	16.5
2002	28.9	18.2

Sources: Rolls-Royce Annual Reports 1987-2002.

Figure 1. Stock price indices, Rolls-Royce plc and FTSE100, Sept. 1987-Sept. 2003 (adjusted close on the first trading day of each month)

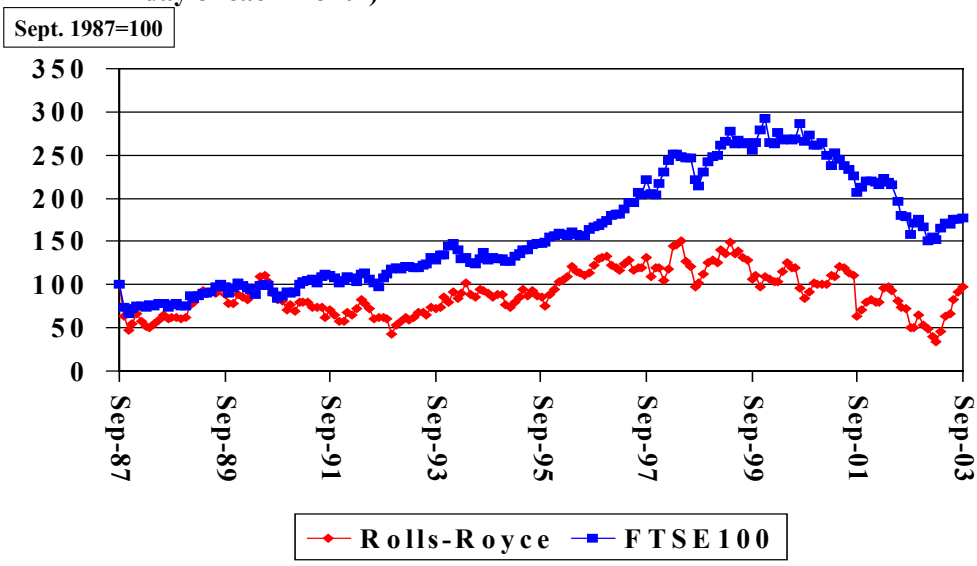
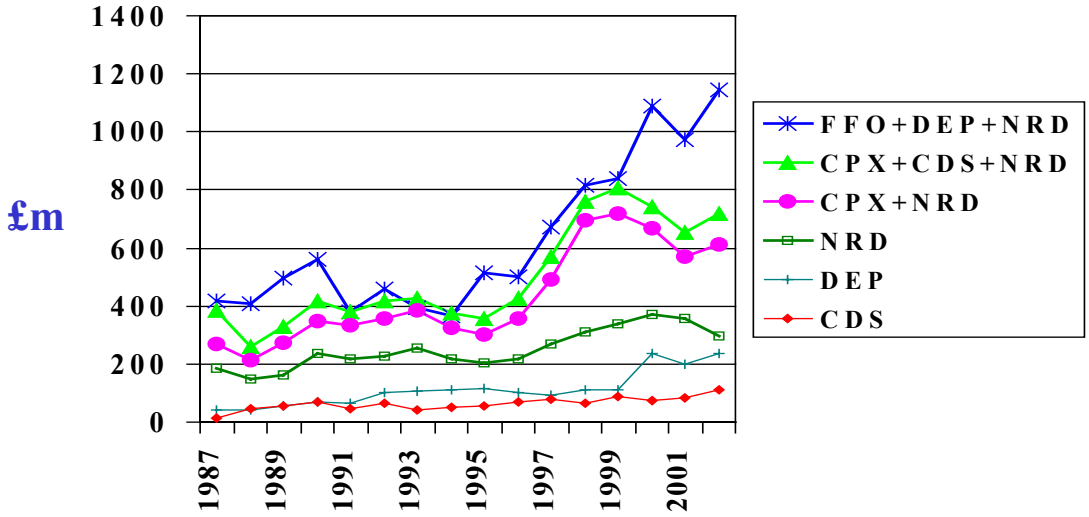


Figure 2. Rolls-Royce: Sources and Uses of Funds 1987-2002

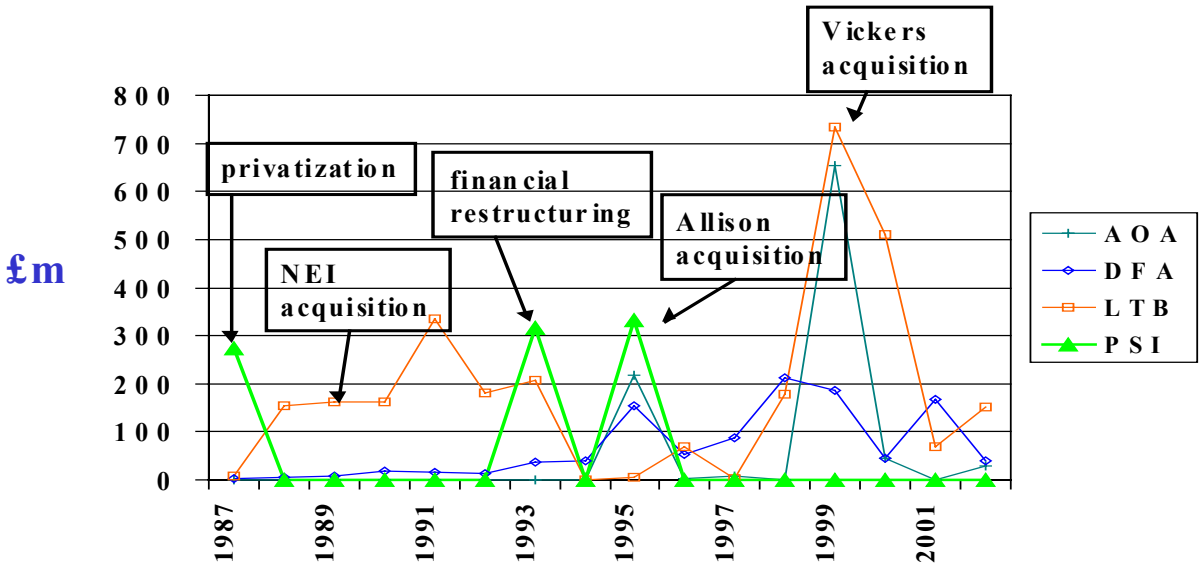


FFO=funds from operations; NRD=net R&D; DEP=depreciation

CPX=capital expenditures; CDS=cash dividends;

LTB=long-term borrowing; PSI=public share issues

Figure 3. Rolls-Royce: External Funding 1987-2002



AOA=acquisition of assets; DFA=disposal of assets

LTB=long-term borrowing; PSI=public share issues

[i] "Launching aid is an interest-free financial contribution to the launching costs of a civil aircraft or aero-engine project, repayable as a levy on sales and licences to the extent that these are achieved" (Department of Trade and Industry 1972, Annex A).

[ii] See also 'Rolls-Royce: middle-man or medler?, *The Economist*, December 27, 1975, 42; 'National Enterprise Board: Rolls-Royce of a problem,' *The Economist*, February 11, 1978, 112.

[iii] 'NEB and Rolls-Royce: Who needs a lame-duck hospital?' *The Economist*, November 17, 1979, 108.

[iv] See 'Industrial policy: Mrs Thatcher's awkward inheritance,' *The Economist*, May 5, 1979, 120; 'Rolls under Whitehall's wing,' *The Economist*, November 24, 1979, 83.

[v] 'The real problem is money,' *The Economist*, November 17, 1979, 108.

[vi] 'Investor Limit Up at Rolls-Royce,' *New York Times*, July 20, 1989, D5; "BAe, Rolls-Royce foreign ownership limit raised to 49.5 pct from 29.5, *AFX News*, March 12, 1998.

[vii] For an application of this framework, see Carpenter et al. (2003).

[viii] 'Rolls-Royce plc Interim Results 1993,' *PR Newswire European*, September 2, 1993.

[ix] 'Royce-Royce 1 – Right Issue Offsets Rationalisation Costs,' *Extel Examiner*, September 2, 1993.

[x] 'Official Correction: Rolls-Royce – Rights Issue,' *Extel Examiner*, September 2, 1993.

[xi] 'Extel Financial Exclusive: Rolls-Royce to Fund "R&D at Highest level Ever" – Chairman,' *Extel Examiner*, September 2, 1993.

[xii] Some foreign investors had already been forced to sell their holdings to comply with the limit. Meanwhile Rolls-Royce lodged a request with the government to raise the limit to 49.5 %.

[xiii] 'Rolls-Royce Buys Allison Engine.' *European Information Service*, January 5, 1995; 'Clayton, Dubilier & Rice Completes Sale of Allison Engine Company to Rolls-Royce,' *PR Newswire*, March 24, 1995.

[xiv] 'Popular Shares: R-R ahead of Allison OK,' *Investors Chronicle*, February 10, 1995, 54.

[xv] ADRs track a foreign-based company's share-price movements on its home stock market, but obviate the need for US holders of these securities to assume the exchange-rate risk of holding the actual shares.

[xvi] 'View from City Road: NEI an "add-on" for Rolls-Royce,' *The Independent*, April 11, 1989, 25.

[xvii] 'Rolls-Royce and NEI to Merge,' *PR Newswire European*, April 10, 1989. Also N. Garnett, "Rolls-Royce to But NEI in Deal Worth £300 Million," *Financial Times*, April 11, 1989, 1.

[xviii] Ibid.

[xix] "Rolls-Royce plc: Proposed recommended offer for Vickers plc from company for £576m*," Global News Wire*, September 20, 1999.

[xx] "Vickers plc – Recommended cash offer – Part 1," *Regulatory News Service*, September 20, 1999.