Hasselblad and the Shift to Digital Imaging

Christian Sandström
Chalmers University of Technology

Throughout the 1980s and 1990s, the high-end Swedish camera manufacturer Hasselblad struggled to integrate its product lines with emerging digital imaging technology. Hasselblad's history illustrates how digital technology emerges in various high-end niche applications and later enters the mainstream markets and displaces incumbents. The Hasselblad case exemplifies how incumbent firms encounter difficulties when such technologies render their skills and products obsolete.

In 1977, Intel's cofounder Robert C. Noyce called attention to the rapidly increasing use of digital technology in many industries. Although he argued that this trend would create a lot of entrepreneurial opportunities, Noyce also suggested that established firms would encounter major difficulties once their products were replaced by the new technology:

> Time and time again the rapid growth of the market has found existing companies too busy expanding markets or product lines to which they were already committed to explore some of the more speculative new markets or technologies.[1]

Pointing to how mechanical calculators and watches were forced out of the market in the 1970s, Noyce argued that more such displacements would happen in the future because digital technology would provide better performance at lower costs over time.

In retrospect, it is striking how accurate Noyce's prediction turned out to be. In industry after industry, digital technology has disrupted the former technology and created countless problems for established and highly profitable firms. Since Noyce's article was written, products such as telephones, music players, television screens, movie cameras, and gaming machines have become digital. With few exceptions, these shifts have implied major difficulties for incumbent firms.[2] Over the last decade, the camera industry has been subject to precisely this kind of turmoil because of the shift from silver-halide photography to digital imaging. Several established firms have either encountered severe problems or gone out of business completely.[3]

This article describes how Hasselblad, a small Swedish manufacturer of high-end cameras, tried to nurture and develop digital photography from the early 1980s onward. It provides a good illustration of how digital technology emerges in various high-end niche applications and how it later enters the mainstream markets and displaces incumbents. In doing so, this work contributes to the literature on disruptive innovation and to our understanding of how industries are digitized.

Technological Discontinuities and Digital Technology

It is well documented today that established, successful firms often get into trouble under conditions of discontinuous technological change.[4] Several scholars have sought to explain what is sometimes referred to as ''the incumbent's curse'' by looking at the supply-side and firm capabilities.[5] For instance, Michael Tushman and Philip Anderson wrote about competence-enhancing and competence-destroying technologies. They argued that the technologies that render the technological skills of established firms obsolete tend to create major difficulties.[6] Drawing upon a case study of how Polaroid sought to handle the shift to digital imaging, Mary Tripsas and Giovanni Gavetti pointed out that cognitive barriers among managers prevented the firm from commercializing

 Published by the IEEE Computer Society 1058-6180/11/$26.00

Digital technology has often exhibited disruptive characteristics.

the new technology.[3] In another article, Tripsas studied the typesetter industry and argued that only a firm's technological competences matter. The impact on firm-specific complementary assets—assets that were not directly related to the technology but helped the firm sustain its competitive advantage—also played a key role in a technological shift.

In a series of articles from the mid-1990s, Clayton Christensen shifted the focus away from supply-side-related factors to look at the impact a new technology has on the market. Drawing on evidence from the disk-drive industry, he argued that the technologies that were not initially demanded by a firm's existing customers were particularly difficult to handle.[7] Each new generation of smaller disk drives offered lower performance in terms of storage capacity and therefore started to prosper in lower segments or in new markets. The incumbents struggled to find a financial logic in entering an inferior technology that grew in a small, low-end niche of the market. As the performance improved, it eventually displaced the former disk drives and the established firms who were misled by existing customers. Christensen labeled those technologies that were cheaper, with initially lower traditional performance and some new attributes, as *disruptive*. The technologies that kept satisfying a firm's existing customers were referred to as *sustaining*. His book *The Innovator's Dilemma* showed that incumbents tend to win sustaining battles whereas entrant firms are better at introducing disruptive technologies because they are not held captive by an established customer base.[7]

Digital technology has often exhibited disruptive characteristics. Although frequently starting off with inferior traditional performance while bringing new attributes to the market, the rapid pace of development in digital technology makes it attractive for mainstream customers. It then displaces the former technology. For instance, Christensen and Michael Raynor used the transistor radio as an illustrative example of this pattern.[8] Compared to analog radios, it had a poorer sound quality, but it brought some new attributes to the market, such as a lower price and portability. Therefore, it prospered among teenagers who previously could not afford a radio. This customer segment appreciated the portability and did not bother about the lower sound quality. In the 1950s, entrant firms such as Sony created a mass market for transistor radios, and as the sound quality improved over time, this technology eventually displaced analog radios and established firms like RCA.

Clearly, Christensen's notions of sustaining and disruptive technologies have shed new light on how discontinuities happen. However, it is still a bit unclear how this framework fits with the nature of digital technology. The dynamics of digitization have often been described in terms of a rapid increase in performance along with declining prices. For instance, Intel's other cofounder Gordon Moore predicted in 1965 that the amount of transistors that could be crammed onto an integrated circuit would double every 18-month period.[9] Often referred to as Moore's law, this prediction can be thought of as a description of the rapid development of digital technology.

Although digital technology has often brought some ancillary attributes to the market, it has usually, as Moore's law would suggest, started off with poor performance and a high price. Consequently, in many cases it has initially prospered in advanced segments that are not sensitive to prices, such as in military or scientific applications.[10] Therefore, it is unclear in what way Christensen's framework, which focused on low-end applications, is compatible with the economics of digital technology. Christensen showed how the disk-drive manufacturers were displaced when entrants introduced smaller drives, targeted low-end segments, moved up in the market, and removed incumbents. Thus, it is unapparent whether this pattern is compatible with digital technology's growth. By studying how and why digital imaging emerged in Hasselblad's segment, I argue that digital technology is substantially consistent with the notion of disruptive technology, albeit in a way that differs from what has been previously suggested.

Hasselblad and Early Digital Cameras

Hasselblad became a dominant player in the medium-format segment of the camera

industry after WWII. This small segment of the camera market used larger film than the normal 24 × 36-mm format and was aimed at professional photographers with high demands on image quality. One reason for Hasselblad's dominance was that its cameras were compatible with a range of lenses manufactured by Carl Zeiss, film magazines, and other accessories used by photographers. Hence, a photographer who used a Hasselblad camera had great flexibility. But Hasselblad did not develop these products.

The company became world famous in 1969 when Neil Armstrong took the first photos on the moon with a Hasselblad camera. During the 1980s, the firm had about 500 employees and an annual turnover of approximately 600 million Swedish Krona (MSEK). The company showed relatively high profitability in these years, delivering annual profits of 50 to 60 MSEK. However, the medium-format segment decreased by approximately 40 percent from 1981 to 1985, mainly as small-format cameras improved.[11] Despite this reduction, Hasselblad managed to sustain its revenues and profits in these years, mainly thanks to its strong brand.

The camera industry had reached a mature phase toward the late 1970s. By that point, Japanese firms such as Canon, Nikon, Olympus, and Fujifilm had entered the scene and captured market shares primarily from European companies like Leica and Rollei. Technologically speaking, the industry had reached a point of saturation. Rolls of silver-halide film in various formats were used in cameras that were essentially based on precise mechanics. Although Kodak had exhibited the first digital camera that used a charge-coupled device (CCD) in 1975, it had not caused any panic among the established firms.

In 1981, however, the entire camera industry was shaken when Sony introduced its Mavica, the first fully electronic, non-film-based camera. The camera stored images on floppy disks instead of film. It was presented as a still-video camera. Images were captured by a CCD chip, transformed into electric signals that were handled by processors inside the camera, and stored on a floppy disk. Fifty photos could be taken and viewed on a TV screen later.

Many Japanese companies became concerned that this new technology would eventually replace their current products. A few years later, Canon, Fuji, and several other firms had developed their own versions of the Mavica that they exhibited at the annual Photokina fair. Photo journalists argued by that time that the camera industry would become computerized at the same pace as the calculator and watch industries had during the preceding decade.

At Hasselblad, the company's CEO Jerry Öster tried to figure out how to handle this potential threat: ''I met with Sony's CEO and the person behind the Mavica project. It soon became clear to me that the technology had so many drawbacks and limitations that it would not become a commercial success.''

After consulting Hasselblad's R&D manager, Lennart Stålfors, Öster concluded that several technological breakthroughs were needed before the Mavica concept could threaten analog photography. Öster and Stålfors also agreed that digital imaging had a future and that the company ought to learn more about the new technology.[12] Hasselblad's attitude toward digital imaging in the early 1980s is well captured by this comment from Öster:

> Even though I did not believe in the Mavica concept, I was convinced that the photo chemical film would in the future be subject to serious competition from electronic photography and would eventually be replaced by this technology.[13]

Hasselblad Electronic Imaging

Instead of trying to develop a digital camera, Hasselblad explored the new technology through various applications. Stålfors had a background in electrical engineering and had previously been working on adding electronic features to the Hasselblad system. Among other things, he had been involved in a development project together with Saab and a professor at the Royal Institute of Technology in Stockholm that included an image analysis machine. The final product, named Osiris, was primarily intended for digital analysis of images taken by aircraft and satellites. In the end, the project became a commercial failure—the price was too high and the image quality too low. Hasselblad therefore left the project in 1982 after two years.

The insights Stålfors gained from this project made him realize that the technology for telephoto transmission—the sending of images over the phone line—was underdeveloped. Images lost considerable amounts of

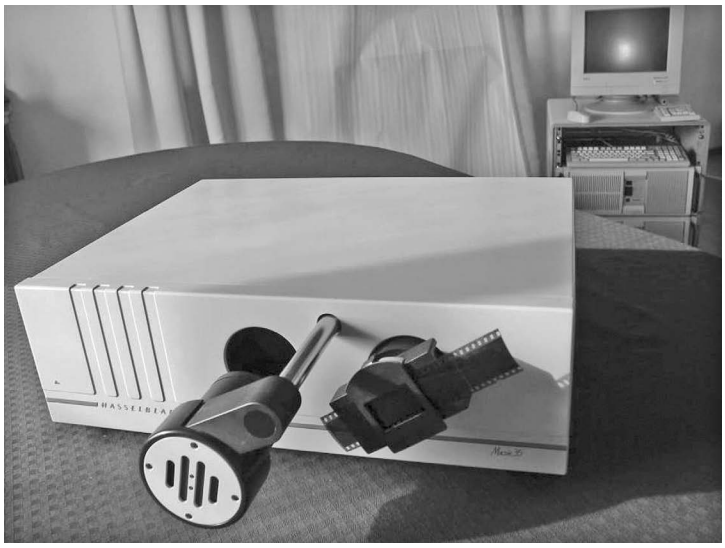

Figure 1. The Hasselblad telephoto transmitter. Hasselblad developed the Dixel 2000 as the Digiscan's successor in response to a large order from the news agency Agence France Presse. (Courtesy of Lennart Stålfors.)

quality when being transferred. Consequently, photographers had to bring darkrooms with them to finish photos and send the photos. The equipment weighed 10 to 12 kilos, which in combination with the darkroom became a heavy burden for photographers. The analog technology also implied that small amounts of noise over the phone line would significantly distort the images. Hasselblad looked into using technology to create a telephoto sender that was faster and offered superior image quality. Such a product would clearly make photographers' everyday lives much easier.[14]

Hasselblad wanted a potential partner to begin using their upcoming product to create attention around it, so they contacted Lars Falén at *Expressen*, one of Sweden's dominant newspapers at the time. Falén thought that such a telephoto transmitter would be interesting to use during the 1984 Olympic Games in Los Angeles. He explained that the newspaper only had 30 minutes until press stop after the last finals, and he needed a product that would enable the most recent photos to be included in print.

The development work started toward the end of 1982, and about five people were involved at Hasselblad. With these scarce resources and a sharp deadline 18 months away, the team worked hard and eventually produced two functioning prototypes of the Digiscan to send with *Expressen* to Los Angeles in July 1984. Digiscan was an abbreviation of the digital scanner that could digitize film and offer 1-megapixel (MP) resolution of the scanned film. The images were sent via modem, directly from the Olympic stadium to Stockholm, Sweden. By doing so, the photographer gained about 40 minutes and obtained much better image quality.[15]

The Digiscan became a great success for *Expressen* because the newspaper was able to get pictures in print faster than its competitors. The news agency Agence France Presse (AFP) became interested in the product and offered Hasselblad a visit to Paris to discuss a potential collaboration. The two parties agreed that Hasselblad would further develop Digiscan, provided that AFP bought 40 of them for 120,000 SEK each. AFP signed and paid one third of the sum up front, and this led to the development of the Dixel (see Figure 1).

Hasselblad's work had initially started off as an effort to learn more about digital technology and quickly turned into a business opportunity. The company now had to decide how the digital development should be organized. Digiscan had been developed by Hasselblad's R&D department. It had included some of the company's key staff and had been fundamentally different from the daily development work at Hasselblad.

Öster thought that digital development should be put outside the parent company and therefore started the subsidiary Hasselblad Electronic Imaging AB (HEIAB) in 1985. The former R&D manager, Lennart Stålfors, became the CEO of the new company. Öster and Hasselblad's CFO Bengt Ahlgren were also members of the board. In the 1985 annual report, Öster wrote, ''The Dixel 2000 is a natural link for Hasselblad between the traditional chemical photography and tomorrow's electronic image technology.''[11]

Initially, three employees worked at HEIAB. The company's ambitions were not high in the beginning, and the subsidiary was often regarded as an attempt to create knowledge rather than profits. The subsidiary had only six employees in 1986, but it grew rapidly over the coming years. The Dixel was launched on a much bigger scale than the Digiscan and the demand for it grew quickly. During 1987, it was used at many large sports events, including the global athletics championships in Rome. As sales grew, HEIAB became increasingly profitable. The subsidiary had only cost 3.5 MSEK before it broke even in 1988.

Over time, several other products related to digitally transmitting and handling images were developed. By the early 1990s, HEIAB's revenues had grown to approximately 50 MSEK and showed good profitability. Between 1990 and 1991, 20 to 25 percent of the company's total profits came from an organization that had only existed for a couple of years.[16] Table 1 shows HEIAB's financial data for 1985 to 1992.[17]

The work at HEIAB generated valuable knowledge and created a new source of profit for the company.[18] In the 1980s, the camera industry's medium-format segment became increasingly saturated and was even subject to negative growth. Hence, the profits that came from HEIAB were needed in the mother company because it was hard to find new sources of growth within the core business.

By the late 1980s, the uncertainty regarding digital imaging was still high. Both Canon and Fujifilm had tried to launch their own versions of digital cameras without any success. Many electronic still-video cameras had been shown on camera exhibitions during those years, but they all had poor image quality and a high price. Since the early 1980s, photo journalists had claimed that analog photography would become history within the coming two to three years, but this had obviously not happened in the camera industry by the end of the 1980s.

The most notable difference between watches and calculators and the camera industry is that the digital technology in a calculator or a watch does not have to be light sensitive. In watches and calculators, electronics displaced discrete mechanical parts inside the products, but cameras were different. Both analog and digital cameras contain large amounts of optics, chemistry, precise mechanics, and electronics. Moreover, an image sensor must be light sensitive, so the demands on digital technology were significantly higher within the camera industry. For instance, by the late 1980s, Nikon launched a still-video camera with 0.6 MPs. In comparison, a photo taken with an analog Hasselblad camera would correspond to approximately 36 MPs, whereas a photo taken with small-format film would be similar to 10 MPs.

Table 1. Financial data for Hasselblad Electronic Imaging AB (HEIAB), 1985–1992.[17]

Year	Revenues (MSEK)	Profit (MSEK)	Profit margin (%)
1985	0	0	0
1986	4	0	0
1987	11	0	0
1988	20	2.5	12.5
1989	30	5.6	18.7
1990	48.6	11.6	23.9
1991	60	11	18.3
1992	48	3.5	7.3

''We should not become a new Facit!''

> Hasselblad's long-term survival may depend upon how much resources we invest in the development of a new digital camera.
>
> —CEO Jerry Öster, 10 February 1994[19]

At its peak, HEIAB had 43 employees in 1992, but the times were about to change. Much of the subsidiary's success could be attributed to the Dixel. However, in 1992, Nikon launched a telephoto scanner that revolutionized the industry. It was better than the Dixel in all respects, and consequently, Hasselblad sales diminished rapidly. Responding to such formidable competition was not an option for a small niche player such as Hasselblad, and therefore HEIAB instead focused on software over the coming years. Nikon's hardware and HEIAB's software came to dominate the market for a few years, but nevertheless, HEIAB had reached a dead end by around 1993–1994.[20]

Another important change was also taking place in these years. After 16 years as CEO, Jerry Öster left Hasselblad. Before leaving, he pointed out that the firm's long-term survival would to a large extent depend upon how many resources the company dedicated to digital imaging.

Hasselblad's owner, Incentive, listened to this advice and began looking for a CEO who could take Hasselblad into the digital era.[21] Eventually, Incentive recruited Staffan Junel. He had a background as a computer science engineer, with many years of experience at the telecommunications company Ericsson, and had experience working with digital technology. One of the first things he did as CEO was to gather the top management and all expert engineers to discuss the long-term prospects for the company. Junel recalled:

> We tried to look into the future and understand where the company would be in 2010. This question inevitably drew us to the issue of the substitution of film by digital imaging. We agreed that 50 percent of our market would be digital somewhere around 2005.[22]

The conflict between analog and digital development would become much stronger over the next few years.

While some of the electronic engineers thought that this would happen even earlier, others argued that it would take more time. Nevertheless, they all agreed that in the long run digital technology posed a serious threat to the established camera industry. Junel thought that it was important for Hasselblad to develop its own digital products in order to obtain knowledge that it would need in the future. The board agreed that it was time to invest more in digital imaging. Therefore, a new division called digital photography was started inside the parent company in autumn 1993.[23] The initial purpose was not to develop a digital camera, but rather to learn more and follow the development, especially in the area of image sensors.

Junel recalled how top management kept repeating that ''Hasselblad will not become a new Facit.'' Facit was a Swedish manufacturer of mechanical calculators that collapsed in 1971–1972 because of the rapid shift to electronics. Ever since, Facit had been regarded as an infamous example in Sweden of what happens to firms when they miss technological shifts.

The new division was headed by the former HEIAB CEO, Stålfors. Because HEIAB was now in sharp decline, many engineers from the subsidiary moved to the digital photography division. After spending some time on knowledge development, Stålfors argued that the improvements in the image sensor area had been so rapid that it was time for the company to start developing a new camera system. Junel explained this to the owner and asked for more resources. Incentive wondered whether Junel was willing to terminate analog development activities at this point. Junel argued that development of the analog system was still needed, but that it did not have to take place with the same intensity as before.

The conflict between analog and digital development would become much stronger over the next few years. However, Incentive agreed with Junel at this point and provided more resources. Even though the company spent about twice as much on analog development, this should still be regarded as a major step into digital imaging for a small company such as Hasselblad. After all, digital imaging would in many ways render the existing skills in precise mechanics obsolete. The company therefore sought to renew its competence base early on.

''Crystal Ball''—Development of a Digital Camera

It was soon clear that digital imaging had properties that made it significantly different from analog photography. For instance, at this point, it was virtually impossible to photograph moving objects with a digital camera. Even though the image quality was surprisingly good at this early point, it did not correspond with what Hasselblad's film-based images could offer. For decades, Hasselblad had relied on superior image quality in their marketing activities. Additionally, image sensors were expensive.

However, digital imaging had other characteristics that made it attractive. For example, images could be viewed instantly and more conveniently copied, sent, and manipulated. Moreover, an infinite number of images could be captured at virtually no cost. In photography segments such as photo journalism, many images were digitized sooner or later, so digital imaging helped remove one step in this process.

These properties meant that Hasselblad had to look for niche applications where digital imaging could create more value than analog technology, despite its lower image quality and higher price. After having performed some market research, Stålfors and his colleagues thought that studio photography would be such a niche.[24] In this segment, customers could be willing to trade off some image quality in order to capture, duplicate, manipulate, and send images at a much lower cost. The fact that such a camera had to be big and stand on a tripod would not be a problem for this customer segment. The idea was to start off with small volumes, charge a lot of money (about US$50,000 for a camera), and then make incremental system developments and lower the price over time. It would initially be targeted to large studio, catalog, and product photography and later would enter Hasselblad's mainstream segment of wedding and portrait photography.[25]

This project was pursued under the name Crystal Ball, for two reasons. First, the product would in the end look like a crystal, and second, management hoped that it would guide the company into the future just like a crystal ball.

The engineers made sure to create a modular system to enable future improvements of each component. Although the goal was to create a commercial product, the main purpose was not to dominate the market with it. Rather, it was an attempt to establish Hasselblad as a digital actor and have a system for further development of different cameras. At its peak in 1996, the project involved more than 20 people at the company.

As I mentioned earlier, the image quality was relatively poor for a long time. However, in 1993–1994, users could obtain up to 16 MPs by using several sensors or letting a sensor slide over the object. To launch a commercially viable product, however, it was necessary to develop a correctly sized sensor at the right price. Therefore, Hasselblad initiated a collaboration with Philips that resulted in a 6-MP sensor at a reasonable price.

By that time, most image sensors were square and 2000 × 2000 pixels big. A 2000 × 3000 sensor would thus give 50 percent better image quality, but because most images are cropped into a rectangular shape, the difference was in reality approximately 100 percent or more.[26]

For several years, Hasselblad was the only company that had access to this sensor, which of course gave them a competitive advantage around 1995–1997. Several firms were interested in using the sensor—for instance, Agfa began negotiations to buy the rights to use it.[27] Moreover, this sensor offered perhaps the best price–performance ratio on the market in those days.[28] Philips was keen to collaborate with Hasselblad because of its strong brand, and in total, Hasselblad only had to spend about 2 MSEK on this project. This figure is about 60 percent lower than what Philips would have demanded from other actors. From this work, it would also have been possible to develop a 3,000 × 4,000 pixel sensor later on. Hence, although both parties contributed to the technical development, the project was quite favorable for Hasselblad.

In parallel with the development of a digital studio camera, some minor changes were made to the analog system. Hasselblad developed a couple of new models and sought to diversify its system. By offering a few models at a lower price, more photographers could use the Hasselblad system, but no major changes were made to the camera system during these years.

At this point, Hasselblad had essentially sustained the same system for more than 40 years. Consequently, it had become rather complex because of all the small improvements over time. Competitors such as Mamiya, Pentax, and Contax were now introducing autofocus in their cameras, something that Hasselblad lacked and could not integrate into its current system. Hence, as the need for a new camera system became more important, the analog development team grew increasingly frustrated. The development of a completely new camera system was considered in the late 1980s and early 1990s, but management hesitated and eventually decided against it because they believed it would be too expensive.

Consequently, the company became more polarized in the mid-1990s. Digital technology had been controversial when HEIAB was founded in the 1980s, but it became even more sensitive when it came to developing cameras. Hasselblad had been split into two camps—analog and digital—that competed for the same pool of resources and had fundamentally different ideas about what the company was and what it was going to be.[29] Under these circumstances, the company became a place of conflicts and fierce arguments. The project manager for Crystal Ball, Lennart Stålfors, remembered spending "a disproportional amount of time defending the project instead of working with development activities."[30] But this was just the beginning.

Big Berta and Private Equity

> By the year 2000 digital cameras may replace film photography for most uses.
>
> —*MacWEEK*, 13 May 1994[31]

Toward the end of 1995, Incentive changed its scope of ownership and decided that it was time to sell Hasselblad. During the years that the company had owned Hasselblad, large amounts of resources had been spent on digital technology. In that respect, Incentive had maintained a long-term scope of ownership. However, once it decided that Hasselblad should be sold, the owner made sure to withdraw as much of the capital as possible that had been accumulated in the company over the last decades. The firm

Within only a few years, Hasselblad went from being well capitalized to being severely under-capitalized.

had been well capitalized, partly to be able to pursue both the analog and digital development projects in parallel. This situation changed when Incentive recouped this money through extra dividends before selling the firm.[32]

Incentive sold its shares in Hasselblad to UBS Capital (the private equity branch of the Union Bank of Switzerland), the British private equity firm Cinven, and Hasselblad's management. Because UBS controlled 55 percent of the shares, Hasselblad's fate was now in the hands of the Swiss bank. At Hasselblad and in the local media, people were concerned that the new owner lacked a long-term scope of ownership. UBS had declared from the beginning that they did not intend to own the company for more than three to seven years. Moreover, UBS intended to do a leveraged buyout—to buy an asset with borrowed money, increase its value, sell it, and thereby obtain a high return on equity. Hasselblad was therefore acquired partly using borrowed money, which was brought into Hasselblad that now had to pay off those interest rates. Hence, within only a few years, the company went from being well capitalized to being severely under-capitalized, drastically impacting its ability to handle the shift from analog to digital photography.

The new owner now had to make up its mind regarding the Crystal Ball project. Toward the end of 1995, a prototype was almost ready and the board was keen to see what progress had been made. As mentioned earlier, the camera had been developed to suit studio photographers. It was an odd product and did not look like anything Hasselblad had offered previously. The camera could not be carried to the boardroom, so the board had to go see it. The product looked more like a computer than a camera, stood on a tripod, and was connected with wires to a computer where the images could be displayed. Afterward, people at Hasselblad called the camera Big Berta because it was clumsy and had the same shape as the golf club with that name.[33]

The new board became skeptical when they saw the prototype. One person who attended the meeting recalled that the product "was gigantic and did not even look like a camera."[34] Other people had a different point of view: "Those who understood the niche for digital technology saw its advantages and realized that the camera had a potential. But the board related it to the analog technology and therefore dismissed the camera."[35]

All in all, it was not easy to convince a financially oriented investor that this camera was the right product for a successful leveraged buyout. The digital development team tried to explain that this was just a prototype and that it would only require an additional 13 MSEK or so before it could reach the market. Moreover, they tried to explain that a camera aimed for studio photography and catalog production did not have to be light and portable or offer stunning image quality. It was enough that plenty of images could be captured rapidly at a low cost and then be handled more conveniently. Furthermore, the image quality was relatively high and pictures could be enlarged up to 0.5 square meters without any problems. Hence, the customer utility was in fact large, yet different from what Hasselblad had offered their customers previously. Even so, the studio photographers at IKEA who saw the first prototype thought that it was too big and clumsy for them. Even within this segment, it was still important to move the camera, if only slightly.

Despite the aforementioned advantages, the board remained concerned. The new owner thought that such a product could harm Hasselblad's brand and its high-end image. Another issue raised was that digital technology had started to prosper in Hasselblad's market segment in the shape of digital backs. Those backs were primarily manufactured by entrant firms such as Leaf Systems, Imacon, and Phase One, but Kodak had also developed some products in this area. UBS appointed Andersen Consulting to perform an investigation into these issues during the end of 1996. They concluded that the industry would be subject to fierce competition once it became digital and recommended Hasselblad to develop a solution based on digital backs.[36]

After receiving generous resources for many years, Stålfors and the digital development team were now suddenly in a lot of trouble. Questions were raised regarding why so much money was spent on things that were outside the company's core competence. Moreover, the board had become increasingly frustrated over all the missed deadlines. Staffan Junel was a firm believer in digital imaging and kept trying to persuade the new owner that it was worth pursuing the initiated project. He failed, and he eventually left the company because he could not enact a strategy he did not believe in.

The digital photography division made one last attempt. Because the board had concluded that the digital-back solution was preferable to Big Bert, the electronic engineers sought to develop a digital back in a short period of time. The 6-MP image sensor was now built into a digital back. It had circuits pointing out on both sides and was nicknamed Mickey Mouse because it looked like the Disney character's head.

The team demonstrated the digital back at a board meeting. Stålfors and his colleague Carl Henrikson attached Mickey Mouse to a Hasselblad camera, took photos of the board, and showed them to the board members on a computer screen during the meeting. The board members did not appreciate this little prank and remained firm in their decision to stop all internal development of a digital camera. The new board explained their decision by saying that Hasselblad's customers did not demand a digital camera.[37] These turbulent events were briefly summarized in Hasselblad's annual report from 1996: ''The board also decided that the digital activities should be changed towards a focus on marketing and sales.''[38]

After this decision, almost the entire digital development team were forced to leave the company. Only three people were invited to stay in order to keep the company updated and pursue collaborations instead of developing products and technologies.

Needless to say, the electronic engineers were extremely disappointed. In one internal discussion, the following statement was made on an overhead slide: ''If the chemical waste from film processing could be turned into beer—film would have a bright future!''[39]

Hasselblad basically laid off all its digital capabilities, an asset that had been developed for almost 15 years. The company also lost its exclusive access to the image sensor it had codeveloped with Philips. Contax tried to use the same sensor when developing a digital single-reflex camera in the early 2000s, but eventually failed to launch a viable product. The decision to stop all digital development was made public in early 1997. A press release to *Dagens Industri* (a Swedish financial newspaper) contained the following text:

> The costly development of a new digital camera has been sold . . . the optimal digital camera will thereby have to be developed by someone else. By doing so, the company saves 15–18 MSEK . . . that can be invested in development of conventional cameras as well as adapting them to digital technology.[40]

Göran Diedrichs, UBS' representative, defended the decision: ''Digital technology is still in its infancy. When it has been developed further we will of course enter and then we need to have a strong financial position.'' In the same article, Diedrichs stated, ''We have been a technology driven company up until now. We have to develop products that are interesting for the market.''[41]

This description of the company's history suggests that Hasselblad had been a market-oriented company. Over decades, the firm had succeeded in charging premium prices by relying on clever marketing and sustaining its legendary brand. With the exceptions of HEIAB and the digital photography division, Hasselblad had not really pursued any development activities for many decades. Its analog camera system was essentially the same as it had been in the late 1950s. The problems that Hasselblad would encounter over the coming years were largely related to the fact that the company had been too ''market-oriented'' over a long period of time.

The Shift to Digital Imaging

Essentially, Hasselblad had postponed all analog development activities and not created a new camera system in the early 1990s. Although the brand helped the company to keep its market in the short term, inferior products eventually resulted in lower volume. Hasselblad therefore lost market share to its competitors between 1997 and 1999.

Consequently, it became increasingly urgent to develop a new camera system. The H1 project was initiated in 1998 with the purpose of generating a completely new system. The idea was to create a hybrid camera, one that would be compatible with both film

and digital backs. Moreover, the system would incorporate many new features such as autofocus. The company had not done anything of this magnitude since the 1950s. As a result, the project was severely delayed and in the end cost 320 MSEK. However, 50 percent of it was in fact funded by Fujifilm, which among other things, developed the lenses that were specified by Hasselblad and in return got the opportunity to launch the same camera in Japan under its own brand.[42]

The new system was not launched at full scale until late 2002. Between 2000 and 2003, Hasselblad suffered severely from a sharp decline in their analog sales. Professional photographers were rapidly changing to digital camera systems, primarily from Canon and Nikon. For decades, Hasselblad had dominated the wedding and portrait photography industry. This market segment was lost within only a few years to companies that had not previously been Hasselblad's competitors.

When the H1 finally arrived, it was not really a digital camera. Although compatible with digital backs, it was delivered with a film magazine and therefore was never really perceived as a digital system. The freedom to shoot either analog or digital turned out to be of little use for photographers, who were instead frustrated by the fact that they had to buy digital backs separately. Moreover, such a system cost approximately 100,000 SEK more than Canon's or Nikon's high-end cameras, and in the end, many photographers were not willing to pay that much for a Hasselblad system. Advanced digital single-reflex cameras were smaller and cheaper, offered sufficient performance, and thus started to displace Hasselblad's high-end products. Therefore, the H1 did not become the expected success and it could not compensate for the rapidly declining analog revenues.[43]

In November 2004, Hasselblad laid off 50 percent of its workforce and balanced at the brink of bankruptcy. The company went from having approximately 500 employees to about 75 in less than 10 years. After having invested in digital imaging more than two decades earlier, Hasselblad was now about to repeat the infamous Facit story, even though its former managers had sworn that this would not happen.

The company eventually survived through yet another ownership change and a merger with Imacon, a Danish manufacturer of digital backs. For the first time in 2005, Hasselblad delivered a complete digital camera system on its own and became an even more high-end company than before. The H system was expensive and offered performance that most customer segments did not need. In the following years, the company made some upgrades to its new system and delivered profits until the 2008 recession. Since then, a few more layoffs have taken place.

Discussion and Conclusion

The story of Hasselblad's long and troubled journey from analog photography to digital imaging provides an interesting case study in how industries are digitized and what challenges companies face in such shifts. One main challenge seems to have been that Hasselblad's skills related to precise mechanics were to some extent rendered obsolete. In this sense, the shift to digital imaging was competence-destroying.

Digital imaging also possessed some disruptive characteristics. It initially offered worse image quality, in addition to some new performance attributes such as the ability to take an infinite amount of photos at a low cost. However, it did not prosper in a low-end segment or in a new market as Christensen's disruptive innovation framework would suggest. Instead, it grew in Hasselblad's high-end segment in the shape of digital backs from the early 1990s onward. The main reason for this seems to be that digital technology simplified the daily work for studio photographers. This description is partly inconsistent with the disruptive innovation framework, which posits that technologies with the aforementioned attributes prosper in low-end segments or in a completely new market. Hasselblad's customers did in fact demand the new technology, and thus the main managerial challenge was not related to a lack of financial logic as stated by Christensen.

The description of how digital imaging initially prospered in Hasselblad's high-end segment in the early 1990s can be regarded as an illustration of how digital technology grows in high-end segments by bringing new performance attributes to the market. As image sensors became smaller, cheaper, and better, the dominant design for professional digital cameras shifted from medium-format cameras with digital backs to high-end digital single-reflex cameras. Hasselblad chose to stay in the medium-format segment and consequently experienced declining sales in recent years. Few photographers are

willing to pay more for a bigger, heavier camera that offered great image quality.

This pattern can be regarded as an effect of Moore's law. Digital technology starts off as big, expensive, and with poor traditional performance such as image quality. However, it often brings a new value proposition to the market that makes it attractive for high-end segments. As the performance of digital technology improves, it can eventually be miniaturized and enter lower segments, where the smaller versions eventually displace the bigger digital calculators, radios, cameras, and disk drives. The process of low-end disruption as described by Christensen can therefore be thought of as a consequence of Moore's law and the continuing decline in prices and improvement in performance. While the technology initially prospers in sophisticated segments, as was illustrated in the Hasselblad case, the low-end disruption happens later.

Robert C. Noyce unintentionally managed to describe Hasselblad's fate almost 25 years before the company balanced at the brink of bankruptcy. In 2004, the Hasselblad CEO Lars Pappila stated that ''the shift to digital technology was much more dramatic than we had expected.''[44] Hasselblad was not the first, nor the last, company to end up this way, despite all its efforts over several decades.

Hasselblad's story provides an interesting case study in how industries are digitized and what challenges companies face in such shifts.

References and Notes

1. R. Noyce, ''Microelectronics,'' *Scientific Am.,* vol. 237, no. 3, 1977, pp. 63–69.
2. E. Braun and S. Macdonald, *Revolution in Miniature: The History and Impact of Semiconductor Electronics,* Cambridge Univ. Press, 1978.
3. M. Tripsas and G. Gavetti, ''Capabilities, Cognition and Inertia: Evidence from Digital Imaging,'' *Strategic Management J.,* vol. 21, nos. 10–11, 2000, pp. 1147–1161.
4. J. Schumpeter, *The Theory of Economic Development: An Inquiry into Profits, Capital, Credit, Interest, and the Business Cycle,* Harvard Univ. Press, 1936.
5. R. Foster, *Innovation: The Attacker's Advantage,* Summit Books, 1986.
6. M.L. Tushma and P. Anderson, ''Technological Discontinuities and Organizational Environments,'' *Administrative Science Quarterly,* vol. 31, no. 3, 1986, pp. 439–465.
7. C.M. Christensen, *The Innovator's Dilemma,* Harvard Business School Press, 1997.
8. C.M. Christensen and M.E. Raynor, *The Innovator's Solution: Creating and Sustaining Successful Growth,* Harvard Business School Press, 2003.
9. G. Moore, ''Cramming More Components onto Integrated Circuits,'' *Electronics,* 19 Apr. 1965, pp. 114–117.
10. C. Lécuyer, *Making Silicon Valley, Innovation and the Growth of High Tech, 1930–1970,* MIT Press, 2006.
11. Hasselblad Ann. Reports, 1984–1990.
12. J. Öster, interview by C. Sandström and J. Jörnmark, 24 Apr. 2007.
13. J. Öster, ''Vår fortlevnad och våra tekniska satsningar'' [Our Survival and our Technical Efforts], *Så leder vi* [So We Lead], O. Granstrand and H. Bohlin, eds., Liber Ekonomi, 1992.
14. L. Stålfors, interview by C. Sandström, 28 June 2007.
15. F. Bergquist, interview by C. Sandström, 9 Apr. 2008.
16. Hasselblad Electronic Imaging Ann. Report, 1991.
17. Hasselblad Ann. Reports, 1985–1992.
18. L. Stålfors, internal memo, Hasselblad, 10 Sept. 1990.
19. Hasselblad, board meeting minutes, 10 Feb. 1994.
20. Hasselblad Electronic Imaging, tech. report, June 1993.
21. Hasselblad, board meeting minutes, 1989–1994.
22. S. Junel, interview by C. Sandström, 6 Nov. 2007.
23. L. Stålfors, internal memo, Hasselblad, June 1997.
24. R. Cederberg, interview by C. Sandström, 3 Mar. 2008.
25. Memorandum by R. Cederberg, internal memo, Hasselblad, 14 Aug. 1995.
26. R. Cederberg to C. Declerk, 10 Feb. 1997.
27. L. Stålfors to H. Wellius, 30 Aug. 1996.
28. L. Stålfors, internal company presentation, Hasselblad, 1997.
29. L. Stålfors to C. Sandström, 17 Oct. 2007.

30. L. Stålfors to S. Junel, 8 Oct. 1995.
31. *MacWEEK* 13 May 1994.
32. Hasselblad Ann. Reports, 1995–1996.
33. B. Ahlgren and C. Henrikson, interview by C. Sandström, 26 Jun. 2007.
34. S. Arvidsson, interview by C. Sandström and J. Jörnmark, 14 May 2007.
35. P. Mark, interview by C. Sandström, 8 Jan. 2008.
36. B. Ahlgren, interviews by C. Sandström, 9 Nov. 2007 and 9 Jan. 2008.
37. L. Stålfors, interview by C. Sandström, 25 Feb. 2008.
38. Hasselblad Ann. Report, 1997.
39. Internal company PowerPoint presentation, Hasselblad, 1997.
40. G. Larsson, ''Hårda tag med börsen I fokus,'' *Dagens Industri,* Jan. 1998.
41. E. Parkrud, ''Från glaskonst till kameror – Göran Bernhoff ny VD på Hasselblad,'' [From Glass to the Cameras: Goran Bernhoff new CEO of Hasselblad], *Göteborgs-Posten,* 10 Apr. 1997.
42. G. Bernhoff, interview by C. Sandström, 4 Jan. 2008.
43. P. Mark, interview by C. Sandström, 24 Sept. 2007.
44. C. Froste, ''Från månlandning till stjärnfall'' [From the Moon Landing to the Shooting Stars] *Affärsvärlden,* 8 June 2004.

Christian Sandström is a postdoctoral researcher at Chalmers University of Technology, Sweden. His research interests concern the digitization of industries and the challenges that this presents for established firms, including how electronics have emerged in cameras, calculators, and video surveillance. Sandström has a PhD in industrial engineering from Chalmers University of Technology. Contact him at christian.sandstrom@chalmers.se.

Selected CS articles and columns are also available for free at http://ComputingNow.computer.org.