Failed Technologies

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Abstract. We are all very aware of technologies that have changed our lives - the microprocessor, the jet engine, the mobile phone, etc... There are also, however, technologies that were going to change our lives, or at least were expected to succeed, that disappeared instead. This project will look at such technologies - ones that were developed but failed to find a market, were predicted but never materialised, appeared but had no real impact. It will look at the reasons behind these failures: technical, financial, social, etc., and consider what lessons they offer for predicting and planning the technologies of our future.

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CHAPTER 1

Introduction

"There is no reason for any individual to have a computer in their home."

Kenneth Olsen,
President and founder of Digital Equipment Corp., 1977.

"No possible combination of known substances, known forms of machinery, and known forms of force, can be united in a practical machine by which man shall fly long distances through the air."

Simon Newcomb (1835-1909), astronomer,
head of the U.S. Naval Observatory.

As can be seen from these quotes, it is by no means easy to predict whether a certain technology will succeed or fail. However, this report will attempt to investigate the general causes of technological failure and to try and draw conclusions of common reasons why technologies do not succeed. But before we start looking into specific technologies, we must ask certain questions: what exactly is a "technology", and under what circumstances can it be defined as "failed"? The word "technology" is mainly used these days in the context of scientific advances, such as improved computer processor speeds, and improved data storage such as DVDs. This was not always the case of course, and as we will see, everyday items such as sewing machines were considered to be technological advances in their time.
So firstly, an important distinction needs to be made between an invention and a technology. There are several dictionary definitions of an invention, such as an item "the contrivance or construction of that which has not before existed."[1] This does not necessarily fit our purpose, as there are several products or services available that are simply improvements on a previous product or service, and so might not be considered as new. An example of this is the dot-com revolution, which was not a new service, but a new application of the existing service of The Internet to the market of buying online. A more appropriate definition comes from a technology as a "practical application of science to commerce or industry."[1] This encompasses a wider range of products or services from which to gain information. The next definition we must tackle is what exactly a failure is? A common definition would be a technology that is not commercially successful, but this does not show the whole picture by any means. If you ask the average consumer on the street which is a more successful computer operating system, Windows or Linux, almost all would say Windows, as most would likely not even have heard of Linux. However, this does not account for the purpose of the respective systems: Windows is designed to be a consumer product for home use, and therefore to have public awareness of its existence is important for its success. On the other hand, Linux is designed for the specialist computer user, one that has different requirements from the home user, and knows enough to differentiate between operating systems. It is also available for free in many versions, so its commercial success or popularity is not a good indication of its overall success. The definition we will use for identification of failed technologies is "an event that does not accomplish its intended purpose."[1] This seems to most accurately describe the technologies that we have investigated.

[1] www.dictionary.com

However, it still does not account for all cases. In the 19th century, an idea was put forward to print rubber newspapers in order for people to read them in the bath. Unsurprisingly this "technology" did not have much of a market, but there is one rubber printing house still operational in the world. This printing house now produces rubber newspaper almost entirely for use as dogs' toys. According to our definition the rubber newspaper is a failure, but has obviously found other commercial uses! Using these definitions, we will firstly examine three major case studies that have many important factors involved in their failure, and discuss how these factors influenced the technology's downfall. Then these factors will be formed into more general themes, and discuss how these themes relate to other examples of failed technologies. Conclusions will be drawn from these themes as to common reasons why technologies do not succeed, and finally, we will attempt to make predictions on the success or failure of technologies currently in the development stages.

The three major case studies that have been included inthe main report were chosen because between them they encompass all the reasons for failure that we discovered in our research.

The dot-com case study was chosen as it highlights the role that marketing and social factors play in the potential failure of a new idea or technology. It is also a very recent example that is still fresh in many people's minds.

At first, the nuclear power case study may not seem like a failed technology but, according to our definitions, nuclear power has not succeded in its intended purpose: To be the main supplier of energy in the UK. It also shows interesting political and economic factors that contributed to its decline.

Finally, the OS/2 Warp study is a classic example of the way in which lack of communication and cooperation between collaborating compaines can cause a project to be unsuccessful.

CHAPTER 2

Case Study: Dot-Coms

> "No possible combination of known substances, known forms of machinery, and known forms of force, can be united in a practical machine by which man shall flay long distances through the air."
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> Simon Newcomb (1835-1909), astronomer, head of the U.S. Naval Observatory.

The end of the 1990's spelled a very important time for communications across the world. Mobile phones were becoming commonplace, and for the first time ever a cheap alternative to letters, faxes, and telephone calls was emerging. The Internet revolution was beginning and it was now possible for small businesses and especially the home user to afford to connect to The Internet, browse websites and use electronic mail. With a large usage of The Internet emerging, the possibility of being able to reach a large number of consumers at a relatively cheap cost was realised by groups of entrepreneurs. The Internet appeared to be an ideal medium for selling goods or services from websites because overheads would be extremely small compared to a standard high street chain store and the possibility of reaching not just a local, but a national or worldwide market. The dot-com boom as it later became known, had just begun.

Within two years, dot-coms had hit the news, mainly because of some catastrophic failures. San Francisco based Webmergers, which provides matchmaking services for buyers and sellers of technology companies, said the plugs were pulled on at least 537 Internet outfits in 2001: more than double the number logged in the previous year. The two main reasons many of these novelty websites had vanished was because of their failure to secure capital and of rampant spending with little calculated projection for return on investment. Many thought that investing huge amounts of start-up capital to acquire customers would lead to a retained market share in the future. Instead, the huge investment blitz only contributed to their demise. The wild successes and dismal failures of Internet initiatives have presented a wealth of learning opportunities and new ideas.

So what actually happened to the huge potential that the dot-coms were founded to take advantage of? The answer to this question gives a valuable insight into the reasons behind the failure of the majority of The Internet retailers and more generally, to why high technology innovations can very easily fail.

The single most fatal miscalculation investors made regarding The Internet was to massively overestimate the speed at which the marketplace would adopt dot-com innovations. That assumption of speed dictated the rapid pace and scale of investment by both venture capital (VC) firms and public investors: The resulting over-investment led to the inevitable bubble and bust. Too much money was the downfall of many companies as they fell victim to the temptation to gin up business plans to meet the size criteria of the typical venture capitalist. A typical VC firm, in order to justify the time it spends on an investment, needs to dispense firehose amounts of cash, implying that the recipient business must be fairly big. – able, say, to generate revenues of $50 million in three years. The resulting dynamic creates a sort of theme park of co-dependency. VCs dangle big carrots to encourage bigger thinking on the part of entrepreneurs whose DNA already is programmed

for grandiosity. The sad result is that many of these inflated business plans were over-funded. They were never destined for the $50 million world, but would have made nice $10 million to $20 million businesses had they been more appropriately financed.

The dot-com frenzy was fueled by dreams of extreme wealth for executives, employees and investors. This greed, driven by the founders and VCs, helped these new businesses to become public limited companies (plc) which then attracted the private and pension fund investors to speculate and add more money to an already vastly over funded bubble. However, it soon became apparent that nearly all Internet retailers were making huge losses as they continued to invest in more resources and budget for huge projected growth.

Billion-dollar statistics tell the tale of many dot-coms' ability to burn through enormous amounts of funding (a.k.a. other people's money) with little consideration for or accountability to spend wisely or earn a profit. Many dot-coms seemed more like groups of kids spending lavish allowances while playing with someone else's technology and sitting in someone else's designer office-chairs. Compare this with more patient large companies, or the thousands of small businesses whose owners start and maintain companies on personal lines of credit and shoestring budgets than demand mindfulness about which expenditures are the most cost-effective. This financial oversight both by investors and founders helped to contribute to the final downfall that occurred within the next two years.

Once investors saw no change in the initial losses made by Internet retailers despite grand financial plans, panic set in and shareholders tried to recoup their money before it was too late. Neither party had taken into account the real economic conditions at the time and soon the rapid economic boom that had bought the dot-coms to their height so quickly, led to their demise. Current investigations suggest that Wall Street analysts, immersed in a conflict of interest, issued false reports to encourage small investors to buy stock. Unfortunately, the hole in the economic bubble that had artificially been created by the massive hype of dot-coms, had been one of the contributing factors to the failure of this extremely innovative technology. The financial issues that the Internet retailers eventually suffered from were caused because they believed there would be a never-ending stream of money from investors and their market base was large enough to reach consumers worldwide. This led to some failed dot-coms believing that Internet-based companies were insulated from economic cycles.

Mortgage.com started as a company providing home mortgages over The Internet. During its early history, interest rates were falling and people rushed to The Internet to find the best possible refinancing for their home mortgages. However, when interest rates began moving up, people seemed much less attracted to originating mortgages on The Internet. As a result, Mortgage.com saw its customer traffic dwindle significantly. Despite attempts to refocus the company to gain added origination of mortgage business, the company simply had to cease operation. The companies had not accounted for the change in economic conditions. This oversight led to a number finding themselves out of business almost overnight since the market had disappeared as quickly as it arrived.

However, artificial economic conditions were not the only factor in the failure of this new technology. Resources were focused on fast-tracking the process to becoming a plc without adequate emphasis on a viable business plan, solid mission and inspiring vision. Paradoxically, the allure of riches brought waves of talented people. However, studies suggest that employees are ultimately most rewarded and show higher rates of job satisfaction and loyalty when they contribute to a workplace that has a larger purpose that aligns with their beliefs. This resulted

in people joining the companies because they were greedy and wanted a slice of the financial success. Employee turnovers were often as high as 75-percent. The outcome was that company directors got rich from the flotations, employees got laid off with little notice, companies failed and as already mentioned, most investors lost a lot of money – in some cases, life savings. The bad management of resources and the reason behind employees joining these companies was extremely unhealthy for dot-coms. This meant that people were uninterested in making a success of the businesses, since their whole motivation was in making lots of money very quickly in the boom bust environment that they were part of.

Another reason that the dot-coms failed was due to their marketing strategies. This might seem obvious, but many failed dot-coms operated under the assumption that selling products below cost is an effective strategy for gaining customers. Although this assumption may gain customers, if the strategy of selling below cost is maintained, failure of the organization is inevitable. A case in point is pets.com. Selling products below cost is often cited as the primary reason that it had to be shut down. For pets.com, delivery costs were a primary problem. Shipping products like an 18-pound bag of cat food was very expensive. Some at pets.com believe that patience would have yielded mechanisms to ensure breakeven and eventual profits. Getting beyond the harm caused by selling below cost however, proved to be too much of an obstacle to overcome. This marketing gimmick of attracting customers by offering low prices failed to work successfully and ultimately helped create the huge losses that caused massive financial problems for many Internet retailers.

Many dot-coms also failed in part because they spent millions of dollars of VC, and money from floating on the stock exchange, on the task of building brand awareness and acquiring customers. They worked on unlimited advertising and gimmicks, such as selling products at a loss, to attract more customers. These were not sound economic decisions since they repeatedly failed to work. This strategy seemed to be based on the assumption that the more money spent on advertising and marketing, the more successful the company would be. Boo.com, an Internet fashion retailer, was recently sold and relaunched under new management. Many believe that overly aggressive advertising expenditures severely weakened the original company. Originally, Boo.com spent a whopping $223 million in advertising and promotions, including a $42 million print and TV launch program. Overall, the company got a very meagre return on its enormous advertising investment. Essentially, by over marketing their companies, the dot-coms managed to channel too much money into advertising and running loss leaders, which helped create the financial problems that led to their eventual failure.

A big problem faced by the dot-coms during boom was whether somebody else would set up a company selling an identical product. With the growth of the technology almost overnight many dot-coms found themselves providing goods and services that were much like those of competitors. When the dot-com era blossomed, thousands of investors were only too happy to support an e-commerce start-up or anything with dot-com in the name. The words “online” and “e” gave companies the midas touch, regardless of industry, resulting in a kind of greed-induced mass hysteria. Rather than following a vision specific to, and suited for, the organization, dot-coms followed the few seemingly successful e-enterprises hoping to ride their wave. As with actual waves, there comes a time to break on the beach and the copycats that had no viable business came washing up to shore like driftwood. The possibility of this kind of cut throat competition led to “Getting to market first”, “urgency” and “speed is a competitive advantage” becoming common business mantras of the dot-com and high-tech world. Yet, the faster these organizations moved, the more they ignored signs of severe employee burnout, pending

droughts of funding, poor customer service, unfocused leadership, and diversions from the original vision and mission (for those that had bothered to define them in the first place). Each of these factors helped bring the e-meteor crashing to Planet Earth. The speed element of the competition put pressure on companies to offer services and products without checking if it was what the consumer really wanted or whether there was a viable business plan for the product.

The lack of planning at an early stage resulted in a lack of sound business plans, virtually ignoring even basic human-resource and customer-service requirements. Most dot-com leaders focused on expensive, splashy websites and a polished "Gen X" image. – An emphasis that didn't bode well for hundreds of the startups. Unfortunately, simply getting funding and building a technology infrastructure doesn't make a successful business. There has to be a need and a purpose to the enterprise (aside from spending someone else's money) for a member of the public to become a customer, and to then continue buying the products offered by dot-coms. Communication between the company and customers needs to be good, especially with an e-company where the consumer never meets the staff face to face, and the initial design needs to be successful. The lack of both these key requirements helps contribute to company failure.

The failure of dot-coms was not for any singular reason. Instead it occurred for a number of main reasons ranging from economic conditions and greediness by investors, to the lack of basic requirements such as communication, marketing and design. With too much money and no clear business plan most dot-coms were doomed to failure from the beginning. The mad rush by investors because of the marketing hype the Internet retailers created for themselves helped growth spiral out of control, encouraging people to start companies that were offering similar services so they could simply get a slice of the money from shareholders and VCs. The simple idea of selling goods and services over The Internet had led to a catastrophic failure that nobody managed to foresee.

CHAPTER 3

Case Study: Nuclear Power

"...any one who expects a source of power from the transformation of these atoms is talking moonshine..."

Ernest Rutherford, 1933 (1871-1937)

For centuries the generation of power using the principles of nuclear physics was though, even by those at the forefront of science, to be impossible. Taking the words of Albert Einstein (1932)

> "there is not the slightest indication that (nuclear energy) will ever be obtainable. It would mean that the atom would have to be shattered at will."

Despite much scepticism, such thoughts were clearly contradicted with the 1950's heralding the opening of the first commercial nuclear power stations. This created much interest amongst the general public and even greater excitement within the world of science –

"There is little doubt that the most significant event affecting energy is the advent of nuclear power... a few decades hence, energy may be free - just like the unmetered air..."

John von Neumann, scientist
and member of the Atomic Energy Commission, 1955.

However, "a few decades hence" has seen the rise and, in recent years, fall of nuclear power. The following case study investigates the highly debatable issues surrounding the nuclear power industry as a whole, in addition to raising significant questions regarding the viability and long-term future of such methods of power generation.

The science of atomic radiation, atomic change and nuclear fission was developed from 1895 to 1945; however, between 1939-45, as a result of the outbreak of World War II, development was focused on the atomic bomb. Following the end of the war in 1945, research and development was focused to harnessing this energy in a controlled fashion for the production of electricity, in addition to naval propulsion. Since the first commercial nuclear power stations started operation in the 1950s, the nuclear power industry has steadily grown and there are now some 440 commercial nuclear reactors in 31 countries worldwide, supplying over 350,000MWe of total capacity. This translates to 16% of the world's electricity, as base-load power, and the efficiency of such power production is increasing. In addition to reactors found in commercial nuclear power stations, 56 countries operate a total of 284 research reactors, thus providing a source of neutron beams for scientific research and the production of medical and industrial isotopes.

The number of nuclear power plants being constructed has slowed considerably in comparison to the development of such power stations during 1970's and 1980's; however, due to advances in both knowledge and technology over this period of time, partly as a result of the larger number of research reactors available, the efficiency of such methods of power production has increased. In 2001, nuclear power generated 2,544billion kWh, an increase in production of 4% (97billion kWh) over the previous year. The increase of 414billion kWh over the past seven years is equal to the output

from 60 large new nuclear plants. However, between 1995 and 2001 there was a net increase of only 3.5% in capacity, which equates to two reactors. This improvement in production is due to the increased efficiency and performance of existing plants. Despite nuclear power accounting for approximately 16% of the world's energy production, non-renewable fossil fuels are utilised in order to generate 64% of the world's electricity, as illustrated in figure 1;

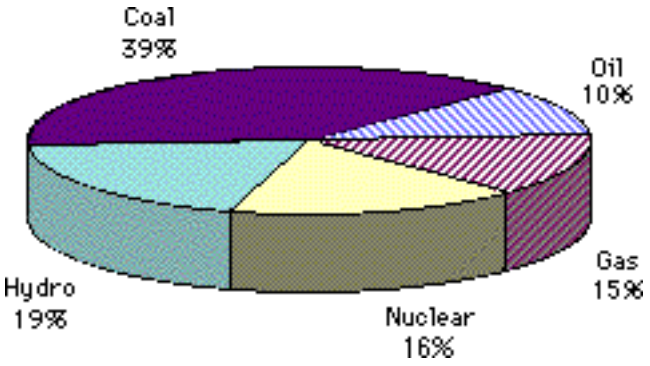

FIGURE 1. World Electricity Generation

In recent years the nuclear power industry in countries across the world has been under increasing scrutiny regarding issues ranging from the potential health risks posed by the waste products produced by the process, to the economic viability of such methods of energy production. The nuclear power industry in the United Kingdom is no exception. There is an ongoing debate regarding the use of nuclear energy to generate electricity and the use of such energy sources remains a contentious issue politically, socially and economically in terms of both ideology and physical facts.

Producing electricity utilising any form of primary energy has associated environmental effects which may occur either directly, or indirectly, as a result. One waste product of nuclear power plants is depleted uranium which although it is not classified as a dangerous substance radiologically, it is a potential hazard in large quantities. The most common form of depleted uranium, U-238, is a gamma emitter; therefore, even with trace amounts present, the material is difficult and hence costly to handle. Every year in excess of 50,000 tonnes of depleted uranium is added to the already substantial stockpiles in the USA, Europe and Russia, increasing the world stock, which at present is of the order of 1.2 million tonnes. This substance continues to emit low-level gamma radiation as a result of such depleted uranium having a half-life of 4.5 billion years (the age of the earth).

Despite much study and research, the information available regarding the occupational and environmental health effects of nuclear power is very conflicting. As with any subject matter, sources of information concerning nuclear power are written very subjectively with noticeable bias depending on the author's point of view on the issue. As a result of this, the general public form opinions based on 'subjective' facts, thus creating a difficult environment within which the nuclear power industry must operate. In addition to this, horrific accidents, such as that which occurred at the Chernobyl nuclear power plant in the Ukraine (former Soviet Union), heighten public awareness about the potentially devastating effects of such methods of power production. The radioactive material released in the explosion at Chernobyl was spread over a very large area of northern Europe by north-westerly winds (as illustrated by the maps shown in figure 2).

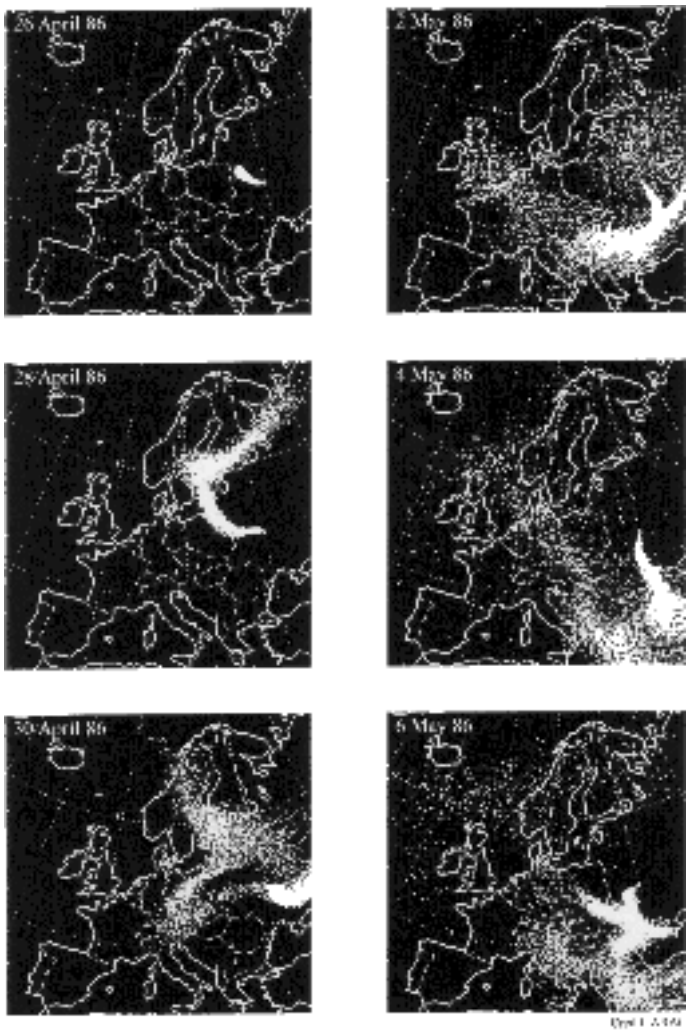

FIGURE 2. Aerial Photos of Nothern Europe

The effects of this accident are still very apparent today; therefore, due to it being such a contentious, highly debated issue, the discussion regarding the nuclear power industry has received a very high level of media interest and coverage. This often results in the operations of companies involved in the nuclear power industry being documented by the world's media; therefore, creating a very mixed, and in some cases hostile, view of the industry as a whole. Also, the potential for catastrophic accidents to occur within this field, such as that at Chernobyl, has severely reduced public confidence in nuclear power. Hence the reputation and credibility of the industry has been damaged. From the first, extremely controversial, application of nuclear physics, seen when two atomic bombs were developed and detonated in 1945 during the World War II, to present day with the current political tension regarding the reported stockpiles of nuclear weapons in Iraq, the hostile utilisation of nuclear energy is well documented. Hence, for more than four decades, concern has centred on the possibility that uranium intended for commercial nuclear power might be diverted for use in weapons. Even now with attention being focused on the role of military uranium as a major source of fuel for commercial nuclear power,

the association of the nuclear power industry with the production of weapons of mass destruction will remain; further damaging the nuclear power industry.

Since 1987, the USA and countries of the former USSR have signed a series of treaties agreeing to reduce their arsenals of nuclear weapons by 80% by 2003. The surplus nuclear material declared by the military, which is commonly highly enriched uranium (HEU), is being converted into fuel for use in commercial nuclear power stations by blending it down with other forms of uranium to produce LEU (Low enriched uranium). The HEU created from weapons stockpiles is displacing some 10,000 tonnes of U_3O_8 production from mines each year, and meets only around 15% of world reactor requirements. This process however, requires the transportation of radioactive material, which is slow and hence costly due to the safety regulations that must be met in accordance with legislation laid down by the International Atomic Energy Agency (IAEA), which acts as the "international inspectorate for the application of nuclear safeguards and verification measures covering civilian nuclear programmes". Such transportation often results in protest by anti-nuclear campaigners and action groups, particularly when the material crosses international borders; therefore, gaining media coverage and again bringing the contentious debate regarding the viability of the nuclear industry into the public eye.

The UK nuclear industry is currently in severe decline. British Energy plc (BE) is the United Kingdom's largest generator, producing one fifth of the country's electricity, with its core business being nuclear generation. At present, BE owns and operates 8 of the 16 nuclear power stations in the UK with a combined capacity of approximately 9,600MW. The remaining 8 are owned and run by BNFE (British Nuclear Fuels Ltd). British Energy was privatised in 1996 and is listed on the London and New York Stock Exchanges. However, since this privatisation, the company and the industry as a whole has been under pressure financially. (Figure 3)

From figure 3, it can clearly be seen that since 1998, two years after the privatisation of the BE, capital expenditure has increased by approximately 277% from £81million in 1998, with net funds falling from £10million in 1998, to a debt of £859million in 2002. The finances of BNFL are also in a very similar situation. In the past year alone BNFL have estimated that the company's liabilities have risen from £35 billion to £40.5 billion, hence with the nuclear power industry in Britain comprising of BE and BNFL, the industry as a whole is in serious financial trouble.

The poor state of the nuclear industry, in terms of both structure and finance, is a result of various factors. However, many of these have evolved as a result of organisational and managerial issues. One cause of the appalling financial performance of BE and BNFL, and hence the whole nuclear industry in Britain, is a gross lack of investment. The construction of Britain's first nuclear reactor to provide electricity was completed and later opened in 1956. Like most of the nuclear reactors built at this time, they had an intended operational life of 20 to 25 years. However, low public opinion and confidence in the nuclear industry has resulted in low profits and therefore little investment over many years. Therefore, the infrastructure has been neglected without forethought regarding the future of the industry. By 2010 all the nuclear plants owned and operated by BNFL will close, with the final closure of Britain's existing nuclear plants expected in 2035. As a result of this poor foresight into developing and modernising the existing nuclear plants, public opinion and confidence in the nuclear industry has decreased further, thus having a negative effect on the finances of the nuclear industry in Britain.

In addition to this, in the enthusiastic, early stages of this new and potentially revolutionary technology, the pioneers of nuclear power kept poor records and very

	2002 £m	2001 (restated) £m	2000 £m	1999 £m	1998 £m
1. Balanced Sheet					
Net assets	627	1,298	1,313	1,684	1,60
Net current assets	891	854	73	1,042	665
Nuclear liabilities (discounted)	3,719	3,728	3,770	3,762	3,790
Capital Expenditure	(225)	(133)	(137)	(78)	(81)
Net (debt)/funds	(859)	(730)	(936)	176	10
2. Ratios					
Dividends per ordinary share (p/share)	8.0	8.0	8.0	16.0	14.7
Special supplementart dividend (p/share)	—	—	—	—	10.0
(Loss)/earnings per share (p/share)	(88.5)	1.2	23.2	27.1	26.6
Business performance (loss)/earnings per share (p/share)	(8.4)	(4.2)	24.9	29.3	18.1
Dividend cover (based on business performance)	—	—	3.3	1.8	1.2

FIGURE 3. BE key financial data for 1998 to 2002

little documentation; therefore, when dismantling and decommissioning nuclear plants, engineers have very little information regarding the structure and design. This results in lengthy engineering operations, thus increasing the decommissioning costs of nuclear plants and hence damaging the industry yet further.

The City is also extremely sceptical of the nuclear industry, highlighting that a high proportion of BE's cash flows are eaten up by debt interest and decommissioning costs; therefore, BE will find it difficult to continue investing, paying dividends and meeting liabilities without a big change in the trading outlook. The scepticism of the City was strengthened in August 2002, when BE announced the closure of a second reactor at one of its plants. This resulted in the cutting of share prices to an all time low of 63p after having had a peak value of 728p only three years earlier. Such announcements of huge shortfalls in profits, by both BE and BNFL, have resulted in Government intervention in the 'privatised' market. In September 2002, the UK government announced that a £650million loan would be given to BE as a temporary measure, in order to prevent the company going into liquidation, which would have resulted in approximately 5,000 job-loses. However, in a privatised market, the financial aid given to a private company by the state is not only somewhat embarrassing for the government, yet also very damaging for the image of the nuclear industry and hence is another indication that nuclear power is not in the short and medium run. In addition to this, despite BNFL having a fund known as the 'nuclear liabilities investment portfolio', which is designed to aid the clean-up costs of nuclear power and has a value of approximately £4billion, the huge shortfall is to be funded by the taxpayer; which will decrease confidence amongst investors and the public. As a result of poor management and organisational decisions, lack of investment due to poor confidence in the City and amongst the general public, and hence a decaying infrastructure, there are real doubts about

the future viability of nuclear power and fuel reprocessing. The implications for the future of the industry are double-edged; however, any government intervention could make the prospect of new stations even less attractive to the public, whatever reassurances are given about the ability of new technology to minimise waste. Whereas the issues such as a warming climate and hence lower power prices in the market may not be predicted, financial, organisational and managerial problems may be foreseen through the analysis of accurate, up to date information regarding both technical and financial performance. Nuclear power is a highly contentious and politically sensitive issue and it is far from clear whether any profits can or will be generated in this industry.

CHAPTER 4

Case Study: OS/2

> "No possible combination of known substances, known forms of machinery, and known forms of force, can be united in a practical machine by which man shall flay long distances through the air."
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> Simon Newcomb (1835-1909), astronomer, head of the U.S. Naval Observatory.

In 1982 when the Personal Computer revolution was in its early days, IBM introduced its PC-XT that came with a choice of three operating systems. - CP/M-86, UCSD Pascal P-System and MS-DOS, licensed from Microsoft as PC-DOS. In 1983, Microsoft started development of Windows and in 1984 IBM released its 80286 based machine, known as the PC-AT. By this time MS-DOS had become the dominant operating system in the PC market, comprising mainly IBM and IBM compatible machines.1984 also saw the start of the collaboration between Microsoft and IBM on a new operating system that would become OS/2.

OS/2 was supposed to be a joint effort between both companies, but from the start each already had their own ideas about how they wanted things to evolve: IBM was insistent that the new operating system was to be compatible with its mainframe systems such as System/360 and System/370; while Microsoft was insistent that the new operating system be compatible with existing MS-DOS programmes. The computer arena at that time was rapidly changing and the desktop market that was beginning to unfold was completely different from the mainframe market of the past. This new market played by completely different rules and no one was yet established in the new market; it was too new. IBM wanted to be able to set the standards in the PC market like it had been doing in the mainframe market. On one hand, IBM wanted to offer its customers the features of its mainframes and on the other, IBM did not want the PC to overtake mainframes and push them out of the market. In effect, IBM was not taking the newly born PC industry seriously and did not believe that they would almost entirely force mainframes out of popular computing. This proved to be a big mistake. In an increasingly competitive world with the globalization of markets taking place and where technological advances were occurring at an exponentially increasing rate, IBM was not in any position to "throw its weight around".

Microsoft, on the other hand, was interested in promoting its own Windows "Operating System" which it designed to be smaller and lighter than OS/2 Warp. Microsoft believed that OS/2 Warp was becoming unwieldy and too much like a mainframe operating system and was not what the masses needed. Microsoft was not interested in the mainframe arena and wanted to spread the use of its own programs even further in the PC arena. Unfortunately, both companies were approaching the design of this new operating system from completely different angles and were guilty of addressing the problem in a narrow way. The fundamental mistake was clear: That both companies had their own agendas for the project. Microsoft was perhaps more interested in bringing the graphical features and ease of use of the Macintosh system to the PC and they thought that working with IBM on the project may help them in achieving this. Looking back now, it would have been more profitable for Microsoft to have developed Windows, which turned

out to be a huge success, on their own. Today one wonders why the joint effort was attempted in the first place since Windows has been so popular. However, it must be remembered that Windows was not properly accepted until version 3.0 and before this Microsoft may have been worried that they would be unable to get a foothold in the graphical software market. Joining forces with the biggest player in the field must have seemed like a safe option.

As time went by, each companys confidence in the other slowly eroded and in 1986, shortly after the company was made public, Steve Ballmer offered IBM a 30% share in Microsoft. By then, IBM was no longer interested. They continued development of OS/2 by themselves and eventually released OS/2 4.0 (or more commonly known as OS/2 Warp 4) in September 1996 - 9 years after the release of the original OS/2. The failure of OS/2 was primarily due to an inability or unwillingness on the part of both companies involved to communicate effectively. Both IBM and Microsoft sought to shape OS/2 into something that was good for themselves and that fitted into their existing structures. Neither company was prepared to be flexible enough for amicable agreements to be obtained. They continued doing things each their own way with IBM, in particular, not wanting to undermine its monopoly in the computing arena that it had been nurturing for many years. As Bill Gates once said, "IBM promoted all good programmers into management."[1] suggesting that IBM were haunted by a successful past and unsuited to the new, fast changing PC world.

OS/2 might have been made to succeed if the companies had worked together more closely and had been willing to compromise on respective views. Ineffective teamwork and a lack of communication meant that the project did not fulfil its potential and neither party ended up with what they aspired for. The failure cannot be blamed on the arrogance of the two companies alone: The PC revolution was still in its infancy. IBM was using tactics that has consistently worked for it before and was just beginning to find out that it was hard to fend off competition in a market where everyone was a beginner - IBM only had the lead because they shipped the first PC. Conversely, Microsoft was still a relatively new, small and inexperienced company which had made a lot of money from the license agreement with IBM to ship MS-DOS for a low fee with the PC-XT and then the PC-AT. They, quite understandably, thought that working with IBM was going to be a "winner".

[1] Bill Gates - The Road Ahead

CHAPTER 5

Themes & Analysis

> "No possible combination of known substances, known forms of machinery, and known forms of force, can be united in a practical machine by which man shall flay long distances through the air."
>
> Simon Newcomb (1835-1909), astronomer, head of the U.S. Naval Observatory.

Through the exploration and analysis of many case studies, including the 3 aforementioned examples, many correlations between these cases were apparent; therefore, it was possible to extract seven major causes of failure;

- Design
- Competitors
- Marketing
- Economic & Politics
- Resources
- Social Factors
- Communication

These seven causes will now be developed further, using examples from additional case studies researched.

1. Design

The aesthetics of a product or technology can influence its success in different ways. In the automobile industry, the way a car looks is very important to a customer, in fact people often pay as much attention to the aesthetics of a car as to its performance. A classic example of this is the Skoda. This manufacturer traditionally had a very bad reputation for performance and bad aesthetics, but in the last few years have completely redesigned their range of cars. At the same time, they launched a very popular advertising campaign which didn't settle for simply promoting the new design, but enhanced its appeal by making fun of the old designs, and people's perceptions of them.

In some cases however, aesthetics are more or less important depending on the particular group targeted. The first GUI (graphical user interface), MacOS, developed by Apple Macintosh, captured a large market share, due to its aesthetically pleasing design and ease of use; therefore, ensuring a niche market share for Macintosh for over a decade[1]. In contrast, console based operating systems, such as Unix, are considerably less user friendly yet provide much greater control for the user. This is also a niche market, largely used by programmers and computer enthusiasts.

As seen in the Tyrrell P34 example, lack of pre-production testing was a serious issue in the automobile industry, before computer-aided design (CAD) programs became available in the early 1980s. With access to such equipment, Tyrrell would have been able to model the P34's performance, and thus recognise the design flaws before such great and ultimately unnecessary capital expenditure.

[1]Mary Bellis, Inventors of the modern Computer, The Invention of the Apple MacIntosh and Apple Computers

Firms are often driven to produce items that increase the ease of the design process or take advantage of loopholes in legislative law. The Sinclair C5 was a small, three-wheeled vehicle powered by either pedal or battery and was designed by the entrepreneur Sir Clive Sinclair. Using this as an example, rather than a product to suit the needs and desires of the customer, the design of the C5 was tailored to take advantage of government incentives for producing low-emission, environmentally friendly vehicles; therefore, resulting in the production of a product that was undesirable to consumers.

The lack of battery technology was the main stumbling block for all forms of electric transport, including the C5; however, Sinclair chose not to invest in improving battery technology, and so ended up with a product that was let down by that very same lack of technology. Their view was that the existing battery manufacturers should be the ones to come up with the technology, thus relying on firms who had no interest in whether the C5 succeeded or not. When released, the main consumer complaint with the C5 was that the battery life was not long enough, and this made it inconvenient and unusable for most consumers, thus making the C5 a failure.

2. Competitors

Competitors can often be one of the largest threats to an emerging technology. Competing companies often use there size or brand name to influence customers view of new superior technologies with cheaper substitutes and propaganda.

New technologies almost always represent an enormous threat to competing company, making derailing the new technology in their interest. Companies are working hard to satisfy customers and implement customer relationship management, but doing this alone may not be enough to succeed when others do it better or faster with a newer technology. The complexity of the current marketplace demands flexible and quickly executed strategies in order to gain customer loyalty through superior customer relationships rather than a superior technology. There are several ways a competitor can go about this legally or illegally:

- Brand name propaganda
- Agressive price wars with existing substitutes
- Physically threaten competitor (not so common in modern times)
- Highlight and emphasize any and all advantages of existing substitutes over the new technology, keeping quite its improvements through propaganda
- Control required infrastructure or resources
- Given forewarning develop a successor

Brand name propaganda is usually not the only or primary reason for forcing new technologies out of a market however can still influence market shares of products heavily. An example of this is the video game console Atari linx which despite being technically superior compared to its Nintendo counter-part failed to claim a comparable market share[2].

A competitor can engage in aggressive price wars with its substitutes by drastically reducing their price usually to the point of making a loss in an attempt to bankrupt its competitor before raising its price again. An example of this was seen between British Airways and Virgin Atlantic on transatlantic routes.

[2]ATARI GAMES CORP. and TENGEN, INC., Plaintiffs-Appellants, vs. NINTENDO OF AMERICA INC. AND NINTENDO CO., LTD., Defendants-Appellees. 91-1293 United States Court Of Appeals For The Federal Circuit.
http://eon.law.harvard.edu/openlaw/DVD/cases/atarivnintendo.html

Competitors threatening inventors of new technologies with death is not very common in recent years, however was common place in past centuries. An example of this is Barthlemy Thimonnier who despite inventing the first sewing machine in 1830 was threaten by death after 200 competing tailors destroy his factory and forced him to flee Paris in bankrupt. The sewing machine was reinvented successfully several years later[3].

Given forewarning of a looming new technology of a competitor, a company may strive to release a successor to it at a similar time as the release of its competitor's new technology. This is done either through corporate espionage and/or step-up their R&D programs.

Competitors controlling a technology requiring an existing infrastructure or limited resource usually have government intervention with new technologies or lease use of the infra-structure however the can often be biased towards their product which are substitutes. Without government regulation of the telecommunications industry, BT could utilise its control of the existing infrastructure, in order to dominate this market.

In addition to this, competitors with a dominant market share, can use this monopoly position to gain great advantage over rival technologies, thus leading to their failure;

> "Microsoft Corp. Chairman Bill Gates, the world's richest man, made his first extended appearance in the antitrust trial of his company Monday, arguing in disembodied electronic form on a giant video screen that he and his company never tried to intimidate or hobble competitors in the technology industry." [4]

3. Marketing

After a product has been designed, prototyped, tested and actually constructed to its final specifications, the next step is to ensure that people actually use the product: That they actually want it and that they will pay money for it. A product may have been designed by the best designers available, have passed all it's prototyping and testing and work perfectly in every way, but if consumers can see no use for it, then they will not want it. Having said this, marketing is not just about what happens to a product when it is finished: Marketing should be considered throughout the development process. Marketing is part of the "vision" for the product. Marketing links the functions and services of the product to the requirements and needs of its users. A "good" product will have a clearly defined purpose. Marketing is about showing right people what the product can do.

If the product is "good" then its success now rests on marketing. Marketing is about 5 things:

- Identifying who needs the product
- Identifying what consumers need the product for
- Telling the consumer about the product
- Making the consumers believe that they need the product
- Making the product accessible to consumers

Good design dictates that, in the early stages of development, the product should have been targeted at a specific part of the market or a specific group of people. However, as the design progresses, specifics may change. It is therefore important to reevalutate where the product is required, and who can benefit from

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[3] "Sewing Machine", Microsoft®Encarta®97 Encyclopedia. ©1993-1996 Microsoft Corporation.

[4] The Washington Post, November 3rd, 1998

it, when it is complete. An application for a product may not be immediately obvious and it is only through reevaluation of the finished product, or maybe only further thought later on, that this application becomes apparent.

It is important that the consumers know what the product will do for them: How it will make their lives better or easier and how they will benefit from investing in it. If the product is to be released alongside another product, from a different company, that does a similar thing, then the new product must appear significantly better than the existing one in order for people to change. People will like to stay with a product or a company that they know and are familiar with. If the new product appears to offer something that the existing one does not, or if the new product makes a significant improvement over the existing one, then consumers will be less loyal to the brands and labels that they already have. It is important not only to take advantage of this lack of loyalty to win customers, but also to be aware of it when developing and marketing new products or upgrades to existing products.

If there is a gap in the market and a product is produced that fills the gap then informing people about it will be straight forward: The gap in the market was evident because people were expecting a product. Therefore, there is already an audience. Once a supplier knows what their product can do, and what it can be used for then, if consumers know about the product, the supplier can illustrate to them why the product will be useful, even invaluable, to them.

In the late nineties Acorn began developing a new RISC (Reduced Instruction Set Computer) machine called “Phoeb”. The announcement of this came before a fully operational prototype was produced; therefore, potential customers did not want to invest in an untested, unfinished product, thus resulting in poor advanced orders, in addition to reduced sales of its predecessor machine. If consumers are not expecting a product then there are many ways of advertising it to them. The method that is chosen will depend on, amongst other things, the type of people who are the target of the advertisment, where they will see the advertisment and, indeed, the nature of the product itself.

Once a product has been successfully advertised, it is important that it is accessible to the people who want it. This means not only must the customer be able to obtain the product with the minimum of fuss and effort, but they must be able to obtain the product at a price that they can afford. When setting a price for a product, it is important that the development, production and distribution costs are covered. However, it may sometimes be attractive to lower the cost of a product so that it is lower than the cost of an equivalent product from a competitor. If this is the case, then there must be some kind of long term plan in order to make money. - It maynot be necessary to make money on that particular product if there is a good chance of acceptance of the product enabling lots of money to be made further down the line. It is important to set out price boundries early on in the development cycle and then work to budget: There is no point in specifying a product for a group of people, only to find that none of them can afford the finished item. It is also important to decide how to deal with a project if it exceeds it budget: Should the product be scrapped, rendering all the money invested in it wasted, or should more money be invested so that the product can be made better and therefore eventually sell more.

Even if marketing is carefully considered, it is easy to make mistakes. There is a very fine line between releasing a product in the wrong place at the wrong time and making a success of the product. Where technology is concerened the time scales can be months. - If a product is delayed then it could “miss the boat”. If an innovation is concieved before it is needed then people will not be interested.

Despite all the precautions that can be taken and all the planning that can be employed, there is also a lot of luck involved in marketing a sucessful product.

Some products may designed perfectly, but they are not necessarily designed for the right consumer. Take the Nintendo 64, for example. When it was released in mid 1996, the Sony Playstation had already been on the market for six months. The N64 was the first 64-bit games console to be released, and consumers had high expectations. But all the game titles that were released for the N64 were designed for the 10+ market, as Nintendo have always had a reputation as a family-oriented company, and this was the traditional market for console machines. This was a mistake, as Sony was beginning to capture a new market of consumers that had previously not been associated with consoles. Due to the Playstation offering more adult-oriented games such as Resident Evil, twenty-somethings were attracted to the more mature themes that Super Mario didn't have to offer. Subsequently, the N64 was a flop, and with the release of the Playstation2 in 2001, Nintendo had to rethink their strategy.

4. Economic & Political

Interest rates have a large effect, on the amount people have available to spend and the amount people want to spend. It also has an effect on the amount of money people are likely to borrow. In periods of high interest rate, people are encouraged by this rate to save money in bank accounts, due to the higher returns that they can expect than in normal circumstances, and discouraged to borrow large amounts of money, due to the large amounts of interest they would have to pay back on loans. However, when interest rates are low, there is little incentive to save money, so this encourages spending. When marketing a new technological product, companies have to think carefully about the amounts of money people have available and are willing to spend. Luxury items are less likely to be bought in times when people have less money to spend, but essential items will be bought no matter what the economic conditions are.

A recession is a time when production falls and trade dwindles, and people spend less money. Like the situation with high interest rates, people are less likely to buy luxury products in times of economic recession. But recession has a much greater effect than high interest rates. During recession, the uncertainty over jobs, and lack of consumer confidence causes people to cut down their spending as much as possible and can often only afford to buy essential items. It does not necessarily mean that a new technology will fail in times of recession, if the technology is something that will save people money, the product will flourish. For example, genetically modified foods are much cheaper than non-GM foods, and inorganic foods are cheaper than organic foods. Organic foods have been very popular recently with all the major supermarkets selling organic items alongside other items. However, if there was a recession, people may not be able to afford the "luxury" organic foods, and that situation could cause the GM food technologies to flourish and prosper. Also if there were new advances in pesticides and fertilisers during a recession, these technologies would be a success. Unemployment has the same effect. If there is high unemployment, the population has less money to spend on luxuries and will want to try and save money. Although recession would cause some products to fail in the marketplace, recession can also cause problems in the development stage. A company would find it difficult to find investors for their new technology, because there were would be a general lack of confidence.

The introduction of sanctions by the government, either by placing limitations on levels of production or requiring a company to gain official authorisation to enter

or remain in a given market (e.g. broadcasting licences or pharmaceutical products) can result in failure. Taking the case of the pharmaceutical industry, products must pass tests carried out by government scientists[5] and be given approval before entering the market, which is not guaranteed, despite extensive research and development, at considerable cost. Also, it simple may not be feasible to enter the market, given the stringent sanctions enforced by the government. Such sanctions may be introduced to monitor business practise, protect consumers' interests or to simply maintain a controlling influence on the technology or market as a whole. This often introduces much 'red tape', thus preventing companies from operating with the optimal level of efficiency; therefore, reducing the ability of the company and hence technology to compete in a given market.

The outbreak or threat of war can cause failure for a number of reasons. The effect on the economy of the country, in addition to individual markets, particularly technological industries, can result in the failure due to financial reasons. The heightened fear of terrorist attacks following the attacks on the World Trade Centre[6], for example, has increased the fear that nuclear facilities could become targets; therefore, increasing the contentious nature of the nuclear power industry, thus reducing confidence amongst city analysts[7] and ultimately leading to the failure of the nuclear industry. Also, the research and development of a product or technology may be halted or reorganised to concentrate efforts on areas relating to national security; thereby, increasing the likelihood of the failure of a new technology in a market, due to inability to maintain research and development at levels, resulting in a likely reduction in market share and a firms competitive advantage over rivals.

The imposing of taxes, whether paid by the manufacturer, for example due to tax on raw materials, or on the completed product and thus payable by the consumer, may result in the failure of a given technology. This may, for example be due to a lack of demand, as a result of increased prices and thus consumers' unwillingness to pay, or an inability to maintain or develop a competitive advantage over rival companies or technologies due to increased capital expenditure. For example, according to the former executive chairman of British Energy, the climate change levy (a single stage tax payable by business on fuel as a specific rate per nominal unit energy) resulted in increased business rates[8]; therefore, contributing to the failure of the nuclear power industry. In addition to this, products that are categorised such that tax exemptions apply, are often adopted by manufacturers with the expectation that such tax savings will be desirable to the consumer. However, the Sinclair C5 was designed to meet new government incentives, such that owners would enjoy exemption from insurance, road tax, crash helmet and even a drivers license; therefore, placing substantial limitations on the design specification of the product.

Laws can in many situations restrict technological development and stifle innovation; therefore, limiting the viability of production which may result in failure. For example, despite being in place to protect the public, the stringent laws regarding the treatment, transportation and disposal of nuclear waste in the nuclear power industry, has created much hostility from lobby groups[9], in addition to

[5]Medicines Control Agency - http://www.mca.gov.uk/

[6]BBC News Online, 7 March, 2002 - http://news.bbc.co.uk/1/hi/uk/1860358.stm

[7]The Observer, 18 August, 2002 - http://www.observer.co.uk/business/story/0,6903,776228,00.html

[8]The Observer, 18 August, 2002 - http://www.observer.co.uk/business/story/0,6903,776228,00.html

[9]Green Peace Nuclear Campaign - http://www.greenpeace.org.uk/contentlookup.cfm?CFID=361075&CFTOKEN=48246511&ucidparam=20021018152847

anxiety amongst the general public; therefore, heightening the awareness[10] of the sensitive, somewhat controversial issues regarding the industry, hence ultimately making nuclear power production less viable.

Regional politics may result in the failing of a particular technology, for example a feasible, successful technology in one region may fail to succeed in another, due to variations in any of the aforementioned political parameters.

5. Resources

Before we look at this in more depth, it must be noted that a resource doesn't just mean a natural resource such as oil or coal, a resource can mean many other things such as human resources, even time should be included as a resource. One dictionary definition of a resource is "An available supply that can be drawn on when neededx". A technology can fail due to a resource because its cost is too great, the resource could be too rare, or the resource could be lost midway through the project. These will now be discussed in more detail.

5.1. Cost. The cost of resources is a major factor in technological projects. This cost can cause a technology to fail for many reasons; the project may be too expensive to develop, or too expensive to produce, it may cause the final product's price to be too great.

International markets and cartels control many resources' prices. For example, the cartel OPEC controls oil prices throughout the world, and there is an international price for diamonds. If there is a new technology that is dependant on a particular resource, either directly or indirectly, and the price of that resource changes during or after the product has been developed, that could have a huge effect on the success of that technology. If this price change occurs during the development stage of the project, or even if the price remains the same, but the development requires a larger quantity of that resource than originally planned, a decision has to be made on whether to continue with the project. These decisions are often a very fine line, and some projects will be cancelled even after huge amounts of money have been spent on them.

One technology that was perhaps perceived as a failure at an early stage of the technology was the automobile. Before Henry Ford started manufacturing his Model T, cars were incredibly expensive, and very few people could afford them. There were very few cars around, and certainly not any of the motorways or highways that we see around the world today. At the time this technology could have been thought of as a failure. Why would anyone need a car anyway? They couldn't travel the long distances cars of today can. A horse and cart could do just the same job but was much cheaper. It failed because of the enormous cost of the materials used to build the cars and in deed, the cost of the human resources of the technicians and engineers who built them. Then in 1913, Henry Ford started to produce his Model T on the world's first production line (with the help of Frederick Taylor) and from that moment onwards, the automobile was a technological success - one of the major successes of the last century.

5.2. Human Resources. It is vital to have the right people working on a project. The wrong people with not as much skill or expertise could cause a project to last months longer, if not fail. But of course human resources cost money too; what is better value for money, hiring the best (and most expensive) engineers and technicians to work on a project which would make the project manager very confident about the completion of the project and in a reasonable timescale, or pay

[10]Green Peace Press Releases -http://www.greenpeace.org.uk/contentlookup.cfm?SitekeyParam=G-A

less for not such good engineers and having the risk of the project failing or taking too long?

The management of human resources is extremely important, but even if this is done well, other human resource issues can lead a project to failure. What if the chief engineer becomes ill? What if he dies? Can he be replaced? There are some projects where the chief designer or engineer is such a specialist in that particular field that he is irreplaceable.

There are also instances of a chief engineer dying midway through a project who in some case can be irreplaceable if that person is a leading expert or the only person with certain skills and/or knowledge. This of course is down to luck, which makes it impossible to stop or plan for. However, if there is strong opposition to the project the loss of a human resource is not always down to luck. As in the case with the world's first sewing machine, the inventor did not pursue with this after his factory was attacked and he received death threats[11]. Although a similar situation is unlikely from competitors today, other groups of people such as animal rights protestors have used similar tactics against scientists working in animal research. The organisation or individuals in charge of the project must consider this and take necessary security precautions to ensure the safety of their staff, in particular someone who has irreplaceable skills or knowledge as they would be most at risk.

6. Social Factors

Technology and society are inseparable. The design, development, adoption, utilization, and diffusion of technology are inherently social processes. As Howard Segal writes in his book Future Imperfect (1994), "all structures and machines, primitive or sophisticated, exist in a social context and, unless designed for the sake of design itself, serve a social function". Technology and society interact and influence each other, sometimes benignly, other times violently. Technology impacts, shapes, and defines society and, in turn, a variety of social factors affect the development, implementation, and spread of technology.

All technologies impact the society in which they are used. Toffler (1970) succinctly describes technology's impact when he writes that "new machines do more than suggest or compel changes in other machines – they suggest novel solutions to social, philosophical, even personal problems ... they alter man's total intellectual environment – the way he thinks an looks at the world". Segal (1994) adds an important point when he writes that "if, as in the significant case of the auto, modern technology solved a number of problems, social as well as technical, from the outset it simultaneously bred or helped to breed several others, social and technical alike".

A number of factors play a role in determining the rate at which an innovation or new technology will be adopted. It can be said that the technological superiority of an innovation plays a relatively minor role in determining its success. Many other factors, most of them relating to the social factors present at the adopting site, play just as large a role as technological superiority in influencing the success or failure of an innovation.

As discussed earlier in this report, technological failure is not only defined by commercial success, whether in terms of quantity sold or popularity. However, many products that adopt such technological advances are then used commercially solely for financial gain; therefore, in order to succeed, such products must be commercially viable and create demand amongst consumers. Hence, whether or not the product sells depends on the consumer, and because the way in which they behave, think or react is hugely influenced by the society they belong to, society ultimately decides the success or failure of the technology. This contributed to the

[11] http://www.dincum.com/articles/history_res.html

failure of the C5, which was designed for use by any member of society of any age. Parents, however, due to the low design and thus poor visibility to other road users, were apprehensive to use the vehicle, let alone allow their children to drive it and this lack of demand was clearly visible in the sales figures of the C5.

Different religions have different beliefs and values which may affect the way people look at or react to certain products or technologies. For example, Catholics do not believe in birth control; therefore, products such as contraceptive pills and condoms would have a low chance of succeeding in a society where most of its people were strictly followed Catholicism. However, certain beliefs and values may be common in more than one religion or are just generally present in the society due to the way people live or raised. For example, the belief that God is the Creator is something that many people live by, and as remarkable an achievement it may be for mankind to create another man, the creation of a human being through science is something that will never be accepted in many societies. It is something which many believe is wrong because moral boundaries have been crossed. Despite being advanced and technically perfect, cloning, genetic engineering, cryogenics and organ farms may never succeed in this world for their intended use, as a result of the religious and moral factors involved.

The judging of what is right or wrong is highly subjective. One can argue that God never intended us to create another human being. Conversely, did he mean for us to create artificial hearts to help heart patients, prosthetic limbs to enable accident victims to walk again or to transplant kidneys to another body so that someone can lead a normal life? It is clear that there is no one law that governs the way in which a society thinks. The views of society can change depending on the situation, such that something that may not be accepted at present, could be accepted in years to come.

A technology or product may be successful initially for all the benefits or usefulness that it was designed to bring about, and it does so, but then later labelled a disaster because it led to effects or events that were never intended to happen. Take Group B rally cars for example. In the 1980s, Group B cars were introduced to the world rally championships, which saw cars like the Ford RS200 that produced up to 800 horsepower. They were literally F1 cars on the road. Subsequently, the number of deaths during these championship events increased dramatically and these included both drivers and spectators. This continued the following years and not long after, these cars were banned and new rules had to be introduced. However spectacular these cars might have been or how much entertainment they might have brought to viewers worldwide, society just cannot accept the consequences.

A society goes through different generations and eras. Every community goes through changes and as time passes, the peoples' views, needs, wants and behaviour change as well. In some societies they may change faster than the rest, but in others, they may not change at all. An innovation may fail because it is simply at the wrong place at the wrong time. It may be not wanted by people now but might have succeeded with the next generation of people. On 28 March 1819, The Klonische Zeitung (Kln, Germany), listed a number of objections against the introduction of street lighting. For example, "morality deteriorates through street lighting. Artificial lighting drives out fear of the dark, which keeps the weak from sinning/*ldots*". Despite being a somewhat radical example, such views would be highly contended in the present day!

Trends in society also play a role in a technology failing. Just a few years ago, start up companies were all the rage as .dot coms began sprouting out of nowhere. Following the success of a small number of pioneering internet companies, others believed such a business could be established with little capital, knowledge

or experience. Many people tried to enter the industry yet failed to succeed because they merely followed the trend, without vision, forethought or proper business plan.

Thus, it can be seen how social factors play a part in causing a technology to fail. A product may be a total failure in one society, but a huge success in another. It may flop now, but then 10 years later, everyone needs it. Whether or not a product fails or succeeds sometimes cannot be calculated. Society cannot be predicted, just as life is unpredictable.

7. Communication

The basic concept of communication in a task can have a huge impact on the eventual success of a project. When looking at failed technologies, a lack of communication between individuals, departments or companies can often be a major contributing factor or the reason that a project failed. Communication is one requirement that is vital for any company to run effectively. A lack of internal or external communication can result in work being missed out, duplicated, or if there is no communication with the customer, the wrong product or technology could even be produced.

In a lot of failed concepts such as the satellite phones and the CT2 cordless phone the reason for failure has laid in the failure of communication between the possible consumer and the producing company or consortium. The satellite phone is an extremely successful piece of technology technically because it works where other phones such as GSM don't, however the price for the service has driven it out of the consumer's affordability. However, if the company had known how many customers they would attract from the start by speaking to consumers, Motorola would have realised that it would not be economically viable for a commercial service because consumers wanted cheap calls and service in a small package. The CT2 cordless phone failed as well because consumers wanted to be able to get incoming calls anywhere and whilst CT2 could not offer this, GSM could. If communication had been effective between the consumer research area and the development section, it is likely the CT2 phone would never have existed.

Sometimes it is the communication between companies that jointly develop something that can be to blame for failure. In the production of OS/2 Microsoft and IBM did not communicate with each other effectively and were essentially working towards different goals. It is therefore not surprising that the new operating system never took off as it was intended to. The same can also be said for Acorn and their new RISC PC called Pheobe that never got past the working prototype stage, despite lots of market hype. This was a failure because Aleph One never produced the Pentium compatible chip in time. The result of this meant that it was not a viable competitor to the cheaper and widely accepted "Wintel" solution. If there had there been better communication between Acorn and Aleph One then possibly the RISC PC would have taken off because it would have been a viable and more flexible option at the time.

Essentially if the developer does not know what the consumer wants, or what its partner is doing, then it is quite unlikely that a product will succeed in a market place that might already have similar technology competing against it. While it is not always communication that plays the pivotal role in whether a technology fails it is often a large contributory factor, and a company which has a non-effective communication structure cannot expect its technology to survive unless it is large enough to dictate to the consumer that it wants its product (such as Microsoft), or that there are no other comparable technologies.

CHAPTER 6

Mindmap

"No possible combination of known substances, known forms of machinery, and known forms of force, can be united in a practical machine by which man shall flay long distances through the air."

Simon Newcomb (1835-1909), astronomer,
head of the U.S. Naval Observatory.

CHAPTER 7

Conclusion

"If the world should blow itself up, the last audible voice would be that of an expert saying it can't be done."

Peter Ustinov.

At the very outset of the project, our first thoughts were that the definition of a failed technology would be a product that was not commercially successful, or one that had an unfeasible implementation. It quickly became apparent that this was a typically narrow and dated view, and that we needed to concisely redefine the definition of failure in order to analyse and evaluate which technologies have failed and reasons for their failure. For example, one of our first ideas was that DAT (Digital Audio Tapes) technology, used for studio and live recording of music, was a failure, purely due to its lack of success in the commercial market. However, following this thought, it became clear that the technology, despite not being marketable for the home user, is widely used in professional applications such as recording studios[1]. This niche market has made the technology a success, however this clearly contradicted our original definition.

Having identified our definitions, our main expectation in examining failed technologies was that there would be one or two main reasons for any given technology to be unsuccessful. During our research, it became very apparent that modern technologies have a multitude of reasons for failure, and that these often had knock-on effects on each other, as illustrated by the dot.com case study. What was even more surprising was how significant the roles of social factors and communication were in these cases.

We did not expect social trends to affect the consumers image of a product to such an extent that it became commercially unviable, as contributed to the downfall of the nuclear power industry in England. It was also surprising to see how many technologies produced from joint ventures have failed due to poor communications between the companies involved, as occurred between IBM and Microsoft in the development of the OS2/Warp operating system.

Another interesting point was the way in which reasons for failure have changed over the past century. The complexity of technological development programs has increased dramatically in the last hundred years, and corporate size and complexity has grown with it, thus accentuating the reasons for and increasing the frequency of failure. There are so many factors involved in starting a project that need to be considered, companies in the present day almost always undertake feasibility studies to assess the likelihood of success.

Despite having identified seven general areas relating to technological failure, some of these were found to be considerably more influential than others. From our analysis of the examples and case studies, it became apparent that design and marketing were most prevalent. This is very surprising as both these factors are under the complete control of the manufacturer and have no outside influences. It seems as though human error, whether on the part of individuals (as in the case of

[1] 1

the Sinclair C5) or the company as a whole (for example the Acorn RISC PC), is one of the largest causes of technological failure.

Another interesting and somewhat unexpected conclusion that can be made, was that the two main factors identified are independent of one another and therefore cannot influence each other. Whereas the design of the technology is primarily concerned with the way in which the final result can be achieved, marketing relates to the intended purpose and the functionality of the product or technology. Hence, it is clear that marketing cannot influence design and vice versa; however, communication is an important foundation for both these factors and is vital in order to achieve a successful design and marketing strategy. This can be concerned by the success of GSM (Global System for Mobile communications) phones. Initially the GSM phone was aesthetically similar to the satellite phone, which was its main competitor, yet due to the versatility of its design, such as its ability to work indoors and its strong marketing campaign, promising cheap handsets and calls, it has dominated the global mobile telecommunications market. It has been noted that marketing was and still is a highly prevalent element in the success of a product or technology. In todays society and competitive market place, this has become more crucial than ever with the development of new forms of advertising media and the increasingly materialistic behaviour of consumers.

Although it was discovered that design and marketing were independent factors, the other recognised factors are both heavily and complexly linked. Attempts were made to analyse these links in more detail, yet it was found that through the extrapolation of possible extreme situations, these links became overly abstract and diverse, thus making their use for analysis rather vague. Also, these components are external influences and therefore extremely difficult to control, unless the company in question is a monopoly within the market, such as Microsoft. Hence company resources would be put to more valuable use concentrating efforts on design and marketing, whilst ensuring that both internal and external communication is maintained to a high level.

CHAPTER 8

Prediction

"It is difficult to say what is impossible, for the dream of yesterday is the hope of today and the reality of tomorrow."

Robert Goddard (1882-1945).

Why bother studying the history of technology failures? Well the answer is extremely simple. We study the past, so we can understand the present, and also to predict the future. The key being that, by examining the reasons for previously failed technologies, we may have more chance of predicting whether something will be successful. These predictions have the potential to save the huge resources that are ploughed into new technology, and the ultimate embarrassment of failure.

Communications technology over the last decade has been a substantial growth industry across the world. There have been catastrophic failures such as the dot-coms, satellite phones and CT2 phones, but there have also been huge successes such as the GSM network and ADSL Internet technology. With the high stakes involved in these potentially risky technology areas, it would be extremely useful to be able to predict whether a new technology would be a success.

After examining a number of case studies, the group was able to draw a number of reasons for these failures, and by examining these common reasons it was possible to see a pattern for failing technologies. These patterns helped to produce a model showing which reasons were found to have more of an effect on the failure of technologies, and also gave the possibility of using this information to predict the failure of future technologies.

Although the IEEE 802.11[1] wireless networking standard has been around since the 1980s it is only recently that wireless local area networks (WLAN) using spread spectrum technology have started to take off. With the success of basic WLAN in the office and for the home user, telecommunications companies have been looking for a way to harness this technology and use it to increase their revenues. Their solution has been to come up with an idea of access points in busy areas such as airports, railways stations and shopping centres in a similar system to the failed CT2 cordless phones of the 1980s.

So will public WLAN technology be a success, or will they meet the same fate as the CT2 cordless phone networks such as rabbit and mercury callpoint nearly two decades ago?

The groups analysis of failed technologies showed that there are 2 major factors that feature in most failures, so considering the design and marketing of the technology should help to give an insight into the success of public WLAN services.

WLAN is already an established working system that has been catching on with home and business users because of the recent price reduction and ease of setup[2]. There are also a wide range of different network adapter cards on offer for devices that people use on the move such as PDAs and laptops, which do not have the problems of being big and bulky like satellite phones did. Essentially the new

[1] www.ieee.org

[2] http://news.bbc.co.uk/1/hi/sci/tech/2045483.stm

technology is building on an earlier, successfully designed technology, so it should not fail for design reasons.

The second major factor connected to failure is marketing. This has become particularly important this century since to make money and be successful people need to buy the technology. BT and a number of other suppliers have already launched their WLAN services, but there has been very little advertising or marketing for the services. BT have not widely publicised their Openzone product which currently serves 70 "Hotspots"[3], however Megabeam are launching shortly with a large event to celebrate their first network covering the whole of London City Airport[4]. The standard of marketing so far connected to WLAN has been rather poor, with a lack of high profile advertising or trial offers to entice people to use it. Since marketing is one of the major factors that contribute to failure, commercial wireless LAN technology may find itself as successful as its ancestor which sued access points - the CT2 cordless phone.

Poor marketing and design are not the only two factors that cause technologies to fail. The mindmap also showed that luck, politics, competitors, social and economic factors have their part to play. WLAN has arrived at a time when 3G has found itself becoming the buzz word for GSM suppliers, who have invested huge amounts of money in expensive licences for the third generation of mobile phones. The competition that CT2 phones faced from GSM 2 decades ago, is now back to haunt WLAN. With mobile operators having invested £22.5 billion[5] in 3G licences, the emphasis is defiantly not on WLAN to succeed. However market forecasts from "Analysy", the global advisor on telecoms and new media[6] believe that the end result in the play off between mobiles and WLAN will end up with 3G losing out on 10% of data traffic to wireless networking.

Politics is also on WLANs side, since unlike 3G the UK government removed the need for licensing the IEEE 802.11 technology [7] on 31 July 2002. This will make it much cheaper for small companies to set up large networks, unlike the proposed 3G systems. This is all good news for WLAN technology since it may have the edge on its competitor, in its timing and value for money. However to operate in the WLAN area, the user requires a laptop or a PDA which can be fitted with the appropriate card. This may restrict it to people who can afford these devices, unlike GSM phones which seem to have become common place since they only have one use, so mobile operators offer large subsidies on them to customers.

Wireless LAN technology may have a worrying similarity to the failed CT2 cordless phone network; however it does appear it will have one difference: It may succeed. Having compared the technology to the factors found in failed technologies it shows that it has good prospects in the design, social and political areas; however it still faces possible marketing and competition problems. Despite these problems the initial consumer response to WLAN appears to be positive, and provided the marketing problems are addressed the technology appears to have a solid base to work from. Nortel Networks White Paper on WLAN[8] talks about a new game needing new rules and states that Wireless Data Networks will soon establish themselves as the new rules. This is where WLAN and 3G will have to battle it out, so one of the technologies succeeds in the data market. Ultimately the success of Wireless LAN could depend on one major factor: Luck.

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[3] www.bt.com/openzone

[4] www.meagbeam.com

[5] http://news.zdnet.co.uk/story/0,,t269-s2121073,00.html

[6] http://www.analysys.com/default.asp?Mode=article&iLeftArticle=946

[7] http://news.bbc.co.uk/1/hi/sci/tech/2045483.stm

[8] http://a496.g.akamai.net/7/496/5107/20030108063229/www.nortelnetworks.com/corporate/cm/wi/collateral/nn_102100.09-02.pdf

CHAPTER 9

Bibliography

"No possible combination of known substances, known forms of machinery, and known forms of force, can be united in a practical machine by which man shall flay long distances through the air."

Simon Newcomb (1835-1909), astronomer,
head of the U.S. Naval Observatory.