Funding Breakthrough Technology

Case summary : Inkjet printing

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This case summary is part of the 'Funding Breakthrough Technology' project. This project is in the commercialisation stream of activities of the EPSRC funded Cambridge Integrated Knowledge Centre (CIKC) in photonics and macro molecular material. Historical case studies of eight breakthrough technologies of the last 60 years are being investigated with the specific focus of how these technologies were supported and finance in their journey from the lab to market. The other case studies are Photovoltaics, Liquid Crystal Displays (LCD), Light emitting diodes (LEDs), Fibre optic communications, Giant Magnetoresistance (GMR), Micro electronic mechanical systems (MEMS) and Computed Tomography (CT) and Magnetic Resonance Imaging (MRI).

This case study was completed by Jonny Thompson as part of his fourth year Masters of Engineering (MET) long project under the supervision of Andy Cosh and Samantha Sharpe. All of the case study documents are works in progress. If you would like to comment on any of the case study summaries please contact Dr. Samantha Sharpe at the Centre for Business Research on email (s.sharpe@cbr.cam.ac.uk) or telephone (+44 (0) 1223 765 333. As these documents are works in progress we would request that the case studies not be cited without the author's permission.

Introduction

Digital Inkjet Printing is a binary, non-impact dot-matrix printing technology. In its purest form inkjet printing is the jetting of individual ink droplets from a small aperture directly into a specified position on any manner of substrate. The concept of a printer that controls the flow of ink through tiny tubes dates back to the nineteenth century. In 1867 Lord Raleigh[1] developed a method for electrostatically controlling the release of ink droplets in a piece of recording equipment (Robinson and Stern 1997). Although it would be almost 100 years later before the first commercial applications using this method of electronic controlled ink release.

Early applications

Siemens patented and launched the first inkjet printing application in 1951; a chart recorder (Tang, Kuek et al. 2000). However the corresponding development of microprocessors was necessary for the wide-spread application of ink-jet technology to begin in earnest. The next breakthrough was to emerge from an unexpected field; biology.

During the 1960s there was a great deal of research directed towards developing medical devices that could automate standards methods of biological analysis. This was driven by two forces, firstly the belief that such analyses could be profitably automated (both for patient benefit and financial profit), and secondly the needs of the space exploration program in the US, for automated biological equipment for unmanned space flights, particularly early Mars lander projects[2] (Keating and Cambrosio 1994).

One such interdisciplinary team researching these automation processes was located at the Medical School at Stanford University. The team was working on a medical device for cell separation methods that would allow genetic and other analyses to be conducted on

[1] Rayleigh, F.R.S (1878), 'On the instability of jets', in *Proc. Lond Math. Soc* 10 (4), 4-13

[2] Stanford University Instrumentation Research Laboratory, part of the Department of Genetics of the Medical School, had received a substantial grant from NASA to develop instrumentation for use in outer space. NASA funded the cell-sorting project from 1966 to 1969, when the funding switched from NASA to National Institute of Health (NIH) funding in line with the shift of NASA away from searching for life on other planets (Keating and Cambrosio 1994).

subpopulations of separated cells. As part of this project, engineer Richard Sweet[3] developed a vibrating fluid nozzle that allowed cells to be separated by volume, cells would then be charged and subsequently electronically separated (Keating and Cambrosio 1994). A patent was applied for and granted in 1968.

IBM had developed a relationship with the Stanford Instrumentation Research Lab in the field of instruments for space missions, and via the IBM Thomas Watson research lab at Columbia University, worked with the Stanford researchers to develop the cell screening work into a diagnostic device (Keating and Cambrosio 1994). The work on cell sorting was to be overtaken as a diagnostic method and device construction stalled. IBM had created a number of devices but they were messy, expensive and unreliable (Economist 2002), and only a few were used in research labs (Keating and Cambrosio 1994).

Despite the early links with biology, Sweet's work was also recognised quickly in the print technology field. The process of controlling an electric charge that can then be impressed on the drips selectively and reliably, then passing the charged droplets through an electric field and deflected the charged drops into a gutter for recirculation whilst uncharged drops fly onto some media to form an image, became known as Continuous Inkjet (CIJ) Technology.

Sweet's early work on the inkjet printing nozzles was licensed out to Honeywell[4]. The apparatus could generate as much as 100,000 droplets per second in a continuous stream; and defined the state of art of the field (Keating and Cambrosio 1994). By the 1970s other US companies; Mead[5], A.B.Dick[6], Tektronics[7] and IBM[8] all had continuous inkjet research programs (Robinson and Stern 1997).

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[3] Sweet, R,G, (1965), High frequency recording with electrostatically deflected ink-jets, *Rev. Sci Instrum.* 36, 131

[4] Honeywell used the work to improve the spray inkjets on their high speed writers.

[5] Mead Corporation produced business forms, paper and packaging. Mead exited the CIJ printer business in the 1980s, selling their operations to Eastman Kodak, which in turn sold onto Scitex Corporation (Tang et al 2000).

[6] A.B. Dick produced printing and copier equipment. A.B. Dick spun off their CIJ activities to create Videojet (Tang et al 2000).

[7] Tektronics also had a relatively short go at CIJ printers, selling their activities to Xerox in the 1980s as well (Tang et al 2000).

Mead released the Dijit (Direct image jet ink transfer) 2700 model in 1978. This device had 960 individual inkjet mounted in a single bar and a speed of 800 forms or 80,000 lines of text per minute (Keating and Cambrosio 1994). A similar inkjet application was developed and introduced by A.B.Dick. In the UK at approximately the same time David Paton was leading research for Cambridge Consultants to develop a CIJ printing system for Imperial Chemical Industries[9].

Drop on Demand inkjet printing

Technological development in the drop-on-demand (DOD) printing method also advanced in the 1970s. Siemens and Silonics[10] both developed early drop-on-demand inkjet printers. These printers, unlike CIJ printers, were designed for office markets; they were smaller and quieter than their CIJ counterparts. However image quality and printer reliability were major obstacles for early drop-on-demand printers. As a result these early models were not commercially successful (Tang et al 2000).

The period between 1978 and 1980 marked a breakthrough for DOD printing. Researchers at both Canon and Hewlett Packard[11] developed the thermal inkjet principle. This meant that

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[8] I have not been able to find direct reference to technology transfer at IBM between their interest and work on automated diagnostic devices and inkjet printing, but the assumptions is that this occurred. IBM spun off their inkjet printing activities into Lexmark International in 1991(Tang et al 2000).

[9] Imperial Chemical Industries was founded in 1926 by way of the merger of four companies – Brunner Mond, Nobel Explosives, United Alkali Company and British Dyestuffs Corporation. It produced many chemicals, explosives, insecticides, paints and from 1951 pharmaceuticals. The company grew consisting over the twentieth century, making foreign acquisitions, becoming the largest paint manufacturer in the world and the first UK company to achieve £1bn in annual pre-tax profits in 1984. In 1991 ICI was the subject of a takeover bid by corporate raider Lord Hanson. Although the bid failed it led to ICI spinning off its pharmaceutical and agrochemicals businesses in 1993, Zeneca and Switzerland based Syngenta respectively. In 1997 the firm moved away from bulk chemicals altogether, focusing on specialty chemicals and paints. It sold off its bulk chemical business in more than 50 separate deals over the following five years (Guardian 2007). In January 2008, ICI was taken over by Dutch firm Akzo Nobel. ICI Imagedata a subsidiary of Akzo Nobel continues to develop speciality chemicals and films for printing and paper.

[10] Silonics was a Silicon Valley start-up, founded in 1977. They introduced *Quietype* drop-on-demand printer in 1978 Le, H. P. (1998). "Progress and trends in inkjet printing technology." Journal of Imaging Science and Technology **42**: 49-62.

[11] The developments in both labs happened simultaneously. Hewlett Packard did not find out about Canon's work until two years later. Both had filed patented separately, and within months of each other (Economist 2002).

instead of relying on piezoelectric methods; using crystals that vibrate when charged to squeeze out controlled amounts of ink, heat was used instead.

In the case of both labs the discovery was somewhat accidental. In Hewlett Packard's case, researcher John Vaught came up with their version of the thermal principle when thinking about the operation of a coffee percolator. In Canon's case, researcher Ichiro Endo noticed ink squirting from a syringe when a hot soldering iron accidentally touched the syringe (Robinson and Stern 1997).

Thermal inkjet printers developed quickly, with first prototypes following two years later. Developing ink cartridges proved difficult (Tang et al 2000), especially disposable cartridges; the idea of developing equipment with embedded I.P. that customers would throw away (and competitors could easily reverse engineer) was difficult proposition for Hewlett Packard executives to accept (Economist 2002). Hewlett Packard's *Thinkjet* and Canon's *Bubblejet* were both launched in 1984, and rapidly became a commercial success, particularly with the scientific and engineering markets because of their small size and portability outweighed continuing issues of poor resolution and special paper requirements (Tang et al 2000).

Technical Division

Therefore by the 1980s inkjet printing had divided into CIJ and DOD methods, with sub divisions and branches of each collectively serving a wide range of applications and markets. These are detailed in Figure 1. We can understand why so many solutions exist when we consider that packing is just one market for inkjet printing. Here there are endless combinations of base media and folding, cutting, lamination, heat and humidity requirements to name just a few. The solution in each case must be carefully optimised providing the correct balance in print quality, throughput rates, reliability and economics (Slembrouk 2007). There cannot be one technical solution therefore that serves all of these applications and so we see so many specialist inkjet technologies spawn.

Market Divisions

As well as a clear technical division, inkjet technology is also clearly divisible between markets. The inkjet technology is split into desktop and office printing, and commercial and industrial printing. The technical challenges between the two vary considerably, with office and desktop printing being in many cases far simpler a technology. Here the environment is controlled and well known. Distance between the print head and substrate is constant, the environment is clean and the throughput low. The main difficulty is that the inkjet does not print continuously. Since there is hardly any wear on print heads, as long as the ink is properly filtered and degassed, the more often an inkjet prints the better it will perform. In the industrial and commercial sector the technical challenges are far greater, distances are variable, the orientation of the substrate can even vary, the environment is dirty and the print head can often be subject to significant changes in heat and humidity.

Office and desktop printing is the considerably larger market. Revenues from hardware, media and chemistry are expected to reach $59bn in 2009. The largest segment of revenue came from ink, contributing alone almost $33bn, more than 55% of total revenues (American Printer 2006).

The size of the market for industrial and commercial inkjet is much more difficult to establish however. In an interview with Will Eve, founder of both Elmjet and Inca Digital, he explains that "industrial inkjet printing is a very fragmented market. Niche markets are created as very specific inkjet technologies are required to be developed in order to satisfy the various demands of industrial printing". This makes estimating a total market or even market share a tough task. "We produce wide format printing designed for use on rigid media; it is however possible to print using our products on flexible media and it is possible that some of our customers already do this. To try and gauge therefore what our market share is difficult as we find it difficult to define even what our market is without a significant grey edge."

Privately held accounts make estimating market size even harder. During 1992 Domino published figures showing it was number one worldwide in ink-jet printing. US competitor Videojet disagreed vigorously, claiming that Videojet was 40% bigger than Domino (although Videojet's business includes some laser printers, a different product and market). Videojet's claims were hampered by the fact that it is a subsidiary of GEC who "don't believe in giving investors or competitors too many facts and figures"(Management Today 1992). Videojet declined to disclose figures for Videojet's turnover or profits in 1992 and still do in 2009 when contacted regarding this report. Whilst market size remains uncertain, the relative scale of players is easier to establish. In Management Today, June 2009 it was reported

"*What is certain is that Domino is way ahead in Europe, Videojet is way ahead in the US, and the two are increasingly in head-to-head competition. From a national perspective, one can savour the fact that well over half of the fast-growing world market in ink-jet printing is now controlled by British-owned* (and Cambridge based) *companies*."

So whilst office and desktop printing technology, dominated by large multinational companies (HP has more than a 40% world wide market share[12]), is a maturing market with a largely proprietary technology[13], commercial and industrial inkjet is quite the converse. The commercial printing and industrial inkjet markets are still in their infancy [13] and are dominated by a plethora of small, high technology spin outs and start ups. It is thus for this reason that we will focus our attention on firms in the commercial and industrial market.

UK based Inkjet printing firm Xennia expect Inkjet to dominate production all industrial printing by 2015 with the overall shift away from traditional printing driven by:

- Lower operating costs and higher productivity
- Simplifying manufacturing processes
- Real time mass customization on demand
- Flexibility with increased design capabilities and printing on textured or non-flat substrates
- High yields and waste reduction caused by less machine change.

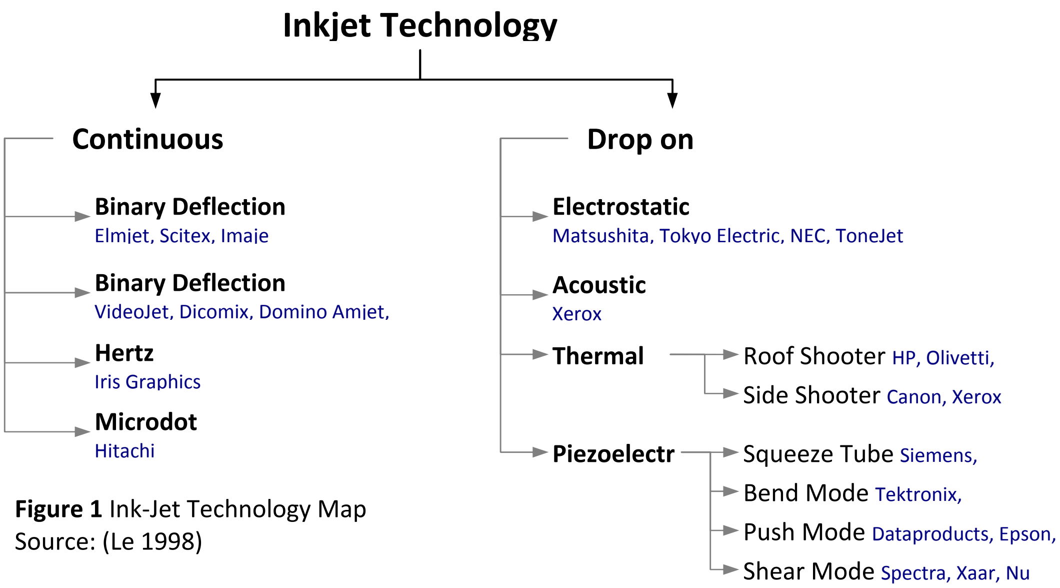


Figure 1 Ink-Jet Technology Map
Source: (Le 1998)

12 **ZDNet Asia, Menon,A** 08 June, 2001

13 **Xaar Annual Report and Accounts 2006**. p3

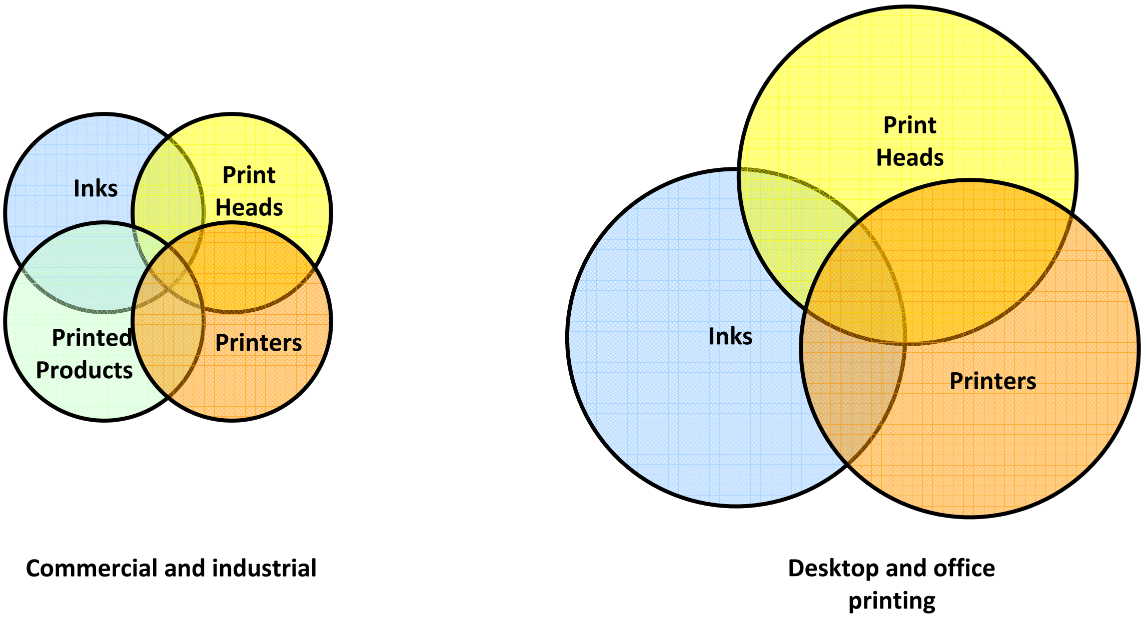


Figure 2

These two markets then further subdivide between inks, print heads, printers, and in the case of commercial and industrial printing printed products.

Commercial and industrial inkjet market distribution history

During the 1970's and 1980's the commercial and industrial inkjet market had two key geographical markets, North America and Europe. The products were initially produced in low volumes at high capital costs and with emphasis on customer service and relationship the markets were unsurprisingly initially dominated by local firms. By 1986 Domino had in the region of 40% of the UK CIJ market share whilst Willett, the number two producer had 30%, both had a similar share of the EU market. [14] The North American market has been dominated by VideoJet a subsidiary of AB Dick, General Electric Company[15].

In recent years the interest of large global companies in the industrial inkjet market has intensified, attracted by a market reported still to be in its infancy. Fuji Photo Film, of Japan, acquired Dimatix Inc., and EFI Inc., of the US, acquired both Vutek – a manufacturer of large format graphics printers – and Jetrion Inc., a smaller integrator using Xaar technology for the packaging market. At the back of this report is a table detailing the top 20 patent holding organisations in print technology over the five

[14] Financial Times, June 1987, Companies News

[15] DODSWORTH, T, 24 May 1988, Financial Times GEC In 21 Million Dollars AB Dick Expansion

decades of its emergence. The trends in changing technological leadership are clearly highlighted in this table.

In recent times European firms have been acquisition targets of large multinationals; between 2003 and 2008 four Cambridge based firms were acquired. Danaher Corporation of the US acquired Willett and LINX, Dainippon Screen of Japan acquired Inca Digital and TenCate of the Netherlands acquired Xennia.

It is the concentration of Europe's Inkjet based firms in the Cambridge region that makes it an area of particular interest. Central for many of the firms in the region has been Cambridge Consultants Ltd (CCL), where the earliest research into Inkjet Technology was carried out by David Paton for ICI.

Cambridge has been credited with playing a pivotal role in the development of the Inkjet, particularly in the commercial and industrial market. The report will thus focus on the firms from this region and examine how they have commercialised the technology that they and others have developed.

Cambridge Focus

During 1970 David Paton of CCL created a concept for printing textiles at high speeds in wide widths and in colour. ICI was looking to develop a printing machine and based a research project on this technology with CCL. ICI was looking for diversification and invested a substantial amount of money into the work at CCL. The objective of the project was to produce a machine that could print in 2m widths of colour; such a machine would require 4000 jets.

In 1974, ICI commissioned an external consultancy to evaluate the potential of the technology. ICI was told that feasibility of successfully developing the technology was low and that reliability of a product with so many jets would be poor. Graeme Minto, leader of the research group said "we tried to build Concorde before the Wright brothers had first flown"

Consequently ICI pulled out of the project, but the project was not a failure for CCL. The project built upon technology and expertise within the CCL ink jet printing group and in 1978 Graeme Minto left CCL to form Domino Printing Sciences to market the first CIJ technology. The work from CCL would also influence the founding of Videojet, Willett, Elmjet, LINX, Xaar and Inca. Not only was much of the initial development work in the 1970's carried out in Cambridge, but the area still houses many of the Commercial and Industrial sector players today.

Inkjet based companies have continued to spin out from CCL at a regular pace since Domino in 1978 right through until most recently in 2000. This Cambridge cluster therefore gives an excellent focus for our case studies, allowing us to examine spin outs and start ups over a period of 30 years. Such a long time period provides the opportunity to examine the trends, if any, in funding and finance models used in these company's foundation. The proximity to Cambridge University is also interesting, particularly as we look forward and start to consider whether lessons from these firms can be applied to current breakthrough technologies being developed at the University. By examining the start up of firms based in the same area of current breakthrough technologies the findings would seem to be most immediately applicable.

Timeline

Figure 3 shows a schematic of the formation of Commercial Inkjet Technology firms in the Cambridge Region. The timeline includes information on date, names of key founders or employees, key funding if interconnected with the companies is also shown. A change of colour is used to denote when a company is floated on a public stock exchange or acquired.

For the sake of simplicity and ease of reading the time line shows no sense of scale of company size (by revenue or number of employees for example).

Key points to note are

- The central role Cambridge Consultants has played.
- The interconnections between firms through:
    - Distribution agreements
    - Joint Ventures
    - Direct funding / Equity Stakes
    - People
- The degree of fragmentation - the number of firms in a relatively small, infantile market, all based within a close physical proximity.
- The recent flurry of acquisition activity by foreign multinationals of Cambridge high-tech firms.

Incubator phenomenon

The Cambridge area is well known for the University and the many firms that have spun from that. Particularly well known is the Segal, Quince and Wicksteed Study (1985). Heffernan and Garnsey (2002) "Technology and Knowledge Based Business in the Cambridge Area; A review of evidence" provides an excellent picture of the Cambridge scene. Barrels 2002"Innovation Champions Network: The Cambridge Cluster Description" does a similar job in explaining the factors at play in Cambridge.
The idea of Cambridge or firms providing incubation for spin outs will be revisited in the Summary and Conclusion section.

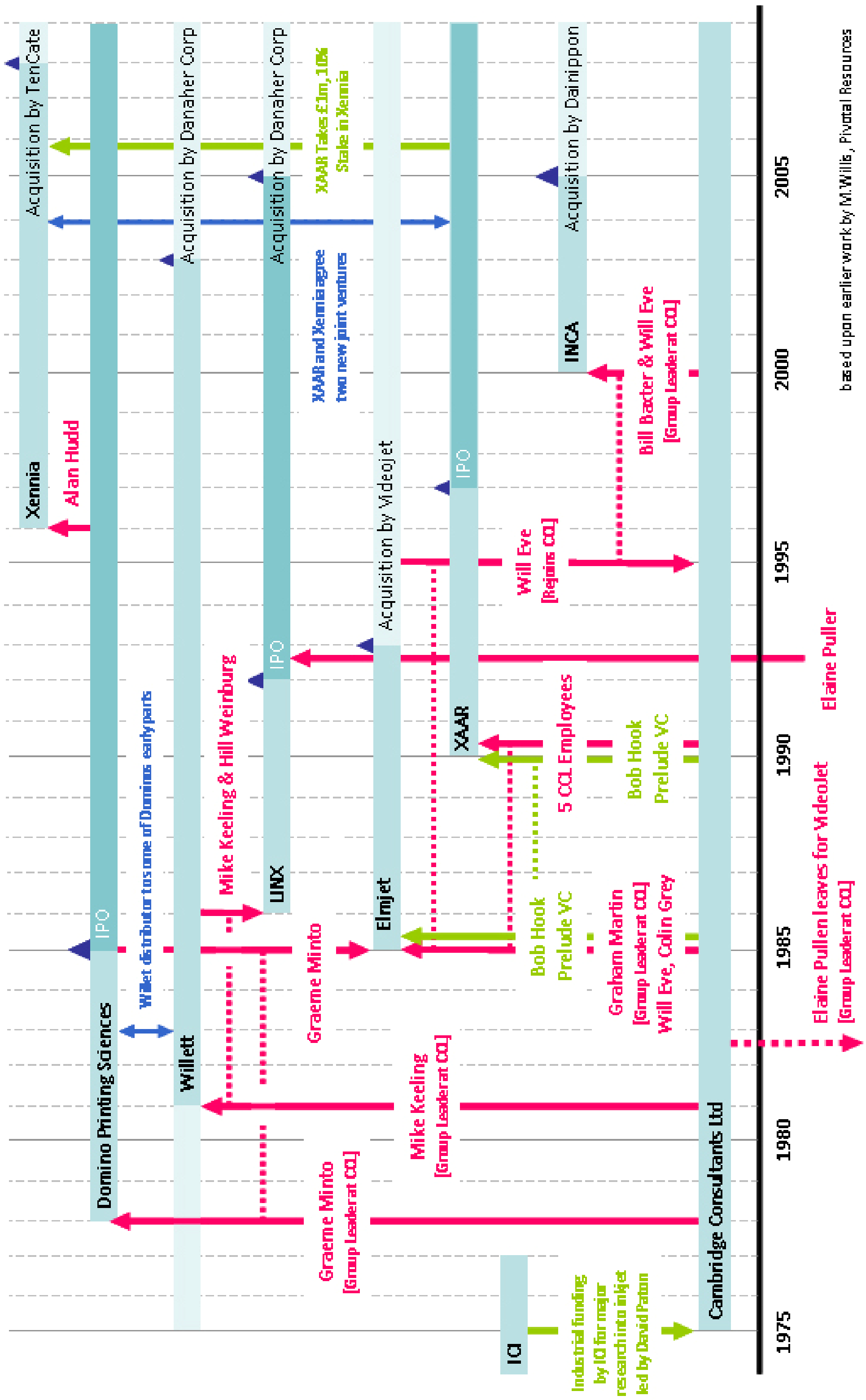
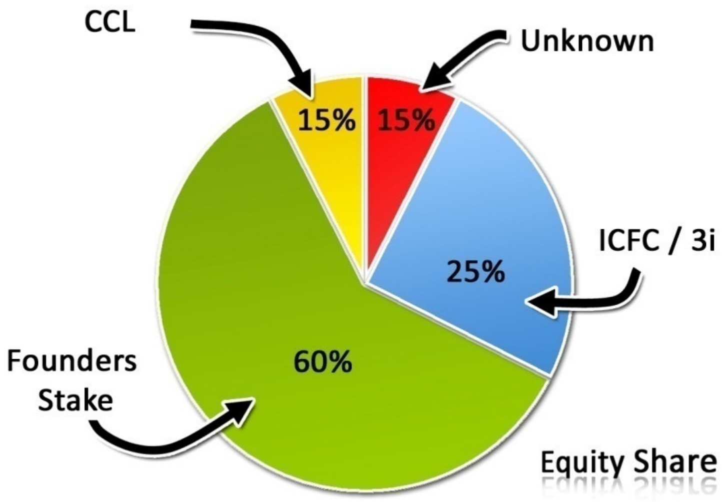


Figure 3 Schematic of the formation of Commercial Inkjet Technology firms in the Cambridge Region

Firm Case Study

1. Domino



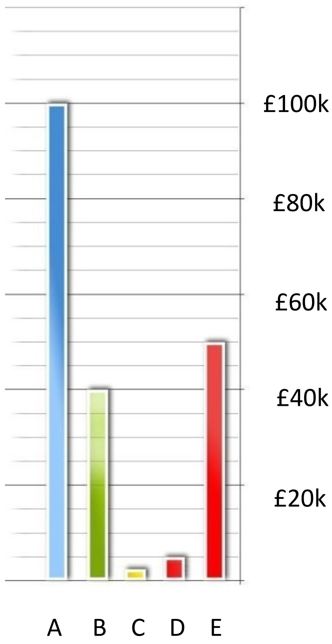


Figure 4
Early stage funding 1978-1982 (pre IPO)
A: **1978** ICFC / 3i: secured loan and share capital **£100k**
B: **1978** Graeme Minto's personal contribution (second mortgage) amount **unknown**
C: **1978** Loan from CCL, **£1k**
D: **1978** Innovator of Year Award , **£5k**
E: **1982** Hill Samuel Anniversary Award, **£50k**

1.2 Company History (founders and background)

Today Domino Printing Sciences is a world-leader in ink jet, thermal, laser and print & apply technologies. They offer total coding and printing solutions, variable data such as bar codes and traceability codes are printed onto products in industries such as food, beverage and pharmaceutical. They form part of the FTSE 250 Index and in 2008 had a turnover of £253m with an operating income of £34m.

Domino was founded in 1978 by Graeme Minto of Cambridge Consultants. Minto had worked through the 1970's on ink jet printing developments at CCL in a programme funded by ICI. ICI decided that their project was too complex and risky to develop further and sold the rights back to CCL. Minto, convinced of the potential of a simpler system secured licences from ICI and CCL to concentrate on smaller application of the technology, a method of printing, using electrostatic deflection of micro-droplets of ink.

Much of the first few months were spent developing their fist product, the Unijet. Domino's big breakthrough, however, only came with its second major product - the Unijet Solo, launched in April 1981. By 1983 it accounted for about 80 per cent of the company's sales [16].

Solo's success can be attributed to its design. It had been designed with customers who want to use it for dating and coding their products in mind. With almost the same capacity and flexibility of its predecessor it was smaller and significantly less expensive[16].

During the autumn of 1983 Domino formed "Domino Amjet", a joint venture with American Technologies to market and service printing equipment. Through it, Domino gained access to American Technologies established sales and service teams in the USA as well as their distributor network in Europe, the Americas, Australia and New Zealand, with an American Technologies being granted a licence to manufacture Domino products. The partnership resulted in substantial sales to companies including Coca-Cola, Del Monte and J&J.

In 1985 Domino floated on the LSE with the aim of raising £11m. Domino went public at 200p per share, with 41.9% of the company's shares offered for sale, valuing the company at £26m. The shares opened publicly at 260p and climbed to around 300p, revaluing the company at £40m. Domino asked its investors to retain a certain percentage of their equity to show confidence in the sale. The sale was oversubscribed 44 times. Of the 5.5 m shares offered for sale, 1.5 m were new, which led to a net £2.4m fund raising for the company. £500k of the money raised was used to repay borrowings. A further 1.62m shares were also sold by American Technologies, these were originally offered in consideration for the purchase of AT's 49 per cent stake in Domino Amjet[17].

1.3 Timeline of key events up until IPO

Year	Type	Note
1970's	Research	ICI funding research into inkjet by CCL
1979	-	Foundation; spin out from CCL
	Funding	Minto's personal savings
	IP	Secured licences from ICI and CCL
	Funding	£100k from ICFC
	Funding	£1k from CCL

[16] Dickson, T. (1983) 'Small Business: How Domino spotted that products alone were not enough', *Financial Times,* 11 January 1983

[17] Garrett (1985), 'Domino Printing Offer To Raise 11 Million Pounds' *Financial Times*, 19th April 1983, p20

	Award	£5k Innovator of Year Award
	Product	Unijet [not a great success]
	Legislation	European Food Labelling Directive
1981	Product	Solo [first breakthrough product]
1982	Award	£50k Hill Samuel Anniversary Award
1984	Joint Venture	American Technologies [immediate access to large distribution network]
1985	Award	Queen's Award for Technological Innovation
	IPO	44x Oversubscribed

1.4 Early Stage Funding Details

Founders Stake, 1979 (Year 1)

- Unknown value represented a significant personal risk, involving loans and an extended mortgage"[18].
- Held an initial equity stake of 60%. Minto wished to maintain a high level of control and did so by avoiding the venture capitalist market. Accordingly:
  "...no time [was] spent convincing venture capitalists, with long elegant reports."
- Strong personal qualifications. Awareness of both the market and technology (including the patent background). Minto had been on the IGC ink jet conference lecturing circuit for several years.
- Shareholding fell from 60 to 40% after the IPO.

£1k and IP from CCL, 1979 (Year 1)

- Minimal financial input, 7.5% equity stake.
- CCL gave Domino non-exclusive access to CCL know-how and patents to enable it to manufacture and sell ink jet products. In exchange, CCL would receive royalties on the sales of all products. If sales fell below a threshold value then CCL would be entitled to grant licences to other companies. Domino was also obliged to offer CCL 'first refusal' on development programmes for further ink jet products.
- Held a 50% representation on the board of Domino,
- With the public floatation the CCL licence become royalty- free, though CCL still retained a small equity stake.

[18] Cambridge Manufacturing Review Summer 2002: Industry Focus, Ink Jet Focus

£100k from ICFC / 3i, 1979 (Year 1)

- Paid £7.5k in 1979 as part of a £100k secured loan and share capital detail representing just over 25% equity.
- Funding came from Technical Development Capital (TDC), the venture capital subsidiary of Industrial and Commercial Finance Corporation (ICFC) who were impressed with the speed at which Minto had got the business running and were willing to overlook his lack of business experience (Coopey 1992)[19].
- Stipulated the appointment of a non-executive director to provide experienced commercial advice [19].
- Led further rounds provided including guaranteeing bank overdrafts, refinancing and funding the purchases of larger office and production facilities.

£50k, Hill Samuel Anniversary Award, 1982 (Year 4)

- Prize money used to set up overseas technical centres with the twin aims of providing better local services for overseas customers and of stabilising prices.
- Nearly three quarters of domino's output is exported to 20 countries including the US and Japan.

1.5 Role of Financers

ICFC / 3i

- Domino experienced early difficulties in realising the true potential of its products, poor sales of their first product (Unijet) was partly due to a poor marketing strategy and resistance of some potential customers to a new, non-traditional technology.
- At one point with its relatively high gearing, the company was technically insolvent. At this point the government created venture capitalist firm, ICFC 20 raised their support and contact with Domino. Domino had to provide monthly management accounts, marketing reports, analysis of sales leads, and monthly R&D spending which was all monitored against cash-flow.
- Minto said 3i's involvement was "crucial to the firm's change in fortunes" [19]

CCL

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[19] Coopey, R (1992): Venture Capital and the Computer Industry: Financing Growth Companies in the UK, *Business and Economic History*.

[20] ICFC (Industrial and Commercial Finance Corporation) is a body that was set up in 1945 by the Bank of England with funding from major commercial lenders to provide capital to small and medium-sized companies. In 1987 the ICFC was rebranded 3i Group when the banks sold off their stakes to form a public limited company. Today the body exists in a radically altered state, in the form of a listed private equity and venture capitalist firm. In 1994 3i floated on the London Stock Exchange at a market capitalisation of £1.5bn. It is a constitute member of the FTSE 250 index.

- Actively involved in the formation of Domino, but with minimal financial input.
- Chief role was in the support and nurturing of the company in its infancy, demonstrated by the volume of development work that CCL undertook for Domino and by the attention that was given to following its growth.
- CCL was concerned they would have to continue support Domino if targets were not achieved, that further equity funding might be needed and that CCL may become embroiled in the patent difficulties that Domino was facing with A.B. Dick.
- CCL desired a less committed long term position, which appealed to Minto who wanted sole control of the company.

1.6 Management Style [21]

'We have grown from a corner shop to a supermarket. To do that, you have to change your staff as some all-rounder jobs disappear to be replaced by more specialised functions,' **Minto (1985)**

Almost ruthless management changes have been cited as being key in guiding Domino's successful early growth as it transitioned from a small entrepreneurial enterprise to a mid-sized to large company. Minto is said to have been able to recognise the need for management changes, whilst still importantly, commanding the loyalty of everyone around him.

Significant changes came during the 1983 - 1985 period. By 1985 all six directors apart from Minto had joined the board since 1983, as well as 12 of the 22 senior managers. Surprisingly the personal changes are not reported to have caused serious acrimony. It seems that the belief that "growth can only come in proportion to the management's abilities" was imbedded in the mentality of workers at domino and so if it was felt directors could not develop with the company, then change would be made.

1.7 Concluding Remarks

- Spin out largely incubated as the riskier, early stages of technology were developed largely by CCL.
- An excellent bet by investors. The lead outside investor, ICFC / 3i - In 1979 paid £7.5k as part of a £100k total package for a 25 per cent stake, which was valued at £6.5M when the company was floated, representing an IRR of over 100%.

[21] Dawkins, W. (1985), 'From 'Corner Shop To Supermarket' / Three years of expansion of Domino Printing Sciences maker of ink jet printing equipment', *Financial Times,* 24 September 1985

- Founder retained large equity stake early on.
- Minimal rounds of funding, few participants.
- Joint venture gained access to large and established distribution network.
- Correct management team a key priority, evolved as the challenges facing Domino changed.
- Multiple awards.

ELMJET

2. **Elmjet**

2.1 Company History (founders and background)

Elmjet was formed in 1985 by Graham Martin (the former group leader of Printing Systems Group at CCL) to develop and manufacture Binary Deflection CIJ technology. The initial target market was consumer markets (e.g. fabric, wallpaper and carpet printing) as the founders foresaw a far wider range of uses than "use by date" stamping. [22] Other founders include Colin Gray and Will Eve, both formally of CCL consultants.

Graeme Minto (Founder of Domino Printing and formally of CCL) was appointed as Chairman in 1985[23].

Elmjet went through five rounds of diverse funding before acquisition in 1993. Its first product was launched in 1988, 3 years after foundation at which point a total of £750k of capital had been committed.

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[22] Landau, S (1986) 'Survey of Venture Capital (10): New stability in the high-risk area / Seed investments' *Financial Times* 8 December 1986

[23] Reporter (1988) 'Elmjet wins award for printer', *The Engineer,* 30 June 1988

2.2 Timeline of key events up until IPO

Year	Type	Notes
1985	**-**	Foundation
	Funding	Founders; contribution unknown
	Funding	£300-400k from Prelude Technology [22] for a "considerable" equity stake
	Appointments	Graeme Minto as chairman
1987	Appointments	Geoff Broad as Managing Director
	Funding	Government Grant £50k
1988	Funding	"User Council" established – (£300k per year)
	Award	£100k worth of MRP II Equipment (Impcon Competitive Edge Award)
	Product	First product launched in November [24]
1991	Funding	£100k bank overdraft backed by 3i to act as a "buffer" [25]
	Dismissal	Graham Martin, founder, fired.
1993	Acquisition	Acquisition by VideoJet, market leader

2.3 Early Stage Funding Details

Prelude Technology Investments 1985 (Year 1)

Prelude26 put in £5k initially, and progressively drip-fed Elmjet [22], providing in the region of £300-400k.Prelude took a substantial equity stake, leaving the founders with a minority holding (Prelude typically took up to 70% equity stake in firms[27]).

Government Grant, 1987 (Year 3)

In the region of £50k was provided free of any equity stake.

User Council, 1988 (Year 4)

[24] Reporter (1988), 'A route to reducing risks – Elmjet's development approach', *Financial Times,* 24 May 1988

[25] Bachelor, C (1991), 'Real men eat quiche in East Anglia', *Financial Times,* 8 January 1991

[26] Bob Hook, Cambridge PhD student and board member of CCL since 1975 found spin-out Prelude Ventures in 1984, attracting funds from major pension funds. Prelude has since grown into a well-known and successful early stage investor in technology businesses. In 2006 Prelude Ventures merged with Cazenove Private Equity to form Esprit Capital Partners. The partnership has assets under management of $500m, focused on European venture capital, typically technology, new media, telecoms, software and life science/healthcare investments.

[27] Bachelor, C. (1988) 'Group Aims To Raise 20 Million Pounds Technology Fund' *Financial Times,* 11 May 1988

A very novel fund raising method that resulted from a brain storming season with Prelude technology two years previous as a way of raising extra funds without diluting any shareholders holdings[24]. 6 Companies (3 UK, 1 Swedish, 1 US and 1 undisclosed), from 6 different market areas (wall coverings, vinyl floorings, packaging, paper, fabrics and carpets) pay an annual subscription for of ~£50k each in order to have an early view of the way technology is being developed and a priority in ordering any product that emerges from research.

The annual fee did not buy the large companies a stake in the way Elmjet is run, or the way it allocated resources. Nor did it give them exclusive rights to any development, a stake in the equity or a seat on the board.Not only did it generate funds for Elmjet but it gained access to resources and large companies which it could not afford by itself.

Award Prize Money [Impcon Competitive Edge Award], 1988 (Year 4)
£100k worth of MRPII manufacturing control software plus the potential savings the system brought. This was equivalent to almost half of Elmjet's projected sales turnover in 1988. This was very much the result of work by Bill Peters', Production Director. The prize was far in excess of what Elmjet could afford or justify, it however gave scope for expansion. According to Peters winning entry the use of the system would save Elmjet "£100k a year from 1990 onwards"

3i Backed Bank Overdraft, 1991 (Year 7)
During 1991 Elmjet was on the verge of signing a large supply contract with a US printing company. Broad, MD at the time felt that a "buffer" was required in case his cash-flow forecasts proved too optimistic. 3i led a group of 8 investors that backed a £100k bank overdraft for Elmjet.

2.4 Role of Financers

Prelude Technology Investments

Prelude helped the founders to write a business plan **Error! Bookmark not defined.**, to go to the department of trade and industry and to find a chief executive [22].

User Council
The fee was put towards development of projects. Elmjet itself gained access to resources which it could not afford itself as well as providing insight into 6 different markets.

Award Prize Money [1988 Impcon Competitive Edge Award]
Prestige associated in winning such an award.

3i Backed Bank Overdraft

Minimal involvement

2.5 Reason for acquisition

Videojet's geographical diverse customer base had enabled it to remain market leader, and in fact achieved record sales and profits despite weak markets in Europe due to recessionary pressures in the early 1990's. Videojet was attracted by Elmjet's industrial array inkjet printer as an acquisition to complement its current single jet product range. Recessionary conditions and recent weak performance of Elmjet meant that VideoJet could acquire at a depressed price in 1993.
Under terms and conditions of the acquisition, Graeme Martin, founder of Elmjet, who had been fired in 1991, was reinstated.

2.6 Success of fund raising

Recessionary pressures during 1991 saw orders for Elmjet begin to retreat quickly. Broad, MD, found himself bombarded by suggestions from all of his investors on action Elmjet should take. This included 8 investors involved with the 5th round of financing. Broad (1991) said

"in retrospect, eight investors are far too many – it would have been better to have arranged bigger slugs of capital which could have been drawn down to an agreed time-table"

Broad, in his own words, had found five rounds of fundraising in three years a considerable drain on his time and a distraction from the business.

Some of the fund raising used, such as the User Council was extremely novel, it raised a substantial amount of sustainable income at no significant cost and no lost of equity. Such methods however were considerably time consuming and involved, with a greatly limited impact due to dilution of equity in the very earliest stage by venture capital.

The impact of the distraction the rounds of fundraising had on Broad are apparent when we see the return early investors got in their money. Whilst they got a return it equated to an IRR <<20%, far reduced to other Cambridge based inkjet firms we examine.

2.7 Concluding Remarks

- Elmjet possessed excellent technical expertise but lacking in business and marketing specialists, for that they relied upon VC.
- Multiple rounds of involving fund raising seriously diverted attention of senior management
- Novel methods of fundraising in an attempt to retain equity share were thwarted due to dilution at early stages

3. **LINX Printing Technologies Ltd**

3.1 Company History (founders and background)

LINX Printing Technologies Ltd manufactures and markets continuous ink jet printers, laser coders, outer case coders and thermal transfer over printers that are used on production lines in many manufacturing sectors, including the food, beverage, pharmaceutical, cosmetics, automotive and electronic industries, where product identification codes, batch numbers, use by dates and barcodes are needed. There products are sold through a global network of distributors. Exports account for 75 – 80 % of sales.

LINX was founded by Mike Keeling and Hill Weinberg, two ex Cambridge Consultant employees who had each spent five years at Willett, who at the time of LINX's foundation were the second largest UK inkjet supplier. LINX was formed to exploit legislation driven marketing and coding opportunities in the UK and European market at the end of the 1980's.

LINX was financed by a single round of venture capitalist funding in 1987. During 1992 LINX was floated raising £1.3m after expenses, and then in 2005 was acquired by Danaher Corporation.

In 1988 legislative demands for product coding began to impact on manufacturers. By 1992 growth of total CIJ sales had accelerated by approximately 25%. Demand outstripped supply and many competitors appeared complacent in the robustness of demand and failed to see urgency in the need to continue to upgrade product offerings [30]. This enabled LINX to grow and develop its business over two years without being spotted as a potential threat by competitors.

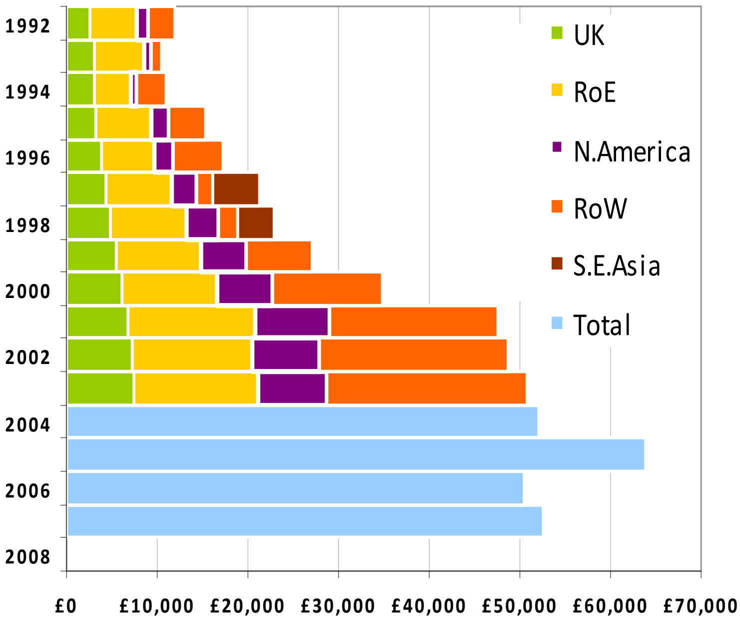

Figure 5
Domestic sales for LINX have never represented more than 28% of total sales

On foundation LINX had

ambitious of being a £30m turnover company within 7 years, to achieve that would required a third of the UK CIJ market. The UK however represented only 17% of world wide demand, establishment of an overseas distribution network was therefore a priority of LINX. In 1988, Imaje S.A, a french competitor with international sales around £10m per annum decided to change from using distributors to direct sales. This left Imajes distributors without a CIJ product range in a market which was growing rapidly. Within 6 months LINX had recruited Imajes former distributors in France, Germany, Belgium, The Netherlands and Switzerland.

3.2 Timeline of key events up until IPO and beyond

Date	Type	Notes
1987	-	Foundation
	Appointments	Marketing and Senior Manager (John Shead and Derek Harris)
	Funding	£83.75k Founders Contribution
	Funding	£870k from MTI and Paribas Technology joint Venture Capital Fund [28]
1988	Distribution	Acquired access to large European distribution network.
1991	Legislation	European Community Directive, all consumable to be marked with sell by date or lot number [29]
1992	Award	Queen's award for export
	Award	Prince of Wales award for Innovation
	IPO	Valued firm at £18.8m, raised £5.7m capital
	Share Price	Halved in value from its initial offer value within several months.
1994	Appointment	Operations director recruited.
1999	Acquisition	Acquired Chinese distributor
2000	Acquisition	Acquired laser coding company "Xymark"
2005	Acquired	Acquired by Danaher Corporation of the US for £86m

[28] Managed Technology Investors (MTI) is a venture capital fund of Prudential Assurance Company, Morgan Grenfell and PA Consulting Services. MTI formed in 1983, takes a hands-on approach to ensure that it is a leader in the field of technology venture capital. The MTI team consists of proven business builders and experienced leaders in the technology sector. Headquarters in the UK, and an US office in Boston

[29] Reporter (1992) 'Fast growth for niche technology' *Financial Times*, 14 October 1992

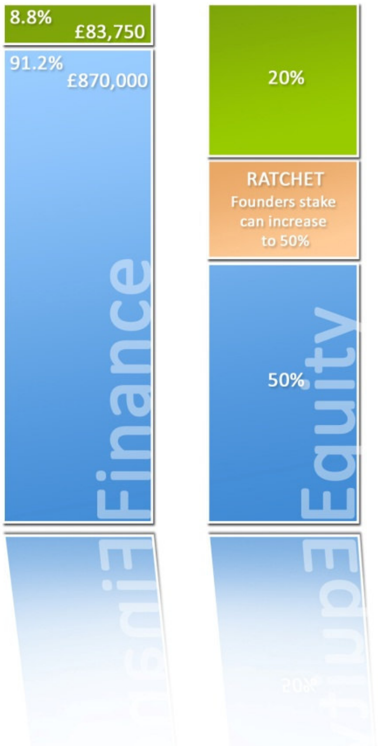

Figure 6
The finance and equity split of LINX in 1987

3.3 Early Stage Funding Details

Founders Contribution, 1987 (Year 1)

Founders contributed 8.8% for the finance for a 20% equity stake. A ratchet in the agreement with the Venture Capital Fund stipulated that the founders' equity stake could increase to a maximum of 50 percent if upon on the realisation of the investment the company was worth more than £30m. [30]

Venture Capital Fund, 1987 (Year 1)

A UK and French joint venture between Managed Technology Investors and Paribas Technology provided 91.2% of the finance for a maximum equity stake of 80% (see ratchet agreement detailed above). The funding was paid in two instalments, £400k followed by £470k some months later.

Initial Public Offering, 1992 (Year 6)

In 1992 LINX floated on the LSE exchange. It intended to use the placing proceeds for acquisitions[31] and to expand its presence in the production line application of ink jet process, with a firm belief that worldwide sales of continuous ink jet printers would grown by 10% per annum for the next few years at least.

Despite the difficulties of a UK economy in recession LINX raised £2m from public investors, allowing its venture capital partners to realise the majority of their original investment. The floatation valued LINX at £18.8m, representing an IRR of 68% over a six year period for the original investors.

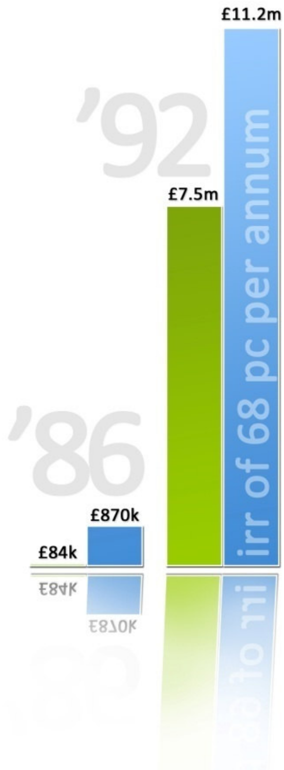

Figure 7
Returns for initial investors after the 1992 flotation of LINX on the LSE

[30] Doyle, P (1998), Innovation in Marketing, p 210

[31] Financial Times, 5 October 1992: LINX print group heads for market via placing

3.4 Downside to floatation on the LSE

LINX managers had been highly successful up until 1992 building an innovative company that had demonstrated significant growth, if helped in part by a conducive and receptive market place.

"*the process of preparing for market listing was extremely onerous on a small and management intensive business during a time of rapid growth and evolution*" Keeling (1994)

In order to complete a successful IPO the senior management had had to divert their attention from the company and its customers to persuade market makers and institutional investors that LINX was an attractive and rewarding business [30]. This wasn't the strength of the board; they were gifted engineers not professional managers and the absence of an operations director to assume day to day responsibility for running the company was missing. Within months of the IPO LINXs share price had slumped to below half of its initial value and was a fledging FTSE 350 stock [32] . In 1994 an operations director was appointed and Keeling was able to return his attention to technical innovation and marketing. The appointment had the right impact, in early 1994 the share price bottomed and began a sustained upward trend.

3.5 Role of Financers

Keeling and Weinberg first tried to find financial backing through the British Venture Capital Association, yet despite excellent technical expertise and a sound business plan were consistently turned down. They correctly concluded that their efforts to raise funding would be far more likely if they were to include an experienced marketing professional and were headed by an established senior management. They made two appointments to solve this issue.

John Shead	Marketing Manager	MBA, had previous experience in major printing companies including Xerox
Derek Harris	Non-executive Chairman	Previous experience as director on the board of a major UK company, chartered engineer, could therefore understand both technical and commercial concepts and complexities.

The changes proved fruitful when Managed Technology Investors co-invested with French firm Banque Paribas.

"*The first thing we look at are the product, its technology, the business and the people, and , if we are satisfied , we will then see whether the financial numbers make sense*"

Dr Paul Castle, founder and chief executive

MTI Managers Ltd

[32] Growth through high value manufacturing (2005), p. 67

MTI gave strong guidance and support particularly relating to issues of financial control. Marketing and technological decisions were left to the expertise of the board who, after the appointments, had that range of experience.

3.6 Concluding Remarks

- Single round of substantial venture capital early on allowed founders to retain a significant equity share.
- Prioritized getting a good balance of technical and business expertise early on.
- Opportunistic – didn't rest on laurels like other firms, and moved to quickly take advantage of large export market. One competitor was still using a critical technology in 1986 developed by the founders in 1975. The new models, which were introduced by Linx, had a specific and important advantage in the area of precise printing on irregular surfaces. [33]
- Successful IPO in tough economic conditions, IRR of 68% for VC
- IPO diverted attentions of senior management that led to a temporary dip in financial performance.

4. Xaar

4.1 Company History (founders and background)

Xaar was established in 1990 to acquire, develop and commercially exploit a new digital inkjet printing technology arising out of work done by Cambridge Consultants Ltd. Today it has revenues of £92m and PBT of £9.8m.

The initial business strategy was to generate revenue from licensing only. This was successful until failure to secure new licence fees in 1999 made the model unsustainable. In 1999 Xaar acquired Modular Ink Technology (MIT), a Swedish company in order to transform to a manufacturing business.

Xaar successfully floated in 1997. The floatation raised £10m capital and valued Xaar at £56.1m [34].

[33] Murray, G, (1996) A synthesis of six exploratory, European case studies of successfully exited, venture capital-financed, new technology-based firms. *Entrepreneurship: Theory and Practice*

[34] Reporter (1997) 'Placing values Xaar at £56m', *Financial Times*, 11 October 1997

By the late 2000’s Xaar had revenues of £48m, of which 87% was represented by product sales, just 9% from royalties and 4% from development fees. Though now an established manufacturing firm, licences put place in the mid 1990s, prior to becoming a direct manufacturer, have created direct competition for itself. In 2008 Xaars licensees gained market share from Xaar, thus reducing their product revenue but boosting royalty income [35].

4.2 Timeline of key events up until IPO

Date	Type	Notes
1990	-	Foundation; spin out from CCL
	Funding	Founders Contribution (5 former CCL employees)
	Funding	£1m from Prelude Technology and 3i for ~50% Equity Stake
1991	Licenses	~£2m from first license sold
1991/2	Funding	£750k Internet Technology Group for 4.1% Equity Stake
	Funding	£750k from Prelude Technology and 3i
1992-7	Licenses	8 sold in total for £2m plus each
1996	Funding	Private Placement raised £12m
1997	IPO	Floatation on LSE raised £10m
1999	Acquisition	Acquisition of MIT36 and established manufacturing in Sweden.

Key Appointment

1991 Graham Wylie Non-Executive Director

- Qualified accountant with 20 years experience in specialising in the development of start-up technology companies in the computer and computer peripherals sector.
- Co-founded Immediate Business Systems plc ("IBS") in 1980 which was listed in 1982 and sold in 1989.
- Joined Xaar as Finance Director in 1991, became Chief Executive in 1993.
- Previous experience key in guiding the company through successive rounds of venture capital funding, a private placing in 1996 and flotation in 1997.

[35] Xaar Annual Report 2008, p.8

[36] Swedish-based Modular Ink Technology was the wholly-owned subsidiary of Pelikan Producktions. Pelikan which was a wholly-owned subsidiary of Nu-Kote International that went into voluntary bankruptcy in the US in November 1998. Xaar funded the deal from cash resources. The acquisition gave Xaar the ability to manufacture piezo-ceramic printheads for both the specialised low-volume industrial / commercial market at its Cambridge facility and to serve the medium-volume market through MIT. The high-volume office market continued to be served through licensees.

4.3 Funding Details

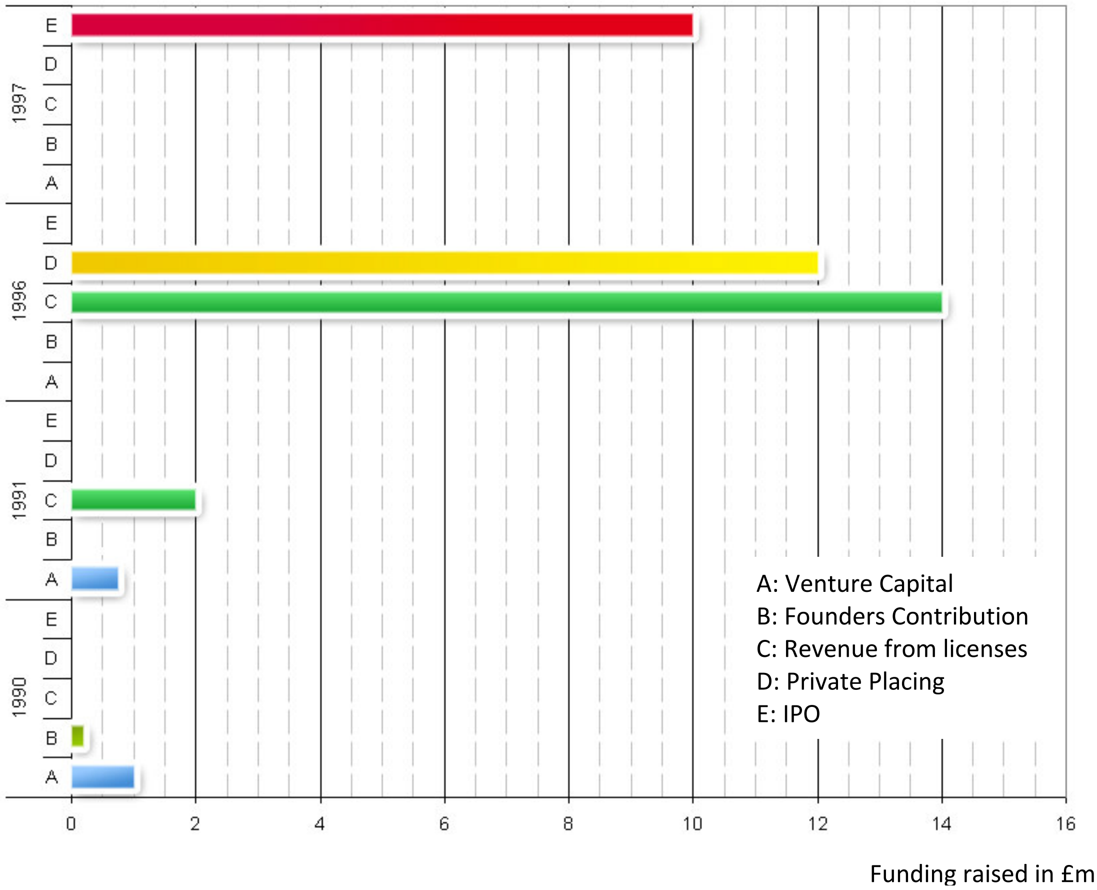

Figure 8
Early funding of Xaar shown by source and year

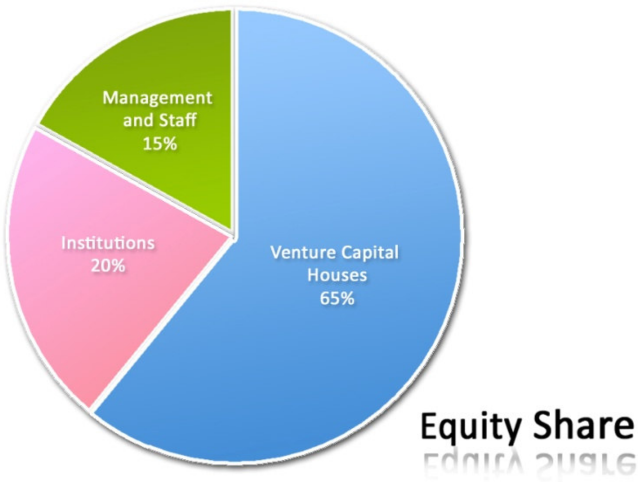

Figure 9
Equity share of Xaar prior to flotation on the LSE in 1997

Private Placing, 1996 raised £12m (year 7)

In 1996 the firm was 75% owned by venture capitalists including 3i Plc and Prelude Technology, half of the £20m placing was used to reduce those equity interests.

The remaining capital raised Xaar invested in its own clean room manufacturing facility to make better and wider print heads

IPO, 1997 raised £10m (year 8)

40% of the money raised was used to build licensing agreements.

XaarJet was established in 1998 using 40% of the proceeds of Xaar's flotation. Xaarjet was established to manufacture and selling high performance specialised print heads and inks for commercial and industrial applications.

4.4 Acquisition details [37]

Xaar agreed to purchase MIT for approximately £3.4m. settled by a payment £2.9m with Xaar forgiving an amount of approximately £500,000 owed to it by Nu-Kote International, Pelikan or their affiliated companies in respect of royalties on sales of printheads and inks. The full cash consideration of £2.9m payable on completion of the acquisition was sourced solely from Xaar's cash balances.

Xaar's directors believed that the acquisition provide an excellent opportunity for Xaar to acquire one of the leading manufacturers of printheads that use Xaar's piezo technology. MIT had manufacturing know-how, a developed product range and an established customer base. The MIT business complemented Xaar's current business in terms of products, sector focus and employee skill base.

Notes

In 1998 the 9^{th} licence agreement was signed by Dainippon Screen Manufacturing Co. Ltd. Screen. Screen held a 3.3% stake in Xaar in 1998 and went on in 2005 to acquire Inca Digital.

4.5 Concluding Remarks

- Xaar is research intensive company with over 20% of turnover going back into R&D [38]
- Funded predominately through Venture Capital Funds before a private placing followed quickly by an IPO.
- Licensing business model resulted in over 250 patents and a further 140 pending in 1998

[37] Regulatory News Service, 12 March 1999, Xaar PLC Acquisition.

[38] Growth through high value manufacturing (2005), p. 88

- Demonstrated ability to adapt business model when no longer suitable. Affects of the previous licensing agreement model resonated on (such as self generated competition) but the change over was swift and successful thanks to the acquisition of a firm with relevant manufacturing expertise.

5. **Xennia**

5.1 Company History (founders and background)

Xennia was founded in 1996 by Alan Hudd who had previously worked for eight years as Fluids Technology Manger at Domino Printing Sciences. Hudd believed he saw an opportunity in industrial inkjet in the "drop on demand" (DOD) techniques and decided to provide solutions for ink formulation. Xennia positioned it self as the world's first one stop inkjet solutions house, offering a fully customized service for industrial applications from initial concept through product development to final printer and ink supply. Xennia is based in the UK and also has a technology team in the United States of America.

Xennia's funding model is unusual compared to the other case's examined as they have not seen any large outside investment, instead have got funding through joint venture projects, topped up by several awards.

The average sales growth of Xennia has been 35% over 2007-2004 with a level of approximately £7m in 2007.

In 2008 Xennia TenCate acquired a control 75% stake of Xennia. Cambridge based Xaar also acquired 9% as part of the deal, leaving Xennia management with 16%.[39]

[39] TenCate Press Release, 29 January 2008

5.2 Timeline of key events up until IPO

Date	Type	Partner
1998	Strategic Partnership	Sarnoff [40]
1998	Strategic Alliance	Trident International [41]
1998	Joint Venture	Source Technologies [42]
2002	Joint Venture	Created "Lumenia" with Leeds Innovations [43]
2002	Joint Development	Forms "Conductive Inkjet Technology" (CIT) with Carclo plc [44]
2003	Joint Venture	Pacific Solar Pty Limited (New South Wales) [45]
2004	Development Agreement	Rohm and Haas Electronic Material LLC (US) [46]
2004	Joint Development	Xaar [46]
2005	Joint Development	Xaar extend joint development programme [47]
2005	Funding	£1m, Xaar takes 10% stake in Xennia [48]
2006	Acquisition	Acquires Vivid Print Innovations, US industrial inkjet generator [49]
2007	Funding	£2.07m, Xennia sells it holding in CIT to Carclo plc. [50]
2008	Acquisition	TenCate acquires controlling interest in Xennia. [51]

5.3 Funding Details

Early Stage Funding

Accounts shown in Appendix 6.1 show that capital and reverses built up from retained profit funded the firm rather than share capital finance as in other cases.

£1m Share Capital from Xaar [48] 2005, (Year 10)

Xennia had been working jointly with Xaar since June 2004, became a preferred integration partner in April. Xaar cemented its relationship with Xennia by taking a 10% stake for £1m cash. Xaar were attracted by Xennia's successes in pioneering ink technologies, including metallics.

[40] *Business Wire*, 13 July 1998: Sarnoff and Xennia Announce Strategic Partnership to Help Inkjet Makers Advance Printing Technology
[41] *Business Wire*, 5 November 1998: Trident Forms Strategic Alliance With Xennia Technology for Development of Next-Generation Industrial Inks for Impulse Inkjet Printing
[42] *PR Newswire Europe*, 9 November 1998 : Source Technologies and Xennia Form Joint Venture
[43] *PR Newswire Europe*, 5 June 2002: The ink is mightier than the pen - against forgery.
[44] *Design Engineering*, 29 November 2002: Breakthrough process prints metal on paper.
[45] *Business Weekly*, 28 November 2003, Xennia widens reach of Oz solar panel.
[46] *Dow Jones International News*, 17 June 2004: Xaar: Two New Development Agreements
[47] *Printing World*, 28 April 2005: Xennia extends Xaar tie-up
[48] *Printing World*, 15 September 2005: Xaar secures Xennia stake
[49] *Ink Maker*, 31 May 2006: Xennia acquires Vivid Print.
[50] *Dow Jones International News*, 1 October 2007: Carclo Buys Conductive Inkjet Technology, Trading In Line
[51] *Hugin Press Release*, 29 January 2008: TenCate acquires controlling interest in Xennia Technology, Financial details were not disclosed.

At the time of the deal Xaar planned to remain a minority shareholder but retained an option to purchase a further 2.5% holding in Xennia at the same price.

£2.07m, Carclo Plc acquires Xennias 25.6% holdings in CIT [50], 2007 (Year 12)

In 2002 Xennia formed "Conductive Inkjet Technology" (CIT) as part of a joint venture with Carclo plc in order to develop technology that will enable manufacturers to precisely deposit and adhere conductive metals onto plastic or paper substrates. In 2007 Carclo Plc decided to acquire the minority interest in Conductive Inkjet Technology held by Xennia, in order to increasing its equity investment in CIT from 74.4% to 100%..

Carclo paid Xennia an initial consideration of £1.07m for Xennia's 5.6% stake in CIT of which £0.97m was in the form of 869,565 new Carclo shares and £0.10m in cash. As part of the agreement, the sale of the consideration shares was subject to lock-up arrangements for one year such that any sale requires the written consent of Carclo. Carclo also agreed that CIT would separately pay Xennia £0.15m for the release of certain intellectual property rights relating to CIT, and £0.10m for transitional support.

In addition, Carclo agreed to pay Xennia a deferred consideration for Xennia's 25.6% stake in CIT of up to £0.75 million, in cash, payable in June 2010.

The first element of the Deferred Consideration is based upon 50% of the EBITDA generated by CIT in the financial year ending Mar. 31, 2010 capped at £0.50m. The second element is based upon sales of MetalJet 2000, 4000 and 5000 production platforms up to Mar. 31, 2010 and is capped at £0.25m.

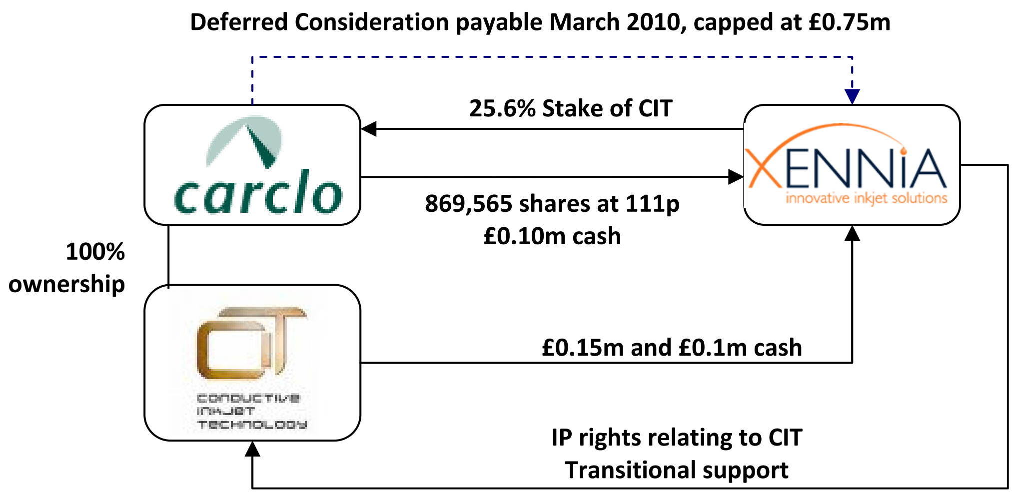

Figure 10
Carclo buys Xennias stake in Conductive Inkjet Technology

5.4 Results of funding method

With no significant outside funding the growth of Xennia has been organic and at times constrained [52]. With much of Xennias work coming from contracted research they have missed out on producing a mass produced product as a method of gaining access to a consistent revenue stream. In 2007 they decided to reassess their growth strategy and looked to take on some funds, which were found through the acquisition by TenCate 53.

5.5 Acquisition details

TenCate was attracted by Xennias strong intellectual property portfolio and a number of key technology platforms for inks / coating fluids and hardware. TenCate had already been working closely with Xennia through the “Digitex” project, a subsidized EU framework development project for digital textile finishing.

Xennias main competitors are in the US and there are companies that are customers, partners and competitors all at the same time. Relationships are complex when Xennia competes and cooperates simultaneously.

5.6 Concluding Remarks

- Not sourcing large funding from an outside source, such as venture capital, combined with having using contracted research as the business model has meant that Xennias growth has been organic and at times constrained.
- By funding through joint ventures the founders have been able to retain a significant share of the firm, yet it is a firm that has grown quite slowly (Turnover £7m in yr7) when compared to other Cambridge Inkjet Firms (Yr 7 revenues, Product based: Linx £12m, Inca £25m, Domino £16m, License based: Xaar £4.4m)
- Technological expertise driving force between all transactions and joint ventures

[52] Growth through High Value Manufacturing, Xennia Ltd

[53] Royal Ten Cate is a Dutch firm (Revenue 2008 €1bn) that strives for leadership in growing market niches for specialist, functional materials. The objective is to contribute to progress in the sectors in which TenCate operates. TenCate develops and manufactures Advanced Materials that are used for protective clothing, in the aerospace industry, in antiballistics, for civil engineering projects, in horticulture, in fish farming, for the manufacture of tents and awnings and in the installation of artificial grass pitches.
Financial objectives

- The net capital employed must generate a sufficient return. The operating result before amortisation as a percentage of net capital employed must be at least 15%;
- The financial position must be sufficiently solid. The ratio of net interest-bearing debt to operating result before amortisation and depreciation (EBITDA) must be structurally lower than 2.5;
- The long-term growth of net earnings per share before amortisation must be at least 10%;
- An appropriate profit margin must be achieved. The EBITA margin should gradually rise to at least 10%.

6. Inca Digital Printing

6.1 Company History (founders and background)

Seven former CCL employees set up Inca Digital Printers in 2000 under the direction of Bill Baxter [former group leader at CCL] including Will Eve, founding member of Elmjet in 1985. Inca assembles wide format printing machines and sells through ink distributors.

Inca is a demand-driven business. It was whilst working at CCL that the founders were approached with inquiries from customers about possibilities of printing packaging at the end of production lines. A prototype printer was made and demonstrated at Ipex in 1998, the interest was so strong as to persuade the founders to write a business plan and seek venture capital funding.

Piezo technology had just been invented and had the advantage of running high-quality, high-colour prints directly onto industrial material. No one had designed a printer for that application, but CCL had invested around £200,000 and the founders had each been working up to 70hour weeks on its development. [54] A chance meeting with the Business Development Manager from Sericol at a conference in 1999 led to a fruitful partnership. Sericol (developer of inks) wanted to get into the digital world and Baxter was aware that his spin out would needed help with marketing.

With the correct mix of technical and marketing expertise they were able to attract VC interest and Inca Digital was formed in 2000. In 2001 Inca shipped its first product, the worlds first commercial digital flatbed printer. Inca broke into profit by year three. It's aggressive growth strategy (avg staff growth of 25pc yoy) and research intensity (30% staff and 15% are in R&D) proved to be a base from which to build a successful company.

In 2005 Inca Digital was acquired by Dainippon Screen of Japan for £30m [55].

[54] *Real business*, 30 August 2007, "How I did it – Inca Digital Printers"
[55] *Business Weekly*, 06 June 2005, Inca growth backed by Japanese parent

6.2 Timeline of key events up until IPO

Date	Type	Notes
1998	Trade Show	Interest shown by customers for product
	Research	CCL spent £200k on research into piezo inkjet technology
1999	Distributor	Agreement with Sericol (ink developer) drawn up
2000	Funding	£2.5m secured from Advent Venture Partners (AVP) 56
	-	Foundation
	Funding	~£350k, foundering partners contribution
2001	Product	First product sold
	Funding	£2m, second tranche of funding led by AVP
2005	Award	Queens Award for Enterprise (International Trade)
	Award	Queens Award for Enterprise (Innovation)
	Acquisition	Acquired by Dainippon Screen of Japan for £30m

6.3 Early Stage Funding Details

£50k, Founders Contribution, 2000 (Year 1)

Baxter invested £50k of his own money into the business, and at this stage no further investment was required from the VCs.

"*VC's don't want a great deal of personal investment. When business owners remortgage their houses and make huge financial sacrifices, it makes them behave too conservatively and cautiously, VCs want people who are going to take risks and really go for it."*

Bill Baxter, founder and MD of Inca (2007)

£4.5m, Advent Venture Partners (AVP), 2000 (Year 1) and 2001 (Year 2)

On May 24, 2000 AVC invested £2.5m, that is when Inca began trading in its own right, and was valued at £6m. A year later AVP led a second round of funding of £2m with Foresight 4 VCT PLC and Gartmore Private Equity.

The acquisition of Inca in 2005 created an IRR of 27% per annum over a 5 year period for Advent Venture Capital on their original investment

[56] Advent Venture Partners (AVP) was founded in 1981 and was one of the first US-style venture capital firms in Europe. In 2008 AVP had over £500m of fund commitments under management. There focus is on venture and growth investment, in two sectors: Life Sciences and Technology. There style is active 'hands-on' involvement from a team of professionals who know the industries in which they are investing and who use their extensive networks to deliver success.

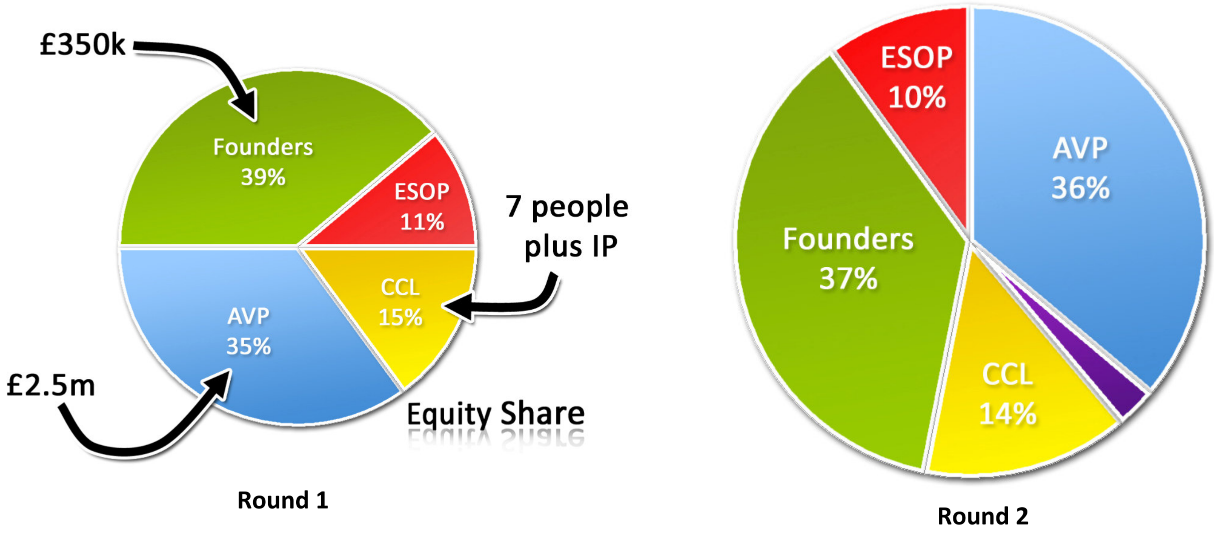

Figure 11

Equity Share after the first and second round of funding, both led by AVP.

6.4 Concluding Remarks

- Market driven. Both market and technology proven prior to company formation.
- Superior technical advantage.
- Two large early rounds of VC funding with minimal number of participants. Retained good equity share.
- Sourced marketing expertise and large distribution network as priority

Summary and Conclusions

Summary Tables

The financial support received within early stages of the firms development are summarised, along with common successes and failings in figures 12 and 13. These two tables give us at a glance an overview of the picture. A picture of NTBFs that rely heavily on government or specialist, technology focused VC funds for equity finance due to an inability to raise collateral based loans in the early stages due to a lack of tangible assets. Figure 12 backs the consensus from the case studies that it is the correct combination of technical expertise together with marketing and distribution channels that make for the most successful ventures.

	Overdraft	Grants	Term Loans	Asset Finance	Equity Finance	Awards	Other		IPO	Acquired
Domino			✓		✓	✓			✓	
Elmjet	✓	✓			✓		✓	User Council		✓
LINX					✓	✓			✓	✓
Xaar					✓		✓	Licenses	✓	
Xennia					✓		✓	Joint Ventures		✓
INCA					✓	✓				✓

Figure 12
Summary of financial support received / access to finance

	Minimal no. of Investors	Technical Expertise	Marketing Expertise	Distribution Expertise	Founders retained equity	Management Distracted	
Domino	✓	✓	✓	✓	✓		
Elmjet		✓				×	
LINX	✓	✓	✓	✓	✓	×	
Xaar		✓	✓	✓			
Xennia		✓			✓		
INCA	✓	✓	✓	✓	✓		

Figure 13
Summary of common success / failings

Conclusions

From the report three distinct points of interest seem to surface. They are;

- **Funding available to early stage firms in the UK**. ICFC played a large role in several of the start ups. ICFC is quite unique in its position as a government created, corporate financial venture capital firm. What affect has that on the firms it backs?

- **Location, location** and its role in creating a seemingly self-perpetuating cycle of innovative start ups. Cambridge has created a cluster of inkjet firms renowned world wide, what role has "Cambridge", what ever that be, played in this?

- **Foreign Acquisition**. Cambridge has been highly successful in creating lots of high technology Inkjet firms, but in doing so has created an industrial and commercial inkjet market place that is highly fragmented. Recently we have seen the acquisition of several firms by large foreign multinational firms, many of who have which acquired in order to absorb into larger business groups. Why hasn't Cambridge, or the UK, been able to create a domestic corporation that could play this role?

Below we will discuss these points in slightly more detail.

Early Stage Funding

Early stage funding from ICFI and/or Prelude Ventures was central to the success of Domino, Elmjet and Xaar, three of the six firms studied.

ICFC is a body that was set up in 1945 by the Bank of England with funding from major commercial lenders to provide capital to small and medium-sized companies [57]. During the 1950s and 1960s, ICFC expanded to become the largest provider of venture capital for unquoted companies in the UK. In 1973 ICFC acquired "Finance Corporation for Industry", a sister company also formed in 1945 which focused on finance for large companies, and was renamed "Finance for Industry" (FFI). In the 1980s FFI became a leading provider of finance for management buyouts, and expanded internationally. In 1983 the company was renamed "Investors in Industry", otherwise commonly known as 3i.

From these origins ICFC as a Corporate Financial Venture Capitalist (VC) Body could act very differently to the typical US VC model. Typically VCs expect exceptionally high growth potential, as only such opportunities are likely capable of providing the financial returns and successful exit event

[57] http://en.wikipedia.org/wiki/3i

within the required timeframe (typically 3-7 years) with a targeted minimum returns in excess of 40% per year. [58] ICFC was formed instead to help provide long-term funding to firms that were too small to tap the stock exchange. [59]

"*ICFC was all about long-termism, its shareholders committed to small companies, a regional structure with local decision-making, high quality well trained executives, superb infrastructure and not much greed.*" [60]

Robert Drummond

Industrial and Commercial Finance Corporation

In 1994 however ICFC, by now known as 3i, underwent sweeping change. The banks sold their stakes in the corporation and 3i was floated on the London Stock Exchange at a market capitalisation of £1.5bn creating a venture capitalist and private equity firm more akin to the typical US model, a radical change from its inception in 1945.

All the activity 3i has played in the Cambridge inkjet cluster we can see from the case studies has occurred pre 1994. In February 2009 the Confederation of British Industry (CBI) published findings that found access to credit is still a main issue for businesses, with almost 60 per cent of those seeking finance revealing availability has decreased in the last three months [61].

"*It's clear that growing numbers of SMEs are going to be in need of the blend of equity and long-term capital that [the ICFC] used to provide – a role that turned out to be especially valuable during the turbulent times of the 1970s*." [62]

Richard Lambert

Director General of the CBI

Speaking to the British Venture Capital Association (BVCA) 2009

As we have seen through all of the case studies, NTBFs find it difficult to fund from anywhere else but specialist venture capitalist funds such as a government back fund (ICFC) or a technical focused fund (Prelude or AVP). NTBFs have limited tangible assets, which significantly reduce their ability to raise collateral-based lending from banks (none of these six case studies did so). Founders of these high

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[58] http://en.wikipedia.org/wiki/Venture_capital#Types_of_Venture_Capital_Firms

[59] This is Money, 15 January 2009, ICFC (Industrial and Commercial Finance Corporation)

[60] *Financial Times*, May 11 2009

[61] Access to finance, February 2009, CBI

[62] http://www.smallbusiness.co.uk/channels/business-banking/news/1007686/uk-needs-new-icfc.thtml

tech starts ups are very heavily dependent on their own personal and family finances for initial funding[63]. We see as well, for example in the case of Linx, that the ability to attract external equity finance is also hampered by their frequent lack of commercial experience and an established track record of successful enterprise.

Investments in NTBFs are notorious for being complex and higher risk rather than their ability to provide investors with attractive returns[64]. As a consequence of this consensus the proportion of venture capital investment that is allocated to technology-based ventures in Europe has diminished from the late 1980s right through the 1990's. In all the cases covered, bar Xennia which uses a joint venture funding model, the enterprises had been financed by specialist, early-stage, and technology-focused venture funds. The advantage of being funded by funds with that technical experience or understanding is clearer communication and the ability of the financer to assistance with additional recruitment to the key management team (which is a common role for venture capital investors). Again this was a point highlighted in the Linx case study.

In conclusion therefore;

Technological focused venture capital or government created venture capital has provide the majority of funding for the spin outs studied, and has in all cases been the most successful. The success can be attributed to

- long-termism stand point of government created funds.
- clearer communication and understanding between financiers and founders.
- greater ability of financiers to provide and advise on appropriate market strategies and business appointments.

The Cambridge factor and transfer of knowledge through people

Cambridge is renowned for high technology spin of firms, and it is a well researched and reported subject. The Silicon Fen Business website says "…there could be anywhere between 1500 and 3500 high tech firms in the Cambridge Cluster, depending upon whose research you believe and how you define a high tech firm…" [65] "...the firms collectively contribute upwards of £4.5bn to the UK's GDP, with the top 20 firms having a market capitalisation of over £6bn…".

[63] Roberts, E. B. 1991. High stakes for high-tech entrepreneurs: Understanding venture capital decision making. Sloan Management Review, Winter, 9-20

[64] Murray, G. C., & Lott, J. 1995. Have venture capital firms a bias against investment in high technology companies? Research Policy, 24(1), 283-299

65Tilston, J (2006), 'It took a while, but the Cambridge Cluster has confirmed critical mass and momentum', *The Silicon Fen Business Report*

Within the cluster of high technology firms sits a world leading industrial and commercial inkjet cluster. Referring back to figure 3 we see that Domino, Willett, Elmjet, Linx, Xaar, Xennia and Inca are all Cambridge based international industrial and commercial inkjet firms, with Domino being a dominate global player. Referring back to figure 3 we see the central role Cambridge Consultants has had in spinning out so many of these firms. CCL have directly created;

- 5 IPOs(4 LSE & 1 AIM)
- 3 high value trade sales
- A combined market value in excess of £2.5bn
- A combined turnover in excess of £2bn
- More than 4,000 new jobs
- At least 20 millionaires [66]

The Inkjet Custer alone has created

- Revenues in excess of £500m per annum
- More than 3,000 jobs
- Major market share participation worldwide
- Diaspora has populated Ink Jet industries in international locations
- Ink jet cluster is enabling "Plastronics" Cluster [67]

An important point to draw from this cluster however is how knowledge and experience is transferred from firm to firm through the movement and appointment of individuals – which seems to fit the Cambridge Consultants model shown in figure 14. Our time line in figure 3 shows clearly how employees move from one firm to another. Also, the importance of R&D contracts in initialising a new stream of technology work that can lead to new firms. CCL employees or ex-employees founded six of the seven firms discussed in this report (Domino, Elmjet, Xaar, Xennia and Inca) all as a result of development contracts by CCL or the early spin-off of CCL. This type of development and spin out enables the founders to reduce some of the uncertainty of the technology (e.g. Domino or Xaar), or to prove the market (Inca) before committing personal or external capital. Such a spin out also makes for a more compelling case for a venture capitalist who wants to see some evidence of plausibility before committing capital (the issue that Linx faced initially).

[66] Wilkinson, E (2008), 'Building a sustainable environment for innovation –a proven model', *Cambridge Consultants*

[67] Barrel, A (2004), Innovation Champions Network: The Cambridge Cluster Description, *Library House*

A recent example of such movement would be in Xennia's appointment of John Corrall as Projects and Production Director in January 2004. Corrall had formerly worked for Xaar, VideoJet and Domino Printing. Xennia were keen to make the appointment due to his "experienced …and proven track record in inkjet product development, manufacturing and field support" [68] . The interconnection are further confirmed when the founder and CEO of Xennia Alan Hudd comments "I have known John since our days when we worked side by side at Domino as inkjet product developers. John has gone on to create a first class reputation in the industry and getting him on board is a real coup for Xennia."

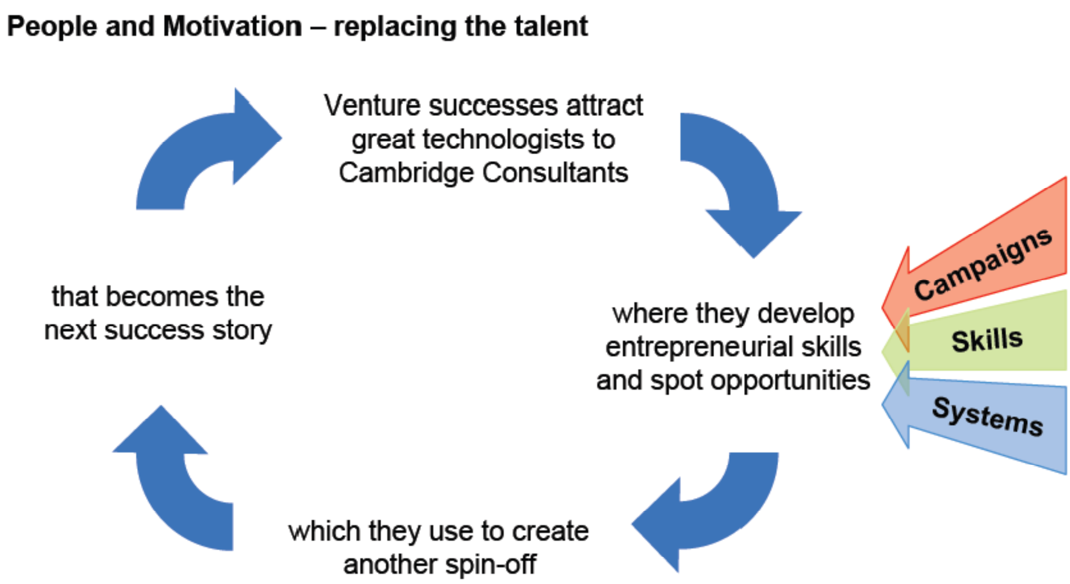

Figure 14
People and motivation – replacing the talent
Source: Cambridge Consultants

This cluster however has grown to date rather organically. Paul Heffernan and Elizabeth W Garnsey (2002) [69] comment that the development of high-tech activity in the Cambridge area was largely self-organising. They discuss that it has reached a stage where congestion effects such as skills shortages, house prices and excess pressure on the local infrastructure, point to the need for improved co-ordination between central and local government and between the university, civic and business communities if the success of the last two decades is to be sustained. [70]

[68] http://www.xennia.com/news/article.asp?ItemID=16

[69] The paper referenced is produced by the Institute for Manufacturing. Permission to quote has not yet been sourced but would need doing if it was to be published.

[70] Heffernan, P and Garnsey, E W, May 2002 No: 2002/01

In conclusion therefore the geographically proximity of these firms has obviously played a large role of Cambridge establishing it self as a centre of Inkjet excellence. The migration of people from firm to firm has provided the mechanism for the transfer of knowledge, ideas and importantly experience (Minto for example was made Chairman of Elmjet for that very reason). As well as a source of experienced staff, these firms, though many small and entrepreneurial start ups themselves, have also been an incubator of new ideas and technologies. The ideas have been incubated until founders are confident in the market and technology, and importantly are confident that they can persuade venture capitalists of the potential successes. For this to continue however, as highlighted by Heffernan and Garnsey, organised co-ordination between the major players in the region (local and central government, universities and industry) needs to be improved to ensure that this cluster continues to operate successfully and efficiently in the future.

Fragmented development of inkjet market and recent foreign acquisitions

What is perhaps most apparent, particularly if you look at figure 3 is the degree of fragmentation in the market.

When Danaher acquired Linx in 2005 they carried out a study into the barriers to market entry and expansion [71] they concluded that,

- Cost of entry into the UK for a supplier of CIJ printers was under £2m
  Cost to an existing supplier to enter the UK market at under £500k
- However they concluded that without the requisite technical expertise and know-how a new company would find it very costly to enter the market given the large R&D investment required.
- Danaher cited a number of recent new entrants at both UK and EU level. This entry they found tended to be from established companies or their subsidiaries already possessing enterprise.

The second and third points certainly seem to concur with the findings of the case studies. Why however firms chose to spin off subsidiaries rather than develop a sub-group remains less clear cut. Possible explains may be that;

- It has become the status quo, and entrepreneurs see it as the tried and tested route to market.
- The technology is highly specialist, and highly tailored to a specific market niche. Skills or research aren't necessarily easily transferred.

[71] Office of Fair Trading, 2004, Anticipated acquisition by Danaher Corporation of Linx Printing Technologies plc

- All the firms studied are small, research intensive companies. They have a small number of highly skilled and trained staff. From the case studies we see that all the firms grow at different rates, and require structural, personnel and management changes as they do so to constantly adapt to their growth. To try and couple two such firms together would be difficult. With no one established firm there would be constant conflict and changing differences between the requirements and needs of each firm. A large, established technology firm would provide a firmer foundation. We've seen this happen recently with the flurry of acquisition activity by large (foreign) multinational firms, of which there are none in Cambridge.

Danaher Corporation who acquired both LINX and Willett International can be taken as an example of this. They advertise "building businesses, building markets", that is acquiring firms as to consolidate them into one of their six product groups (Test and Measurement, motion, hand tools, environmental, product identification and medical technologies) [72]. It is this sort of firm that seems to be currently missing from the UK. Several individuals close to the industry were asked the question "why is this the case" as part of the report, yet none could seem to give an answer.

"*Your question is a difficult one. Videojet is also owned by Danaher so Domino is the only independent player remaining, I think. As the technology and market matures a consolidation of companies is expected, of course, as advantages of manufacturing and marketing scale become important, compared with technological advantage, which, perhaps inevitably, erodes. I guess the simple reason why purchasing has been by US rather than UK entities are that this inkjet industry serves manufacturing which is not a strong sector in the UK. There are no equivalents of Danaher and Dover over here*."

Rick Mitchell

Former Group Technical Director of Domino Printing Sciences plc

In conclusion we have been able to identify how the UK, and Cambridge in particular, have been able to spawn lots of high tech firms through a series of successive spin outs supported by a region of leading research, skilled employees and access to substantial venture capital funding [73]. We are left speculating however as to why it has failed to produce a firm of notable size, one that could assume a growth through acquisition model like the other multinationals mentioned above that look for the synergies these firms can provide to their growing portfolios. This it would seem would form an interesting focus for further work.

[72] http://www.danaher.com/

[73] Cambridge cluster companies secured more than 25% of the UK's venture capital investments and more than 8% of the European total by value in the first half of 2004.

Appendices

Chart 1 – US patents granted in Inkjet printing by country (1st inventor) by year

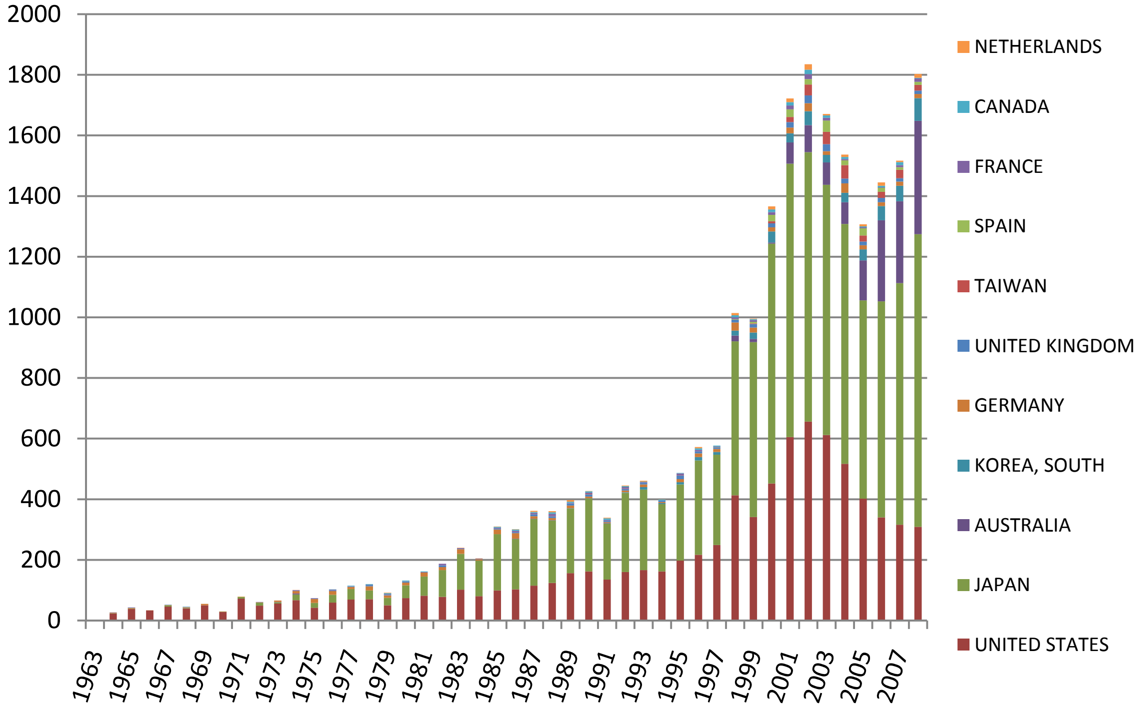

Chart 2 – % contribution of Inkjet printing patenting countries (1st inventor) by year (US Patents)

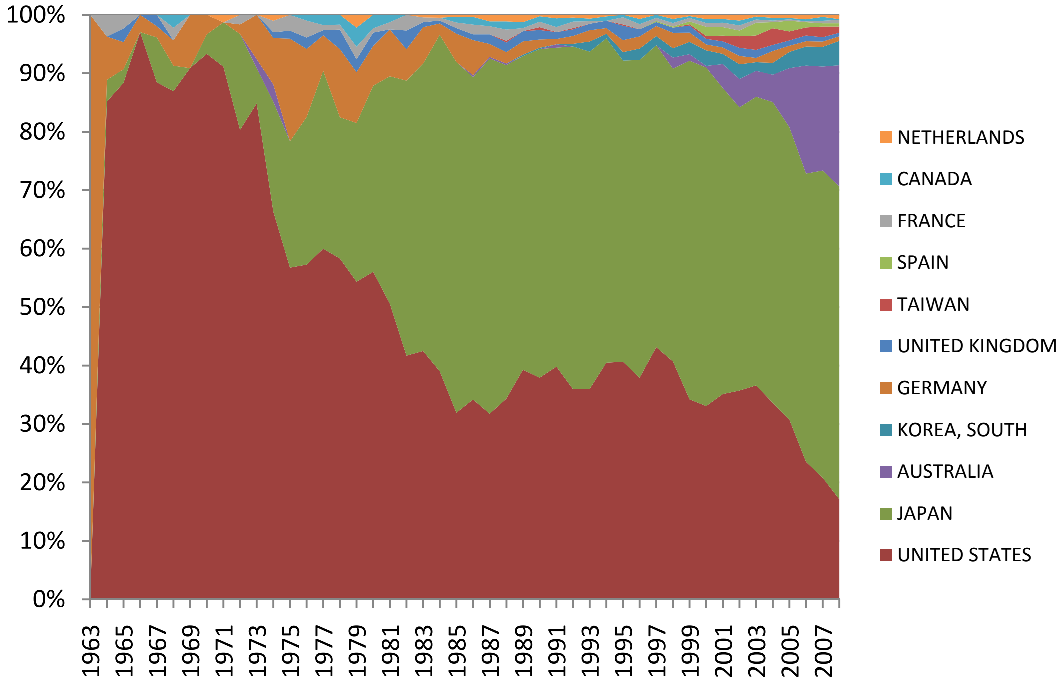

Table 1 – Top patent holders (organisations 1960-2008)

	Top 20 Patent Holders 1960s	Top 20 Patent Holders 1970s	Top 20 Patent Holders 1980s	Top 20 Patent Holders 1990s	Top 20 Patent Holders 2000s
1	Xerox Corporation	IBM Corporation	Canon Kabushiki Kaisha	Canon Kabushiki Kaisha	Canon Kabushiki Kaisha
2	Unisys Corporation	Xerox Corporation	Ricoh Corporation	Hewlett-Packard Company	Silverbrook Research Pty Ltd
3	NCR Corporation	Mead Corporation	Xerox Corporation	Xerox Corporation	Seiko Epson Corporation
4	3M Corporation	Siemens Aktiengesekkschaft	IBM Corporation	Eastman Kodak Company	Hewlett-Packard Development Co.
5	A.B. Dick Company	Hitachi Ltd	Eastman Kodak	Brother Kogyo Kabushiki Kaisha	Hewlett-Packard Company
6	Robert Bosch GMBH	AT&T Corporation	Fuji Xerox Co. Ltd.	Seiko Epson Corporation	Brother Kogyo Kabushiki Kaisha
7	Eastman Kodak	A.B. Dick Company	Toshiba Corporation	Ricoh Corporation	Eastman Kodak
8	Texas Instruments	Honeywell Inc.	Hitachi Ltd	Fuji Photo Film Co. Ltd	Xerox Corporation
9	U.S. Philips Corporation	Canon Kabushiki Kaisha	Mead Corporation	Fuji Xerox Co. Ltd.	Lexmark International, Inc.
10	Honeywell Inc	Nippon Telegraph & Telephone Corp	Sharp Corporation	Minolta Camera Co. Ltd	Fuji Photo Film Co. Ltd.
11	AT&T Corporation	RCA Corporation	Hewlett-Packard Company	Toshiba Corporation	Samsung Electronics Co. Ltd.
12	United States, Army	Texas Instruments	Siemens Aktiengesekkschaft	Sharp Corporation	Ricoh Corporation
13	Canon Kabushiki Kaisha	U.S. Philips Corporation	Fuji Photo Film Co. Ltd	Tektronix Inc	Fuji Xerox Co. Ltd.
14	Hewlett-Packard Company	AGFA-Gevaert, AG	Exxon Research & Engineering Co.	Samsung Electronics Co. LTd	Fujifilm Corporation
15	Seiko Epson Corporation	Ricoh Corporation	Konica Corporation	Rohm Co. Ltd.	Sony Corporation
16	Silverbrook Research Pty Ltd	Matsushita Electric Industrial Co.	Olivetti, Ing. C. S.P.A.	Matsushita Electric Industrial Co.	Matsushita Electric Industrial Co.
17	Hewlett Packard Development Co.	Unisys Corporation	Matsushita Electric Industrial Co.	Lexmark International, Inc.	Sharp Corporation
18	Brother Kogyo Kabushiki Kaisha	Casio Computer Co. Ltd.	NCR Corporation	Hitachi Ltd.	Toshiba TEC Kabushiki Kaisha
19	Ricoh Corporation	Varian Associates, Inc	ALPS Electric Co. Ltd	Konica Corporation	Konica Corporation
20	Fuji Photo Film Co. Ltd	Alden Research Foundation	Pitney-Bowes Inc	Sony Corporation	NEC Corporation

Table 2 – Patents held by cited case study organisations

Piezo-Electronic Drop on printing						
Company Name	**1960s**	**1970s**	**1980s**	**1990s**	**2000s**	**Total**
Xaar Technology Ltd	0	0	0	13	34	47
Vidoejet Technologies Ltd	0	0	0	0	19	19
Dai Nippon Screen MFG. Inc.	0	0	11	14	33	58
Spectra, Inc	0	0	7	31	16	54
Nu-Kote International Inc.	0	0	0	0	25	25
Brother	0	0	7	210	704	921
Siemens	0	25	55	11	6	97
Gould Inc.	0	8	11	0	0	19
Tektronix Inc.	0	3	19	78	4	104
Sharp Corporation	0	8	63	83	125	279
Epsom Corporation	0	0	20	0	0	20
Dataproducts Corporation	0	0	15	29	2	46
Continuous Inkjet printing						
Scitex Digital Printing Inc.	0	0	0	25	19	44
Imaje S.A.	0	0	5	16	14	35
VideoJet Systems Int. Inc.	0	0	4	26	21	51
Domino Printing Services Plc.	0	0	8	12	11	31
AMjet International Inc.	0	1	5	7	0	13
Linx Printing Technologies Plc	0	0	0	5	2	7
Iris Graphics Inc.	0	0	2	4	4	10
Hitachi Printing Solutions Ltd.	0	0	0	0	23	23
Willett International Ltd.	0	0	4	2	2	8

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