Chapter 5
The Digital Path (ca. 1990–)

History is harder to write the closer it is to the present. In particular, socio-technical history of the kind we have been trying to build up in the last chapters begins to lose its coherence in 'eras of ferment'[1] when the dominant design is challenged by new technology and it becomes unclear what will take its place. Consumer digital photography is an era of ferment writ large! Indeed it could be described as the biggest technological discontinuity in photography since the invention of the daguerreotype and the calotype in the 1830s. Based on the replacement of the chemical process for recording an image, electronic (later digital) photography began in 1969 with the invention of charge-coupled devices to convert light intensity into electronic signals. Although most readers will not be familiar with the names of the inventors or the first producers of electronic cameras, the innovation of electronic capture triggered an avalanche of subsequent innovations that have changed the face of domestic photography for good. That the avalanche has not yet come to a stop makes it all the more difficult to summarise what those changes are and point to the new dominant designs and practices that have replaced the old. Ironically, this is despite the increased amount of literature and information about digital photography, which comes with proximity to the present. So we begin this latest path in the history of domestic photography with a new chapter in this book, and a consequent change of tack.

Our aim is still to elucidate the practice of everyday photography and how it has been affected by technological and business factors over time. However, we cannot simply continue to draw on 'milestone' histories of photography and snapshot practice, because these begin to run out in the 1990s with the advent of the first consumer digital cameras. Also, the avalanche mentioned above is still in progress, and, therefore, it is hard to say what technologies and business models are dominant.

In this chapter and the next one, Chap. 6, we use four types of literature as sources of insight into what happened after that and what might happen in the future. First, marketing reports herald the coming of new technologies and their uptake by the masses in different geographies of the world. Second, cultural commentators speculate about the impact of these technologies on our photographic behaviours and our

[1] Anderson and Tushman 1990.

R. Sarvas and D.M. Frohlich, *From Snapshots to Social Media - The Changing Picture of Domestic Photography*, Computer Supported Cooperative Work,
DOI 10.1007/978-0-85729-247-6_5, © Springer-Verlag London Limited 2011

relationship to the image. Third, social scientists describe studies of transitional practice and popular emergent behaviours. Finally, research and development teams report on new lab prototypes and how they were used in small-scale experiments and trials. To pick our way through these bodies of literature and write a first-draft history of digital photography, we adopt in this chapter the notion of *infrastructure*. By this we mean the network of devices, software, cables, protocols, screens, file formats, required to 'do' domestic and snapshot photography in the twenty-first century.

We also divide the examination of the past two decades into two separate chapters. This chapter continues from where the previous chapter ended: the end of film-based photography and the beginning of the transition toward mass digital photography. In this chapter, we go through the *infrastructure* of domestic photography and how each component of that infrastructure became available for use and adopted. The following chapter, Chap. 6, focuses on the academic literature on people's practices with the new technologies and components of the domestic photography infrastructure.

5.1 Digital Photography Infrastructures at Home

The major change in domestic photography in the late nineteenth century was the Kodak camera and the development and printing service Kodak offered. A key characteristic of this change was that Kodak made it possible for unskilled people to capture photographs and receive the photographs as prints. As discussed in the previous chapter, to achieve this, George Eastman of Kodak had to design not only a new kind of camera but a whole new infrastructure. Prior to Kodak, for one to receive a photograph of oneself or a loved one, the whole process was bought as a service from a professional photographer (or perhaps a skilful and wealthy relative had a camera, a darkroom, and the required chemicals and skills). Kodak offered a camera and an infrastructure with which the photographs were taken as easily as possible, and the development and printing (and in the first years also loading and unloading of film) was externalised to a service – in this case, to a combination of unskilled labour and specially designed machinery. This business and technology infrastructure was the 'platform' on which snapshot photography practices were born and built.

Similarly, the introduction of each key element in the digital infrastructure for domestic photography appears to have generated new behaviours and businesses that show up across the various types of literature mentioned above. Although the coverage of information about the impact of each element differs, there is enough on most of the major elements for them to be reviewed separately. Furthermore, there is a historical order to these elements, which it is possible to plot and follow. This is summarised in Fig. 5.1, below, and forms the structure for the rest of this chapter.

In contrast to infrastructures for film photography, which tended to be closed systems dedicated to photography alone, the history of digital photography is a history of increasing assimilation into a general-purpose, networked computing infrastructure. Hence, early attempts were made to digitise prints and negatives with photo scanners for computer manipulation and printing (elements 1, 2, and 5 in Fig. 5.1). Digital cameras followed (3), initially to bring photo 'development'

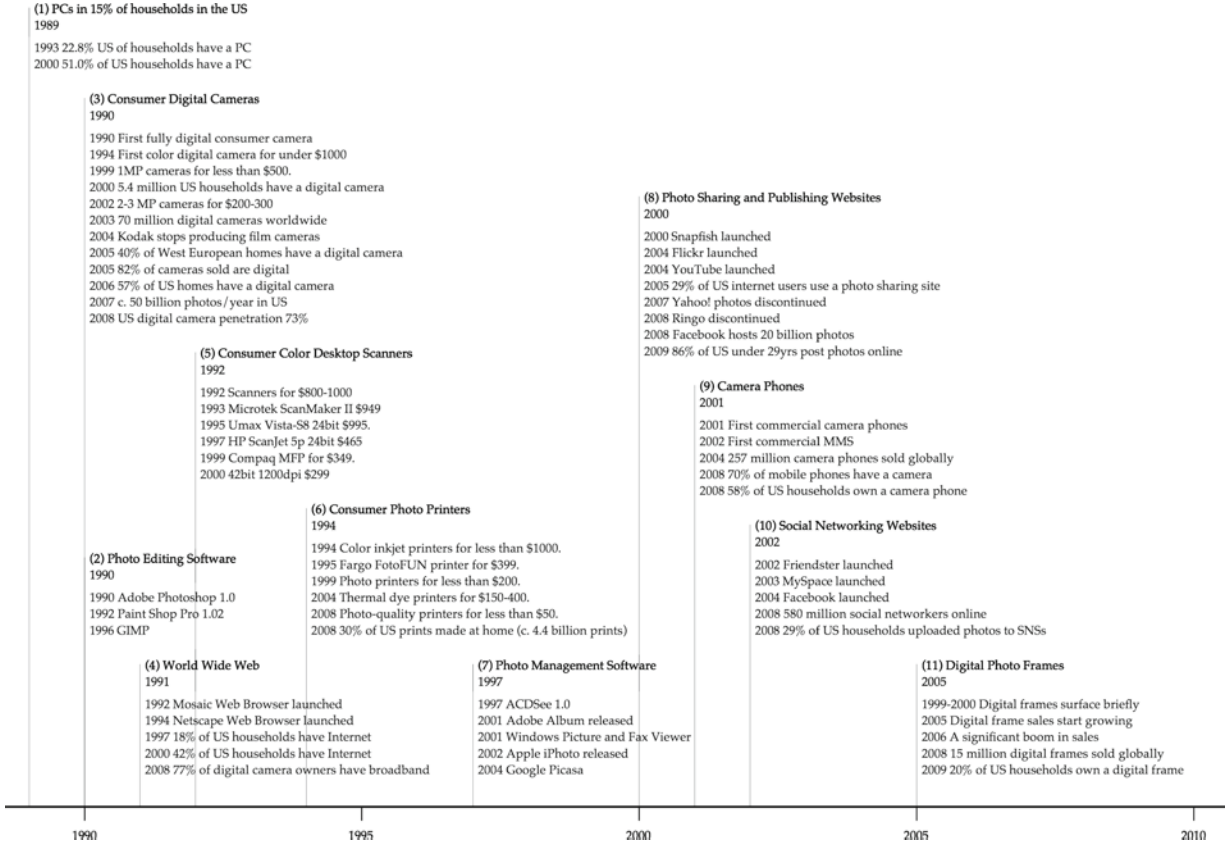

Fig. 5.1 Timeline of key technological additions to domestic digital photography (© Risto Sarvas, 2010)

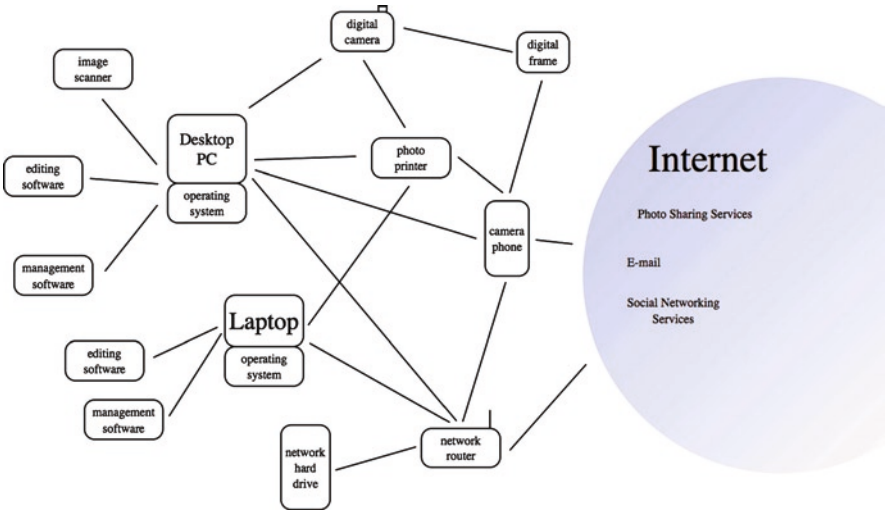

Fig. 5.2 An example of a domestic infrastructure for digital photography. The lines are interconnections, such as USB cable, bluetooth, a memory card, a WLAN connection, or some other specified interface (© Risto Sarvas, 2010)

into the home through local printing. This gave way to more generic computing behaviours involving the management and viewing of home photo collections (7) on the home computer, the incorporation of online photo sharing in existing e-mail and Web publishing activities (4, 8), and the capture and sharing of photographs via mobile phones (9). More recent developments have involved the use of images within social networking services (10) and their presentation on ambient digital displays (11).

Rather than replacing previous elements of this infrastructure, new elements have simply supplemented them, increasing the possibilities for photo 'flow' but also its complexity.[2] The resulting contemporary infrastructure for digital photography, shown in Fig. 5.2, supports a variety of photographic behaviours and businesses, which are more or less integrated with personal and social computing. To understand what these are and how they have evolved over time, we step through different phases in the development of the infrastructure. Because we are dealing here with existing classes of devices and services, we constrain our review to them becoming more or less publicly available for consumer use (*i.e.*, affordable). This largely excludes novel lab prototypes. This literature is referred to in Chap. 7, where we discuss the future of domestic photography.

[2]Neustaedter and Fedorovskaya 2009b.

5.2 A Brief History of Digital Domestic Photography

In the late 1980s, all major camera manufacturers, including Kodak and Polaroid, were experimenting with electronic still video cameras for professional use. The new capture technology was marketed mainly to photojournalists, because of their electronic transfer of images, but also to studio photographers for instant viewing. However, consumer photography was showing few signs of change, partly because there were very few affordable SVCs for domestic use and partly because sales of film kept growing. In 1983, it was estimated that amateurs in the US took 11.75 billion stills annually,[3] and 5 years later the estimate was 17 billion.[4] There was no immediate need to make major changes to the consumer business, so Kodak and others continued to make electronic photography products aimed at the high-end market.[5]

The words of Geoffrey Crawley reflect the prevailing belief in film in 1989: "The conventional colour negative process is thus the clear favourite to be the medium of popular picture-taking well into the next century."[6] Probably no-one guessed that in 15 years Polaroid and AgfaPhoto would be bankrupt and Kodak would no longer produce film cameras.

How did the inferior electronic image capture technology overthrow the dominance of the vastly superior film? Step by step, the core technical elements of the domestic photography business were challenged and overtaken by alternative information and communications technology. First, the selling of film and prints was challenged by digital cameras and home computers (PCs) through which it was possible to view photographs without them being made into prints. Second, the resolution of digital cameras and printers combined to enable 'photo-quality prints', which were indistinguishable from those produced through film developing. Third, the need felt for prints was further challenged by the Internet, which enabled people to share digital images over distances. Finally, the camera phone challenged traditional camera sales by integrating the camera into a mobile phone, which made the camera just another aspect of the functionality of a networked and handheld multi-purpose device.

From the perspective of the photography industry, the only change that was evident in the 1980s was the alternative way of recording the image within the camera: using a CCD to translate light into an electronic signal. Characteristic of the early CCD images was that their technical quality (*i.e.*, sharpness, amount of detail, colour representation, etc.) was nowhere near the properties of film. However, SVCs and CCD image capture were relatively mature technology in the sense that the first SVCs had been introduced already in 1981. It probably seemed that electronic photography was going to be contained inside the film photography industry – at least this must have been the goal of the industry stakeholders.

---

[3] Chalfen 1987, p. 13, quoting *The Wolfman Report 1983–84*.

[4] Crawley 1989, p. 153.

[5] Larish 2008, p. 25.

[6] Crawley 1989, p. 153.

The major producers of domestic photography technology envisioned a new domestic infrastructure based on electronic photography, in which photographs were captured with either an SVC or a film camera, and the electronic images were viewed from a monitor or a TV. The images could be printed on paper, and they could be transferred outside the home over telephone lines. Figure 5.3 shows one future vision from 1987, from Kodak's Electronic Photography Division (EPD). The hub of the infrastructure is a 'Still Video Multidisk Recorder' connecting all of the other products together. Peter Sucy, who made the original image reproduced in Fig. 5.3, explains that the image "reflected one point of view within [Kodak], mainly EPD's. The larger corporate view was a strategy to keep people using film as long as possible".[7]

On the one hand, the domestic photo infrastructure envisioned in Fig. 5.3 is a dream that did come true: a central device that connects a printer, a monitor, one or more cameras, a scanner, and a broader network. On the other hand, what this vision does not predict correctly is that the infrastructure was not a photography infrastructure but a general-purpose computing infrastructure. Electronic photography was not contained within the photography industry.

In hindsight, missing from the 1987 vision are the internet, Web photo services and software, and the camera phone. But most surprisingly, or perhaps intentionally, there is no role for the personal computer in the diagram. The PC was already a household

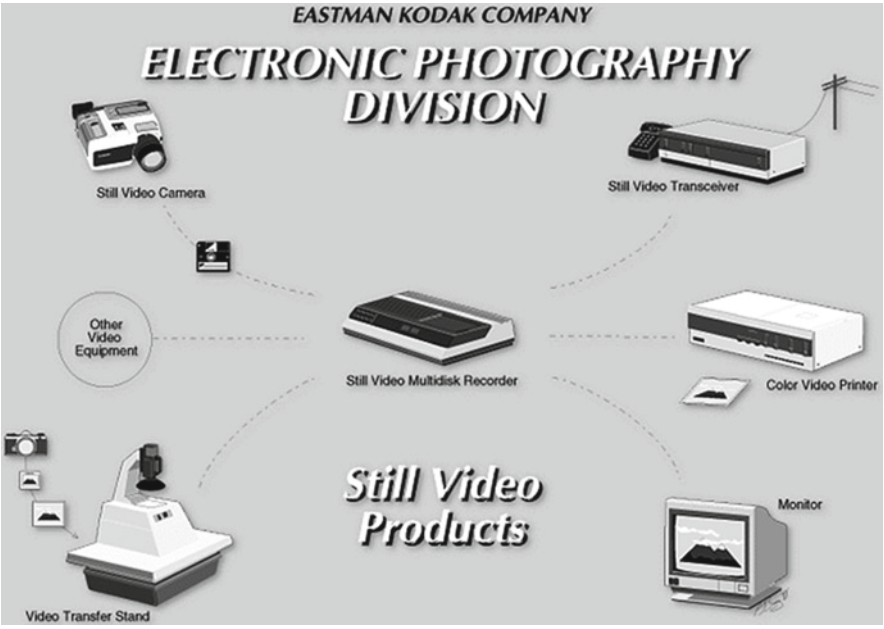

Fig. 5.3 The still video photography infrastructure envisioned in 1987 by Kodak (Original title: Still Video Products. © Peter Sucy, 1987. Republished with permission)

[7] Sucy P, 2010, personal communication.

item in the late 1980s, and the numbers were growing. In 1989, for example, 15% of US households had a PC, and the number had almost doubled since 1984.[8] The IBM PC was introduced in 1981, the Commodore 64 in 1982, the Apple Macintosh in 1984, and the Commodore Amiga in 1985, to name a few popular brands.

For whatever reason, the Kodak vision of the electronic photography infrastructure did not include a PC, and this reflects the fundamental change that occurred in the 1990s: domestic photography gradually was moved from a photography-centric infrastructure into a general-purpose information and communications infrastructure not specifically designed for photography. From the perspective of the photography industry, it was exactly this radical change that was a competence-destroying discontinuity for film-based competencies in Kodak, Polaroid, Fujifilm, and Agfa.

5.2.1 The Digital Consumer Camera

In 1990, the PC was no longer news, but that year saw the release of two other components of the new photography infrastructure. The first version of the well-known photo and image editing software Adobe Photoshop was released in 1990. This marked the beginning of image manipulation software for PCs. Although photographs have always been manipulated and edited, the numerical and computational methods made easy to use in photo editing software have significantly changed our perception of what image editing can achieve. The first editing programs were designed and targeted for professionals, but the combination of home PCs and digital cameras opened a new market for them at home. Where snapshots are concerned, easy and automatic editing applications have become common tools for touching up, enhancing, and cropping images.

The second milestone in 1990 was one of the first fully digital consumer cameras, the Logitech Fotoman manufactured by Dycam. 'Fully digital' in this context means that it stored the images captured by the CCD in a digital format (TIFF or PICT). Several cameras at that time stored the image in an analogue format, and viewing or editing the images on a PC required special hardware for digitising the analogue electronic image.[9] The Fotoman had 1 MB of internal memory, which accommodated 32 compressed black-and-white images of 376 × 240 pixels. The Fotoman cost a few dollars under $1,000. In contrast, the Kodak DSC-100 announced the same year stored colour images with a resolution of 1024 × 1280 pixels and cost 30 times more.

It took years before the prices of digital cameras made them widely affordable. The first *colour* digital camera priced under $1,000 was the Apple QuickTake 100 manufactured by Kodak (640 × 480 pixels).[10] Two years later, in 1996, Kodak made available its own model, the DC-120, which was the first 1-megapixel (colour)

[8] US Census Bureau 2001.

[9] Aaland and Burger 1992.

[10] *Digital Imaging Plus,* Mar 1994.

camera sold for under $1,000. In 2002, consumer cameras with a resolution of 2–3 MP were selling for $200–300.[11] In 2003, there were an estimated 70 million digital cameras worldwide.[12] Soon sales of digital cameras overtook film camera sales, and in 2004, camera phones outsold digital cameras.[13] It had taken more than a decade for the digital camera to replace the film camera in snapshot photography. Then, in 2005, 82% of the cameras sold were digital.[14]

However, the sales of digital cameras did not slow down as more and more households and individuals acquired them. To the benefit of camera manufacturers, people were replacing their old digital cameras with new ones. In 2006, the majority of digital camera buyers were 'repeat buyers'; in other words, they already owned a digital camera but bought a new one nevertheless.[15]

By the end of the decade, in 2010, the price of a digital camera had come down to a fraction of what the Fotoman had cost: a three-megapixel CCD camera could be bought for less than $30. Adjusted in line with the consumer price index (CPI), the cost of a digital camera today is almost the same as the worth of the $1 Kodak Brownie in 1900 (approximately $26.40 in 2009 money[16]). Also, as 70% of mobile phones come with an integrated camera,[17] the price of a camera is perceivably even less.

In 1991, a milestone was reached in the history of the Internet. The World Wide Web (WWW) was made public by Tim Berners-Lee, and in 1992 one of the first graphical Web browsers, Mosaic, was launched. Two years later, the Netscape Web browser was introduced. The Web did not become popular overnight. For example, it took over a decade for Internet connections to reach half of the households in the US.[18] Nevertheless, for those households the Web did reach, self-made HTML homepages viewable by Web browsers were a channel to publish digital photographs and share them with friends, family, or anyone happening to stumble upon the Web page. Another convenient method of sharing photographs, and a more popular one, was e-mail, which was an integral part of the Internet since its beginning. For the first time in the history of domestic photography, it was possible to show and view personal photographs quickly over long distances. Later, this activity (*i.e.*, photos shared via e-mail and on homepages) would spur the beginning of photo sharing Web services, which specialised in providing an easy way to share and publish photographs online. But before photo sharing Web sites, three photography technologies became available and affordable for the home infrastructure: image scanners, photo printers, and photo management software.

---

[11] CNET News, 1.3.2002.

[12] Larish 2008, p. 135.

[13] Strategy Analytics 2005.

[14] IT Facts, 2005.

[15] Shankland 2007.

[16] Calculated via tools at http://www.measuringworth.com/.

[17] Hsu 2009.

[18] US Census Bureau 2001.

5.2.2 The Home Lab: Scanning, Printing, and Organising

A few years before photo printers, colour flatbed scanners became affordable for consumer use. In 1992, flatbed desktop scanners cost between $800 and $1,000, but gradually the prices came down, and in 1997 a 24-bit scanner cost $465. By 2000, colour scanners with 1200 ppi (pixels per inch) were sold for $169–349. At the end of the 1990s, so-called multi-function peripherals (MFPs) or all-in-one devices (AIOs) were introduced. These were integrated printer–scanner–copier devices that acted as PC peripherals. Some versions also plugged in to the phone network and served as fax machines. The relatively low pricing of these multi-purpose machines made them attractive items for home use (*e.g.*, a Compaq MFP cost $349 in 1999), so a photo printer and an image scanner entered the domestic infrastructure, sometimes at the same time.

Inkjet technology brought photo printers for home printing to the consumer market in the mid-1990s. In 1994, one could buy a colour inkjet printer for less than $1,000, and in 1995, for example, a Fargo FotoFun printer cost $399.[19] These printers did their best to make people print their digital photographs at home rather than take the memory cards to commercial services (retailers) for printing. The photo printers were marketed as an integral part of the 'home photo laboratory', where photographs captured by digital cameras and edited by special software were then 'developed' into prints by the printer. This can be seen as a reversal of the old film snapshot philosophy wherein everything between capture and prints was either automated (Polaroid model) or externalised (Kodak model). With the combination of a digital camera, a PC with editing software, and a photo printer, the snapshooter had the opportunity to be in charge of the development process. Whether or not more control was what snapshooters wanted, it nevertheless came with the cost of greater complexity, as now more components and activities were required to produce a print.

As digital cameras were adopted increasingly for home use, people's personal collections of digital photographs started to accumulate. Soon a need was felt for easy-to-use technology for organising and managing one's collections on the computer. In the late 1990s and early 2000s, a new type of photo management software emerged, which was not primarily about editing and manipulation (*e.g.*, ACDSee in 1997, Adobe Album in 2001, and Apple iPhoto in 2002). Some of this software was bundled with cameras, printers, or scanners. Some applications came as a built-in of Windows or Mac operating systems (*e.g.*, Apple iPhoto and Windows Picture and Fax Viewer), and some were standalone third-party programs. Those that came with the operating systems became very popular automatically.

[19] PR Newswire 1995.

5.2.3 *Photographs on the World Wide Web*

As domestic Internet connections got faster, photo management software was integrated more and more often with a photo sharing Web site (*i.e.*, an online photo service) so that selected and searched images on the home PC could be shared easily. But at the beginning of the new millennium, digital photographs were most often shared in e-mail messages as attachments, and the growing size of the cameras' CCDs made the image files bigger. Sharing a dozen photographs as e-mail attachments ran the risk of the mail's rejection or deletion by mail servers for being too large, or filling the e-mail inbox of the recipient. Also, e-mail programs (*i.e.*, e-mail clients) were not ideal for viewing photographs and discussing them. Ofoto, Shutterfly, and Snapfish were some of the first so-called photo sharing Web sites, where people could share their photographs with others, often for free.

In the decade that followed these, different business models were tried on various photo sharing Web sites to cover the costs of running the service: a membership charge, Web advertising, and charging for high-definition downloads, to name a few examples. By the end of the decade, some of the photo sharing Web sites had not made a profit and were terminated. For example, the photo and video sharing Web site Ringo shut down in 2008, and it informed its users that they had a month to download their photographs from the service before they would be deleted. Ringo provided no way to retrieve the users' uploaded videos, because they were hosted by a business partner who did not provide the technology required for retrieval.[20] In the case of Ringo, not only were videos lost, but so were all comments, captions, and discussions about the photographs. The Kodak Gallery photo sharing Web site made the possibility of deletion of its users' photographs an incentive to cover the costs of the service. In 2008, it started requiring its customers to make "a minimum annual purchase" from its Web site or face possible deletion of the photographs.[21]

However, photo sharing Web sites have now become a common component of the home photography infrastructure. In 2009, the combined number of photographs on some of the most popular Web sites was estimated to be 50 billion (with about 325 million unique visitors to these Web sites in February 2009).[22] The Web site with the most photographs was the social networking service Facebook, although the company does not profile that Web site as a photo sharing service. A report by TechCrunch (2009)[23] compared the number of unique photographs on popular services: 20 billion for Facebook, the same for ImageShack, 7.2 billion on Photobucket, 3.4 billion on Flickr, and three billion for Multiply.[24] In July 2010, Facebook was reported to have 48 billion unique images and 500 million users.[25]

---

[20] Hernandez 2008.

[21] Kodak Imaging Network Inc. 2009.

[22] TechCrunch 2009.

[23] *Ibid.*

[24] *Ibid.*

[25] Time Magazine 2010; Zuckerberg 2010b.

Ringo and Kodak Gallery are examples of the risk of losing one's photographs, videos, and related data because of the commercial enterprise behind the Web site changing its terms of use or shutting down altogether. Transferring the social interaction around photographs into a commercial service integrates people's photography practices into the business and profitability of the service at hand. Often the service provider reserves the rights to change the end-user licence agreement (EULA) as it sees fit.

5.2.4 The New Class of Camera: The Camera Phone

But before the introduction of the so-called social networking sites and services to the domestic photography infrastructure, a significant new component emerged from the telecommunications industry: the camera phone. The first commercially available camera phone is credited to Sharp's model J-SH04 from 2001. Later the same year, Nokia released its first camera phone model, the 7560. Advancements in image sensor technology had made it feasible to integrate a camera into a mobile phone. The low power consumption and small size of CMOS (complementary metal-oxide–semiconductor) image sensors made them ideal for the mobile phone. The integrated camera became a sales argument for new models of mobile phone, and soon more and more phone models had a camera, whether the buyer wanted one or not (*e.g.*, in 2008, 70% of mobile phones had a camera[26]). For the first time in the history of domestic photography, snapshooters had a camera device the primary purpose of which was not to capture images, and it was not made by a traditional camera manufacturer. And as we mentioned earlier, in 2004, more camera phones were sold worldwide than digital cameras.[27]

One of the advertised features of the camera phones was the ability to send images to other phones. In Europe, the dominant standard was MMS (the Multimedia Messaging Service), which was a built-in functionality in all GSM-compatible phones. The first commercial MMS system was launched in 2002. The idea was to send picture messages to other phones much like the popular text messages. However, this was not adopted as quickly and widely as the phone network operators had hoped.[28] From the perspective of domestic photography, the MMS approach enabled sharing and sending photographs directly from the camera. It demonstrated that the camera phone was effectively a networked camera, and this made phone network operators concrete stakeholders in the business of photography.

[26] Hsu 2009.

[27] Strategy Analytics 2005.

[28] Humphries 2004.

5.2.5 Social Networking Services

At the same time as camera phones were becoming popular and the Multimedia Messaging Service was introduced, the first social networking Web sites and services started to emerge, among them Friendster in 2002 and MySpace in 2003. Characteristic of these Web sites was that they facilitated connecting people and making these connections (*i.e.*, social networks) explicit. Users of social networking Web sites each had a profile, which could be connected to other profiles on the Web site. The network of profiles then acted as a communication channel, and the profiles themselves as representations of the user. Similarly to HTML homepages in the late 1990s, people using the social networking Web sites used their own name rather than a pseudonym. Also, the connections were dominantly social ties that already existed outside the Web site: friends, family, colleagues, and friends of friends. In contrast to the open WWW, the domain of a diverse range of HTML homepages, a social networking Web site as a closed system had more control over the features and functionality provided to its users. The social networking Web sites provided an easy way to construct an online representation and connect it with acquaintances. In 2004, the Facebook social networking Web site was launched, and in 5 years it had become the most popular in that field. As mentioned above, Facebook had 500 million users, worldwide, in July 2010.

From the perspective of domestic photography, social networking Web sites are important in two respects. First, they seem to serve two of the main purposes of domestic photography: to strengthen and reify social bonds and to demonstrate cultural and group membership. Second, and perhaps because of that first factor, a significant amount of photographic content is shared on these social networking Web sites. As mentioned previously, Facebook in 2009 hosted more personal photographs than any other Web site, even more than Web sites focusing explicitly on photo sharing.[29] Facebook, as a commercial enterprise, has access to personal photographs paralleled by no other business in history. We will discuss in detail in Chap. 7 how the role of social networking Web sites is central in shaping the future of snapshots and domestic photography.

5.2.6 The Latest Component: A Digital Frame

As our final component in the contemporary domestic photo infrastructure we have the digital photo frame. A digital photo frame is an electronic display approximately the size of a traditional photograph frame for paper prints. These kinds of frames were briefly available at the turn of the millennium but did not see enough

[29] Data Center Knowledge 2009.

demand. Therefore, they were almost absent from the consumer market until 2005.[30] Then, 2006 proved to be a turning point for the sales of digital photo frames, and in 2008, 15 million frames were sold, globally.[31] According to a market research conducted by PMA, every fifth US household owned a digital frame in 2009.[32]

A typical photo frame has a memory card reader and some internal memory for storing the photographs and showing them on the display. Some advanced ones can show videos and are connected to the home network wirelessly. The digital photo frame is an alternative display screen to the PC, the television, mobile phones, and laptops. As a traditional photo frame can, it can be used as an ambient display, or it can be picked up and used to scroll through images stored in the frame or on a memory card. The digital photo frame as a product is currently under much research and development in an attempt to differentiate and add functionality to it (*e.g.*, automatic downloads from the Internet, connectivity with mobile phone data networks, and display of videos). Time will tell what functionality and features will be part of a typical frame and whether it will become a more popular item for display and viewing.

5.3 The Characteristics of Digital Photography Technology

Replacing the recording medium inside the camera may seem like a minor change in photography. However, the short history above shows that this is not the case, as the new recording format had enormous repercussions for the whole infrastructure of domestic photography technology. In hindsight, we can identify a few technical characteristics of the new image format (*i.e.*, of the storing of numerical values in a digital file format) that constituted a significant difference from the previous format (*i.e.*, a chemically formed image on celluloid film) and were significant also in a historical context. In our discussion of these characteristics, we apply Lev Manovich's principles of new media: numerical representation, modularity, automation, variability, and transcoding.[33]

5.3.1 Reproduction: Costless, Errorless, and Endless

The possibility of reproducing digital images infinitely and without loss of quality is one characteristic that in the context of history is unprecedented. Although having several copies of personal snapshots was technically possible on the Kodak Path, it had its costs and required extra effort. An exception was the quite common offer of

[30] Wang 2007.

[31] Wang 2009.

[32] PMA 2009a.

[33] Manovich 2002.

photofinishers to provide ‘doubles’ (two prints of each exposure on film) for a small fee or for free.

The possibility of making an exact copy of a digital image at the push of a button has enabled sharing and publishing of photographs in a new way. Giving a digital photograph to another person does not mean that there is one photograph fewer in the giver’s collection. Perhaps this has diminished the value of a photograph as a gift, because there is hardly any uniqueness and singularity associated with a digital image.

The possibility to have endless copies of an image makes it possible also to archive the images while they are still used for other purposes. Backups and remote archives are a copy of a set of images, and if any of the other copies is destroyed, recovering the lost image is possible. However, the easy copying of images also makes fragmentation of one’s image collection possible. As images are copied to other devices, the Internet, and different hard drives, it becomes a difficult task to keep track of whether all the images are in one place or they are distributed over a network of devices and digital storage spaces.

Third, the easy reproduction means that a single photograph can have parallel life cycles and several meanings in different contexts. After capture, one copy of the image can end up on a ‘photo blog’, another copy is made to the photo archive on a PC, a third copy is edited and printed on paper, and perhaps a fourth copy of the same image ends up being deleted. On the Kodak Path, and even more with the Portrait Path, once a photograph was captured, it often had only one instance, perhaps two. Several copies were made of only very special photographs, such as photographs sent with, or as part of, Christmas cards. On the Digital Path, it is almost impossible to keep track of the life cycle of a captured photograph.

5.3.2 Transferability: Bridging Time and Space

The numerical representation of the image captured by the camera makes it possible to transfer the image over electronic networks at unprecedented speeds. Needless to say, to take full advantage of this technical characteristic, the transfer infrastructure has to be in place and accessible. Therefore, the Internet and the other networks connected to it (*e.g.*, the mobile phone network) are critical.

The possibility of sending or receiving an image immediately after its capture was present in the instant photography introduced by Polaroid in 1947. However, in contrast to Polaroids, the image sent is a copy of the original (see above), and, perhaps more significantly, the image can be immediately sent over vast geographic distances. For example, an image captured on a camera phone can be sent as an MMS message to another part of the world, and it will reach the recipient in a matter of seconds.

Not only can images be sent over distances in very little time; they can also be found and viewed independently of time and space. Someone can put photographs on display on the Web, and the viewer of those images does not have to look at them at the same time as the other person or from the same location.

5.3.3 Storage: No Physical Space Required

The numerical representation of the image means that storing that information electronically requires very little physical space. Again, if one is to be able to take advantage of this characteristic, there need to be technologies to store vast quantities of digital data in very little physical space, such as hard disk, memory card, and optical disk technologies.

A hard disk the size of a shoebox can hold a few terabytes of data, which means several hundred thousand digital images (if each image has ca. 14 megapixel resolution and is about 10 megabytes in size). In practice, this means that all of a household's digital photographs can fit into a relatively small space. Second, because of the continuous advances in storage technology, acquiring more storage space will not be a major investment (in early 2010, a two-terabyte external hard drive cost less than €100, which is roughly the price of an inexpensive point-and-shoot digital camera).

The minimal physical storage means also that hundreds of images can be stored on the camera before they have to be transferred elsewhere to free space for new photographs. In practice, this means that people can take a few hundred photographs at a single event, or even of a single subject, without running into limitations on the camera. The ability to transfer the images to even larger storage spaces than those of the camera does not encourage people to delete any of the photographs. As a result, people are accumulating personal photography collections the size of which (as measured by number of photographs) is unprecedented in domestic photography. By some estimates, 50 billion photographs were taken (presumably by Americans) in 2007.[34] In comparison to the 17 billion in 1988,[35] the increase was from 70 to 200 photographs a year[36] per person, and the number is probably growing. However, because of the easy copying and transfer of images, people's image collections include also photographs shared with them or given to them. This increases the number of photographs 'used' in domestic photography, and some of them probably end up in personal archives as well.

5.3.4 Editing: Cropping, Filtering, and Automatically Enhancing

As we mentioned briefly earlier in this book, the numerical representation of the captured images enables editing of the image by means of computation – namely, algorithms and mathematical formulae. Software tools have made these editing

[34] Shankland 2007.

[35] Crawley 1989.

[36] Population estimates from U.S. Census Bureau 2010.

algorithms easy and simple to use, and many of the algorithms are automatically executed without the photographer even knowing about it. For example, a digital camera executes a set of algorithms on the captured image data prior to storage in the camera's memory.

Some of the editing tools are simple to use but significantly different from what Kodak Path film photography allowed. Replacing red eyes with pixels of other colours, for example, is a task that would have required some skill on the Kodak Path in order to yield realistic results. Now, reasonably good editing of red eyes can be done automatically. Similarly, automated algorithms can enhance the colours, contrast, sharpness, and lighting of a digital photograph at the push of a button. However, part of the skill that separated the serious amateurs from the snapshooters used to be editing, and this has not changed in the digital era. The algorithms, tools, and methods for digital editing are numerous, and to master them requires skills.

Not all editing of digital photographs is directly related to the image. Practically all digital photographs are edited to adhere to standard formats and quite often also edited for compression of their storage size.

5.3.5 Convergence: It Is All Ones and Zeroes

The numerical representation of a photographic image turns the image into binary data like any other data for computers. The same can be said about computer files: an image file is very much like any other file on a computer. This means that there is technical convergence of photographs with any other computed data. This similarity is at the core of the change in photography infrastructures. The same devices, protocols, cables, software, operating systems, processors, etc. can be used to handle photographs and any other data. The technology becomes multi-purpose technology rather than being specific technology, such as the photography specific technology of the Kodak Path.

The convergence of the technologies also encourages convergence of practices and new combinations of data. People read news on the Internet with the same device they use to view photos on a Web site; perhaps these activities will be combined in practice such that news-reading is done at the same time as viewing personal photographs. Photographs can now be combined with location data (*e.g.*, geographic co-ordinates), which has enabled practices such as location-based browsing of images.

All of these technical characteristics of digital photography depend heavily on the surrounding and supporting infrastructure of technologies. Digital image capture was invented in the 1970s, but for the rest of the domestic technology to support the key characteristics of that technology it took almost a quarter of a century. For this reason, we pay attention to the infrastructure of domestic photography rather than the individual devices as separate technologies.

5.4 Conclusions

The objective of this brief historical overview is to show how much the infrastructure at home for snapshot and domestic photography departed from the Kodak Path. The main components of the film-based infrastructure were the camera, the film roll, the external photo-finishing service, the paper prints, albums, and perhaps a few frames for some special prints. This simplicity has given way to heterogeneous complexity. Not only are the main components for digital photography different, but also the ways in which they can be combined are numerous. For example, the PC can be connected via an operating system to photo editing software, which can be connected via a USB cable to a printer, which can be connected via Bluetooth to a camera phone, which can be connected via GPRS to a photo sharing Web site, which can be connected via home broadband to a digital photo frame, which can be connected via a memory card to a digital camera, which can be connected via HDMI cable to a television set, and so on.

The heterogeneity and complexity of devices and interconnections means that no two constellations of photography technologies in a home are the same. This also means that no technology provider can know beforehand what the end user's technical environment will be. In trying to adapt to the situation, technology providers have to update their technologies to better interconnect with other technologies, and for the snapshot photographer this means updating device drivers and/or firmware, changing software versions, or buying a new product – in other words, maintenance work that was not required on the Kodak Path.

The monetary costs of snapshooting were relatively easy to measure with the Kodak Path: the purchase of a camera (more or less a one-time cost), the price of a roll of film, and the price of the photo-finishing service. A consumer could estimate the price per captured photograph relatively easily by dividing the cost of a film roll and its development and printing by the number of exposures (24 or 36). In contemporary domestic digital photography, the cost of a single photograph is very difficult to measure. Also, the cost of photography in general becomes hard to estimate because there are a myriad of ways in which to capture and use photographs, and the devices used for photography often have other uses as well.

There is no simple way of estimating the costs of 'doing' snapshot photography. All we can say without a detailed study is that there are significant one-time costs, such as those of a PC, a printer, photo editing software, a scanner, a camera, a memory card, and so on, and there are some running costs, such as for home broadband service, mobile phone data service, and a photo Web site subscription fee. If one is to be able to participate fully in snapshot photography culture on the Digital Path, the costs of acquiring hardware and software, and the costs of services, seem to be much higher than the costs on the Kodak Path.

The contemporary domestic photography infrastructure also shows that, in comparison to the Kodak Path, there are new business stakeholders in snapshot and domestic photography. Domestic photography has become predominantly information and communications technology (ICT), and most of the businesses

involved in people's photographic practices are from that industry. There are software and device manufacturers who are directly involved in photography: photo management and editing software developers, digital camera manufacturers, digital photo frame manufacturers, photo printing and photo product services (*e.g.*, photo books or photos on mousepads), photo printer and scanner manufacturers, and so on. In addition, there are non-photography-specific businesses that also have a stake in snapshot and domestic photography: mobile phone manufacturers and carriers, operating system providers, memory card manufacturers, social networking services, Internet service providers, hard drive manufacturers, and search engine providers, to name a few.

In contrast to the Kodak Path, there is no dominant business model here for making a profit on snapshot photography. The business stakeholders are as numerous and heterogeneous as the technologies involved. Whether there will be a dominant design and a dominant business model in snapshot photography remains to be seen. In the year 2010, we are still living in an 'era of ferment' that began in the 1980s with the introduction of electronic photography.

In the next chapter, we take a closer look at the practices of snapshot photography and how user- and human-centric research in computer science (*i.e.*, human–computer interaction, computer-supported co-operative work, and interaction studies) has studied the practices of the past decade.

References

Aaland M, Burger R (1992) Digital photography. Random House, New York

Anderson P, Tushman M (1990) Technological discontinuities and dominant designs: a cyclical model of technological change. Adm Sci Q 35(4):604–633

Chalfen R (1987) Snapshot versions of life. Bowling Green State University Popular Press, Bowling Green

Crawley G (1989) Colour comes to all. In: Ford C (ed) The Kodak museum: the story of popular photography. Century, London, pp 128–153

Data Center Knowledge (2009) Facebook now has 30,000 servers. Data Center Knowledge. http://www.datacenterknowledge.com/archives/2009/10/13/facebook-now-has-30000-servers/. Accessed 19 Mar 2010

Digital Imaging Plus (1994) Apple quicktake 100. Mar 1994

Hernandez V (2008) Ringo photo sharing Website bows out of cyber space by end of June. All Headline News. http://www.allheadlinenews.com/articles/7011151890. Accessed 19 Mar 2010

Hsu J (2009) The worldwide mobile phone camera module market and Taiwan's industry, 2009 and beyond. Market Intelligence & Consulting Institute (MIC), Taipei

Humphries M (2004) MMS not popular in EU. Geek.com. http://www.geek.com/articles/mobile/mms-not-popular-in-eu-20040513/. Accessed 19 Mar 2010

IT Facts (2005) Film sales drop by 20% every year. IT Facts. http://www.itfacts.biz/film-sales-drop-by-20-every-year/4889. Accessed 6 Sept 2010

Kodak Imaging Network Inc (2009) Terms of service at Kodak gallery. Kodak Imaging Network Inc. http://www.kodakgallery.com/gallery/footerLinksContent.jsp?pageID=600010. Accessed 29 Apr 2010

Larish J (2008) Silver to silicon: a journalist looks back at the changes that have brought us to the era of digital photos. CreateSpace, Seattle
Manovich L (2002) The language of new media. MIT Press, Cambridge, 1st MIT Press pbk
Neustaedter C, Fedorovskaya E (2009) Understanding and improving flow in digital photo ecosystems. In: Proceedings of the graphics interface 2009, Kelowna. ACM, New York
PMA (2009) U.S. households make photo books for family keepsakes. PMA. http://pmaforesight.com/?p=40. Accessed 2 Sept 2010
PR Newswire (1995) Fargo introduces FotoFUN!: Digital color photo printer comparable to a photo lab. 8 Aug 1995
CNET News (2007) Cameras: shipments rising, but prices falling. 19 Sept 2007
CNET News (2002) Toshiba crops digital camera price. 1 Mar 2002
Strategy Analytics (2005) Camera phone sales surge to 257 million units worldwide in 2004. Strategy Analytics. http://www.strategyanalytics.com/default.aspx?mod=PressReleaseViewer&a0=2354. Accessed 19 Mar 2010
TechCrunch (2009) Who has the most photos of them all? Hint: it is not Facebook. Techcrunch. http://techcrunch.com/2009/04/07/who-has-the-most-photos-of-them-all-hint-it-is-not-facebook/. Accessed 19 Mar 2010
Time Magazine (2010) How Facebook is Redefining Privacy. 31 May 2010
US Census Bureau (2001) Home computers and Internet use in the United States. Aug 2000
US Census Bureau (2010) U.S. and World population clocks. U.S. Census Bureau. http://www.census.gov/main/www/popclock.html. Accessed 16 Sept 2010
Wang H (2007) Digital Photo Frames: Picture a Good Year. Parks Associates, Dallas
Wang H (2009) Digital Photo Frames: Annual Global Market Analysis and Forecasts. Parks Associates, Dallas
Zuckerberg M (2010) 500 million stories. The Facebook Blog. http://blog.facebook.com/blog.php?post=409753352130 Accessed 6 Aug 2010