Kodak - Leveraging knowledge assets to create new innovation space

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Managing Innovation

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Introduction

The story of Kodak seems to follow a familiar pattern – from an entrepreneurial start-up using a novel technology which it brought to a mass market, through a sustained period of growth before disruption from a new technology which brought about its downfall. In 2011 Kodak filed for Chapter 11 bankruptcy and since then has been struggling to remake itself as a very different kind of business. It closed its film making operations and pulled back significantly from its once-dominant position in the domestic photography market – a move which many interpreted as a failure to master the digital revolution in both technology and user base.

But behind this story a number of counter intuitive themes have been running. First it is important to note that from a technological standpoint Kodak was well aware of the significant shifts which digital imaging was likely to bring and indeed filed some of the earliest patents in the field. Like its rival Polaroid (also in Chapter 11 bankruptcy) Kodak's difficulties with the domestic photography market stemmed less from the technology than from the changing usage patterns enabled by cheap and widespread mobile phone availability and big changes in the way in which images were stored, retrieved and shared across the internet. It didn't help that the company was saddled with major commitments to physical film-making and distribution which meant its room to manoeuvre in the new innovation environment was constrained.

It is also important to recognise that although Kodak made an early and significant commitment to R&D and sustained this through its long history, investing in technologies which linked in different ways to its core business of films and cameras. Like many giant corporations – 3M, Corning, Philips – this gave the company the chance to move into different fields and which enabled them to deal with a shifting external environment. Its core competence for many decades lay in coating complex emulsions on to a variety of surfaces and it was able to deploy this knowledge in many markets for example, in recording tapes and disk drives, as well as in photographic films and plates. The question now facing the company is whether – in the face of massive technological and market disruption – it is able to redeploy its considerable knowledge in new directions to allow the company to grow again?

There are precedents for this – Corning for example moved from being a glass maker to become a major player in fibre optics and communications, and Philips has continuously reinvented itself around core knowledge, with the current shift in its lighting business from incandescent to slid state technology being the latest example. 3M famously began life with a disaster – the Minnesota Mining and Manufacturing Corporation found it was mining the wrong kind of carborundum and was forced to reconfigure itself rapidly to survive.

The case which follows charts a seven year journey along these lines. It looks first at Kodak's significant history in R&D and knowledge accumulation before focusing on a particular transition – trying to

redeploy a powerful technology originally developed for their film business. In moving from film-making to high speed printing as an application domain they are also having to rethink themselves as a business to business (BtoB) rather than a business to consumer (BtoC) operation. But they are also trying to capitalise on another significant shift in the environment – the move towards low volume high variety and customisation of printing which used to be a high volume mass production domain. They characterise this as the move from a business model based on 'point and capture' (their old photo business which they understood well) to 'point and print' – essentially trying to deploy familiar marketing as well as technological knowledge in new ways.

Looking back …..

In 1878 George Eastman demonstrated for the first time to the world the great convenience of gelatin dry plates over the cumbersome and messy wet plate photography prevalent in his day. Dry plates could be exposed and developed at the photographer's convenience; while wet plates had to be coated, exposed at once, and developed while still wet. In 1879 Eastman invented an emulsion-coating machine which enabled him to mass-produce photographic dry plates. A year later, Eastman began the first commercial production of dry plates in a rented loft of a building in Rochester, New York. In January 1881, Eastman and Henry A. Strong (a family friend and buggy-whip manufacturer) formed a partnership known as the Eastman Dry Plate Company. In September, Eastman quit his job as a bank clerk to devote himself full time to the business.

Building a diverse business

By the beginning of the 20th century, Kodak had become the 'Google' of its day, creating an entirely new set of businesses, many of which achieving significant and rapid growth: photography for the masses, motion pictures, and even the first X-ray film receiver. To support this Kodak had become a vertically integrated company and produced a great deal of what it needed internally. Through much of the 20th century it maintained involvement in activities as diverse as cow herding (for gelatin), forestry management (for chemicals), savings & loan banking (for employees) and even providing fire and rescue services. It became such a 'world unto itself' that it even redefined the concept of time in its internal operations!

Some examples give a flavour of this internal diversification:

Eastman Gelatin

At the end of 1881, customers complained about fogged and darkened plates. Gelatin – the key substance which provided the medium in which the active silver and other chemicals were held – was found to be the problem. Gelatin derives from cows and it turned out that Kodak's original gelatin supplier had changed its source. Where its original cows grazed on sulphur-rich mustard the later cows moved to different pastures and lacked sulphur in their diet and this had an impact on the quality of gelatin produced. To deal with this problem Kodak invested in its own herds of cattle to make sure the animals ate the right grass and thus ensured the consistency of photography! It was not until December 2011 that Kodak announced that it had agreed to sell its Eastman Gelatine Corporation business to Rousselot, part of the Dutch Vion Food Group. That decision was consistent with Kodak's previously announced intention to sell non-core assets to sharpen its focus on its digital growth initiatives. Within Kodak, Eastman Gelatin had been successfully managing the transition away from its traditional photographic market by increasingly expanding its sales into non-photographic categories, such as pharmaceuticals, edible protein and food/confectionery. Rousselot is positioned to help Eastman Gelatin continue this growth trajectory outside the photographic industry.

Photo: Kodak of 19th century

Tennessee Eastman Corporation (now Eastman Chemical)

World War I disrupted the supply from Germany of photographic paper, optical glass, gelatin, and many chemicals, including methanol, acetic acid and acetone. At the end of the war in 1918, Eastman Kodak founder, George Eastman, was determined to have an independent supply of chemicals for the photographic processes. Thus, Kodak bought the facilities to make its own supply including Appalachian forests which provided raw materials to make methanol and acetone and to have an independent supply of chemicals for the photographic processes. From its beginning more than 90 years ago, Eastman has grown to be a leader in the global chemical industry.

Eastman Savings & Loan

Eastman wanted to provide the employees with an institution that served essential financial needs, especially for mortgages. On February 1, 1996, Eastman Savings and Loan changed its charter and became ESL Federal Credit Union. Today, ESL offers members much more than just mortgages and is one of the largest and strongest credit unions in the country. It is the largest, locally owned financial institution in the Greater Rochester area and the largest credit union in New York State. ESL is in the top 1% of national credit unions ranked by assets. Since 1920 when George Eastman founded it, ESL Federal Credit Union turned into a full-service financial institution with $4.3 billion in assets. ESL employs more than 640 people locally and about 310,000 members world-wide. The company was twice recognized as one of the Best Small and Medium Workplaces in America by the Great Place to

Work® Institute and presented by Entrepreneur®. Access to the credit union includes 19 branch locations and more than 40 ATM locations, a Contact Center, and Internet, online and mobile banking channels[1].

…and even the Fire Department

Eastman Kodak Company's Kodak Park plant included 121 major manufacturing buildings, nearly 30 miles of roads, 22 miles of fence line, two power plants, its own sewer system, water treatment facility and even the fire department. Since 1897, the Kodak Fire Department maintained a 24 hour presence at Eastman Business Park and responded to all sorts of emergency calls such as fires, chemical spills, odors, elevator rescues and emergency medical service[2].

Cotsworth Calendar

The International Fixed calendar is a solar calendar that provides for a year of 13 months of 28 days each, with one or two days a year belonging to no month or week [(13 x 28) = 364]. It is therefore a perennial calendar, with every date fixed always on the same weekday. Though it was never officially adopted in any country, it was the official calendar of the Eastman Kodak Company from 1928 to 1989 because it fitted beautifully with the manufacturing schedule. The 13-month calendar (also known as the Cotsworth plan, the Eastman plan, or the Equal Month calendar) was in use at Kodak until 1989 for pay and reimbursement schedules.

Commitment to technology

As many other corporations which came to dominate the 20th century landscape, Kodak made an early and significant commitment to R&D. In 1912 George Eastman hired Dr. C.E. Kenneth Mees, a British scientist to organize and head a research laboratory in Rochester, one of the first industrial research centers in the U.S. Kodak Research became one of the pioneers of industrial research with General Electric and AT&T. Its record is impressive – amongst technological achievements Kodak can number several breakthroughs including electrophotography (1975), OLED* displays (1987), inkjet printer (2007), APEX 2008, stream technology 2009. Significantly it produced the world's first digital camera in 1976.

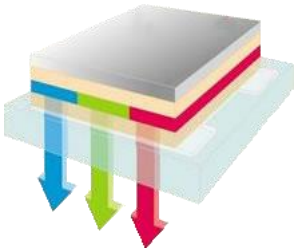
[1] http://en.wikipedia.org/wiki/ESL_Federal_Credit_Union accessed February 2013.

[2] http://pluggedin.kodak.com/pluggedin/post/?id=5289011940653132527 accessed February 2013.

* An OLED (organic light-emitting diode) is a light-emitting diode (LED) OLEDs are used to create digital displays in devices such as television screens, computer monitors, portable systems such as mobile phones, handheld games consoles and personal digital assistants (PDA). Efficient OLEDs using small molecules were first developed by Dr. by Ching W. Tang and Steven Van Slyke in 1987 at Eastman Kodak. The term OLED traditionally refers specifically to this type of device, though the term SM-OLED is also in use. Accessed from http://en.wikipedia.org/wiki/OLED (January 2013).

Electrophotography 1975

Digital camera 1976



OLED 1987

Inkjet printer 2007

APEX 2008

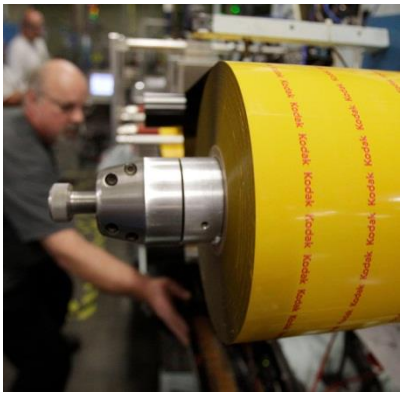
Stream Technology 2009

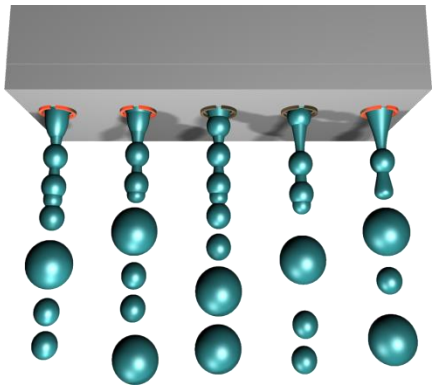
Since the early 1890s most of the Kodak technologies were about building competence in fine coating onto different materials. Its wide IP portfolio is located at the intersection of materials science and digital imaging science, utilizing its history in deposition technologies. Through its R&D Kodak has generated an IP portfolio of 12.000 patents in imaging and related fields, producing them at a rate equivalent roughly to one patent per million US dollars spend in R&D.

A significant amount of this R&D effort went into learning how to deposit layers of chemically active compounds on to various substrates – originally glass plates and later film and paper – and to do so with increasing precision and speed. From a slow manual process in 1878 it moved to a position where it can now deposit billions of droplets per second accurately on to a paper surface using a patented air deflection process. Whilst this knowledge was of enormous value in their film business it had no application in the new world of digital imaging since the manufacturing of film was no longer necessary. But other application domains could be explored and Kodak has realigned this core technology to the world of printing where it is able to use it to produce documents accurately and at high speed.

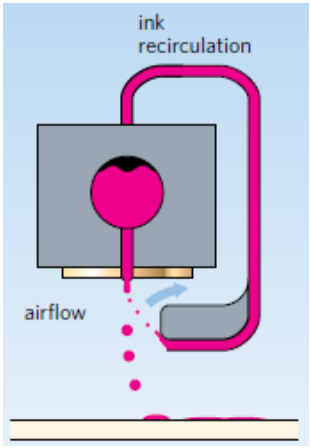
Redirecting knowledge – from photography to printing

The original coating processes in Kodak relied on direct physical contact, using blades and knives to coat the 14 layers of active chemicals needed for photographic film and paper. But a fruitful line of research emerged which involved developing deep understanding of how droplets can be formed from a nozzle and then blown by a highly directional jet of air on to a surface. Using an array of such nozzles under careful control allowed for depositing of billions of droplets per second accurately in patterns on a surface - effectively a spray printing process.





In a classic skunk works project, a small engineering team worked out that if the array could be modulated, it could print patterns of uniform drops at a speed 10 x faster than any other existing technology in the world. This became the 'Stream' inkjet printing system in which a steady stream of fluid is formed under pressure from an array of uniform jetting nozzles. Individual streams are stimulated by thermal energy to break each stream into droplets.



The technology works like a dripping tap in a crosswind. Drops created by tension fall from the nozzle and are deflected by airflow. If the drop is one that is needed for printing, the frequency is adjusted to make the drop larger, which in turn makes it less affected by the airflow so it falls onto the page. The smaller, non-printing drops with less mass are deflected into a recirculation unit for reuse. In effect the Kodak technology offers a novel print head which:

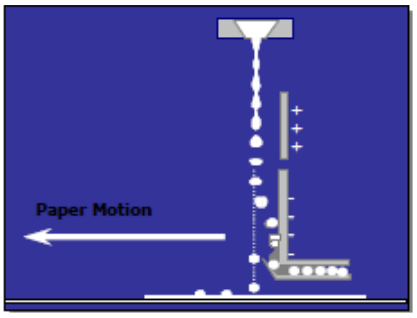
- offers high productivity, reliability, cost, and quality;
- supports a range of papers and substrates;
- produces up to 3,000 ft per minute;
- makes 5.1 Billion ink drops per second;
- introduces a technology so fast that it can print as many pages as in a standard Bible in 4.2 seconds.

The potential of this technology as a fast printing system should not be underestimated. Currently high speed printing – for example for newspapers or magazines – uses offset printing technologies where images are transferred via rollers operating at high speed to spread patterns on to paper. Being able to match these speeds but also to control the images directly and to high accuracy could offer a disruptive technology in this market. Just as Gutenberg's original innovation of printing in 1454 allowed a shift from slow hand engraving of books to fast reproduction cutting production time from months or even years to minutes, so the Stream process could accelerate today's printing processes. By the

end of the fifteenth century, hundreds of book titles were being produced each year on wooden hand presses like Gutenberg's[3]. [4]

Importantly the high levels of control also allow for quick changeover effectively bringing flexibility to the world of high speed printing which ahs hitherto been a mass market application. It enables high speed printing at offset printing quality but with a new and unique advantage – every page can be different. So low volume high variety – even customised printing – becomes possible, with significant implications for new market entry. As Ronen Cohen, Vice President of Marketing, Kodak Inkjet Printing Solutions explains, *"Stream Technology provides a number of flexible features to meet the needs of commercial printers for applications like direct mail, catalogs, and free standing inserts.*

Kodak's understanding of how droplets form and can be controlled also means that the particle size (which affects the colour and precision of the final image) can be managed much more effectively. As *Technology Watch* magazine reported, the pigments in Kodak Inks "*range from 10 to 60 nm mean particle size, meaning that the pigments are much smaller than the wavelength of visible light, greatly reducing scatter, resulting in brighter, cleaner colors …… Kodak's color gamut is superior to offset"*[5].



To come up with a product for use in the printing industry, Kodak had to pull together 3 disciplines:

(i) the Stream print head;

(ii) the paper transport and ink recirculating systems (these were available from Versamark, a company purchased in 2003); and

(iii) inks & media which draw on Kodak's long history in chemicals and imaging. Ink in the system needs to be as mobile as possible but once it hits the page it needs to become as permanent as possible. From a technological point of view it is important to formulate inks so that they will provide the best performance. For example Kodak innovated in ink design creating very small (nanoscale) pigment particles with a uniform particle size. This is achieved using a micromilling process that was developed back in the film days, linked to the creation of small particle silver halide crystals.

In pulling these technologies together, the following results are achieved. Printing has equal or better quality with less ink with lower cost of operation. The equipment has less wear and tear on inkjet nozzle. The end product has less scattering of light, more color and vibrancy. Offset quality

[3] Source: http://www.hrc.utexas.edu/exhibitions/permanent/gutenbergbible/history/#top accessed March 2013.

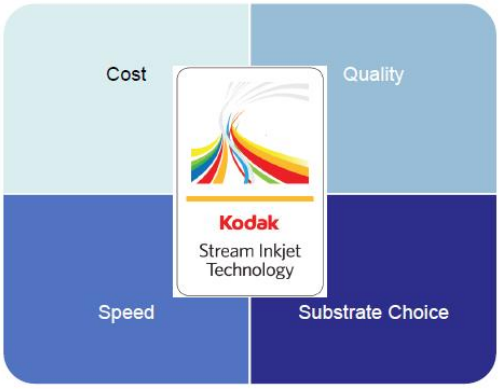
[4] "The printer first cut a block of hard wood the size of the page that he was going to print. Then he cut out every word of the written page upon the smooth face of his block. The letters were inked, paper was laid upon them and pressed down. With blocks the printer could make copies of a book a great deal faster than a man could write them by hand. But the making of the blocks took a long time, and each block would print only one page"[4].

[5] Source: http://graphics.kodak.com/us/en/about_gcg/news/2012/121009b.htm accessed March 2013.

has enhanced optical density and blackness. For coated glossy papers the permanence of the final results are in fast water and light. For a user, the new approach is easy to integrate on-line with analog printing presses in hybrid environments.

Value creation through technology

Simply having a technological superior system is, of course, no guarantee of successful innovation. It is important to explore the potential of this invention from the market perspective and to understand the needs of commercial printing. In general terms the requirement is for high speed, high quality, and the ability to print on a range of substrates, at low cost. Stream is the first digital printing technology to offer these at levels which compete favourably against traditional offset printing – but it also offers the fifth benefit of enabling every page to be unique. Offset printing, by contrast, works most efficiently on long production runs – such as in the newspaper market.



Given the growing demand for higher variety and more customization around short runs (multiple editions, local variants, etc.) there is clearly significant potential for digital printing technology to displace offset and possibly disrupt the industry.

The printed newspaper has been around for well over a century and although the production technology has changed significantly, the basic product has not. In particular there is still an assumption of mass production and distribution with limited variety. But increasing pressures towards customization and the availability of enabling technologies may change this picture. For example, an average customer might browse through 60% of the paper and read in depth 10% of what serves his/her interests. The challenge is to find ways to increase the customization of the paper by developing the 10% personal interests element without incurring heavy cost penalties in production or quality.

Kodak sees the solution in 'Prosper' printing, which offers a highly customisable product but one which is produced at offset printing speed. This enables much wider market segmentation and targeting since every page can be different but still printed at offset speed, quality and cost. Volume flexibility is another advantage – it becomes possible to print an order to fill each delivery van with exactly the mix they need by shop on their route. A third advantage is the elimination of change-over and set-up time and cost since switching from one newspaper to another is carried out in software. The same press can produce a variety of different titles, with every copy different, produced in an order that fits with the van route. Each shop can get a unique mix of papers bundled together straight off the production line.

Summary

Much of the discussion about Kodak as an innovation case study relates to its apparent failure to come to terms with the challenges of digital technology. But as this case suggests the reality is different – although the sheer scale of the disruption caused by the disappearance of the physical film business has been difficult there are still significant growth opportunities for the business if it can continue to redeploy its extensive knowledge base in new directions. Interestingly by 2010 75% of Kodak's revenue came form digital product lines, much of it in the less visible but valuable business-to-business market.