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Table of Contents

Refereed Articles

Juried Articles

Evaluation of Inkjet-Printed Film for Image Carrier Preparation

by Renmei Xu, Ph.D. • Susan C. Londt, M.A. • Hans P. Kellogg, M.A. • Ball State University

Abstract

For photographic image carrier preparation, image film can be created photographically or printed digitally. The photographic methods involve the use of an imagesetter and a photographic film processor. Non-traditional digital printing methods include the use of inkjet printing and thermal printing. These digital imaging methods increase efficiency and eliminate photographic materials, but might result in quality issues. This study is a comparison between the photographic and inkjet printing methods. A Linotronic 330 imagesetter and a Fujifilm FG 550E film processor were used for the photographic method. An Epson Stylus® Photo R1900 printer was used for the printing method along with AccuRIP® software and AccuFast® film, acting as the image receptor.

Introduction

In the processes of photographic image carrier preparation such as platemaking and stencilmaking (Dennings, 2006a and 2006b), image quality of the film is very important because plates or stencils can never be of higher quality than the artwork used to generate them. High contrast films with minimal density in transparent areas and high density values in solid areas ensure good light exposure (Balfour, 2007, and Marsden, 2009). A positive image film should have sufficient density (a high Dmax) to block light from the image area, sufficient clarity (a low Dmin) to transmit light onto the non-image area, and sharp edge definition (acutance) between the two. In contrast, a negative film should have sufficient density (a high Dmax) to block light from the non-image area and sufficient clarity (a low Dmin) to transmit light onto the image area. Dmax of 4.0 is ideal and Dmin should be close to zero.

Film positives and negatives can be generated photographically, which involves an imagesetter and a film processor (Adam and Dolin, 2002, 209–210). Recently, digital printing technologies have been developed to allow the direct printing of an image directly on transparent film from digital files. The printing methods used for this are inkjet printing and thermal printing (Catspit Productions, 2011, and Ulano, 2011). While inkjet printing methods increase efficiency and eliminate photographic materials, there may be a question of quality. In this study, inkjet printing was used to image transparent material, and was evaluated and compared with the traditional photographic film method. It should be noted that a similar evaluation of these methods was performed by Burke and Wilson (2011). Their study revolved around the flexographic printing process. The study discussed in this article differs in focusing on films for use with general print applications that include high resolution linework as well as halftone images.

Methodology

A single color test form (see Figure 1) was created for this study. It contains varied images of text from 4 to 30 points, rule lines of 0.25 to 10 points in thickness, vector and raster images, as well as solids and tint areas.

Positive image films of the test form were created by both the photographic and inkjet printing methods. The characteristics of the halftone process were 75 lpi screen frequency, 45° screen angle, and elliptical dot shape. Films were created by the photographic process using a Linotronic 330 imagesetter and a Fujifilm FG 550E film processor. An Epson Stylus® Photo R1900 printer was used for the inkjet printing method along with AccuFast® film (Ikonics Corporation, 2011) and AccuRIP® software (version 1.01 from Fawkes Engineering). Variables in the inkjet printing process included the ability to adjust the droplet size. Heavy, medium, and light ink droplet sizes were all tested, with heavy ink droplet size eliminated due to the abnormally slow drying time that makes it impractical in an industrial application. Transmission densities

Test form containing type, lines, images, and tints.

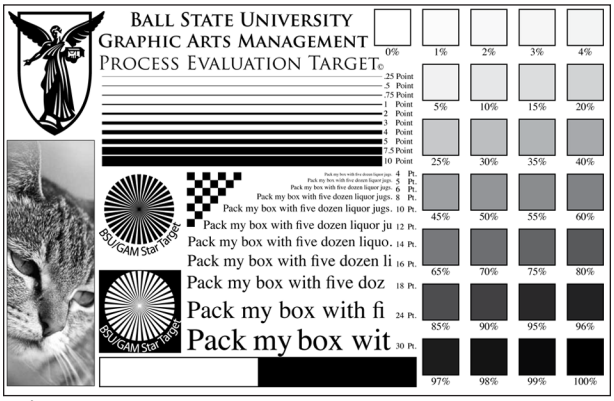

Figure 1

of both photographic film and inkjet-printed film were measured with a Gretag D 200-II densitometer.

Limitation

It should be noted that this research was limited to the creation of inkjet films with only one combination RIP (AccuRIP®), inkjet device (Epson Stylus® Photo R1900), and film image carrier. (AccuFast®). Other RIPs are avaiable for inkjet film production and these solutions may produce different results.

Results and Discussion

The maximum and minimum transmission densities of photographic and inkjet-printed films are listed in Table 1.

Table 1: Transmission Densities of Photographic and Inkjet-Printed Films

	Photographic Films	Inkjet-Printed Films	
		Medium Ink Droplet Size	Light Ink Droplet Size
D_{min}	0.3	0.7	
D_{max}	5.1	6.0	1.27

The films used for inkjet printing had a high Dmin, indicating the films were translucent, but not transparent. This was caused by the application of a light blue coating to the printing side of the film which allowed the film to accept and absorb inkjet inks. In comparison, photographic films had a lower Dmin than inkjet-printed films. The Dmax value of inkjet-printed films depends on the setting of ink droplet size. With a light ink droplet size, a Dmax of only 1.27 was achieved, while 6.0 was acheived with a heavy ink droplet size. Therefore, the medium ink droplet size was used to print images.

The visual appearances of both films are shown in Figure 2 and Figure 3.

Dot gain curves were obtained by plotting dot gain values against the original tone values, as shown in Figure 4. The solid density of the inkjet-printed films produced a higher than expected density value, even greater than the photographic films. The inkjet film also had higher dot gain than photographic film, as illustrated in Figure 4. The tint areas and halftone image of the cat on the inkjet-printed film appeared much darker and dot gain was almost 50% in mid-tone. Although the inkjet film has a coating layer specially designed for inkjet printing, inkjet inks are low-viscosity fluid inks, causing the ink to spread when applied to the film surface. This spreading caused exces-

Visual appearance of a photographic film.

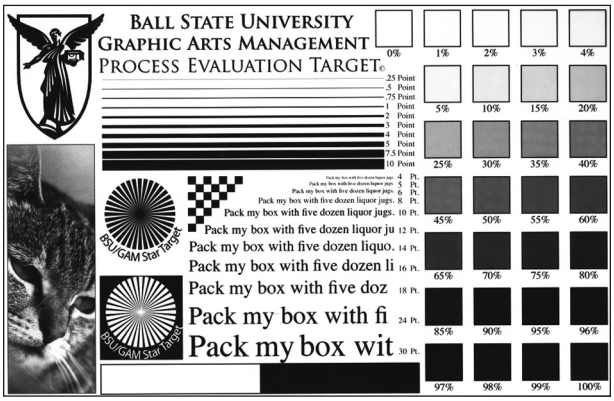

Figure 2

Visual appearance of an inkjet-printed film.

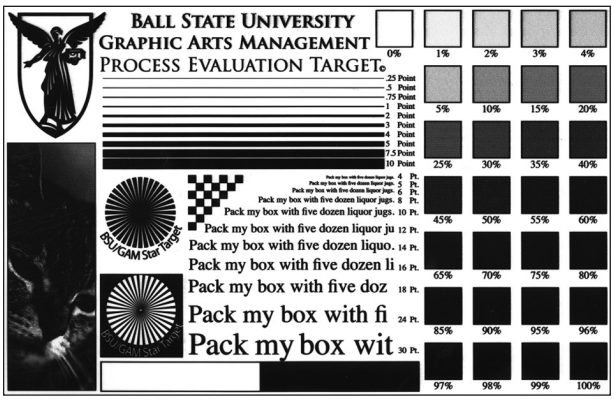

Figure 3

Dot gain curves of photographic and inkjet-printed films.

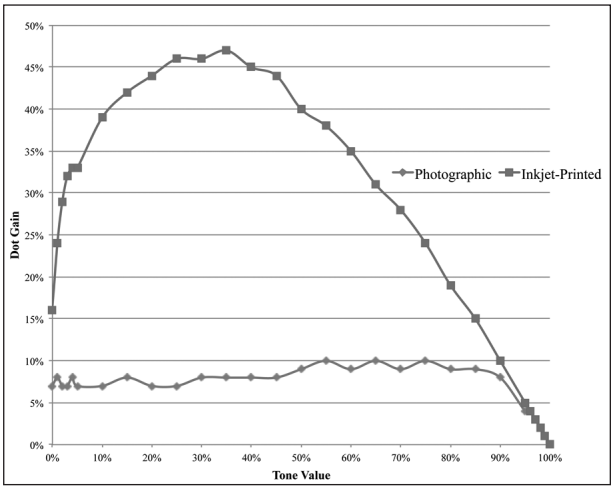

Figure 4

sive amounts of dot gain. Excess dot gain of the film transfers to plates and stencils, and eventually to the printed image creating a darkening effect of the photographic image. Dot gain remained within 10% for the photographic films.

Dot gain curves of inkjet-printed films with different dot shapes.

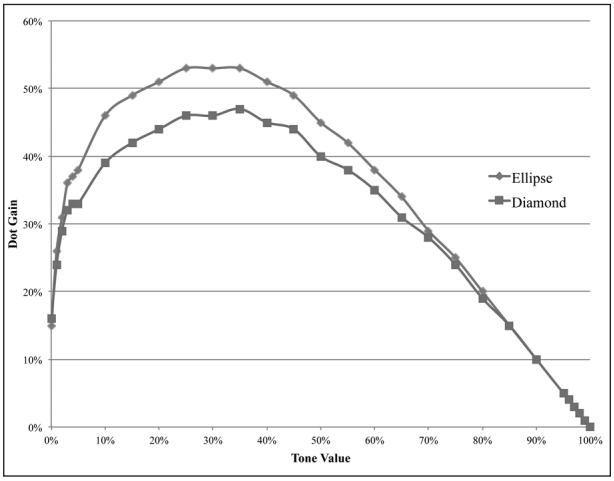

Figure 5

The image on photographic films had sharp image to non-image edge definition, as shown in Figure 6, while directional streaks were observed on inkjet-printed films, as shown in Figure 7. These streaks may have been due to the moving inkjet printheads. If the film image edge (image to non-image area) lacks clarity, the non-image area of a plate or stencil will not be exposed correctly or hardened enough. As a result, it may become vulnerable to removal during next step of development, leading to lower print quality. Based on these findings, it is expected that plates or stencils made with inkjet-printed film would not achieve the same quality level as those made with photographic film.

Details of a photographic film.

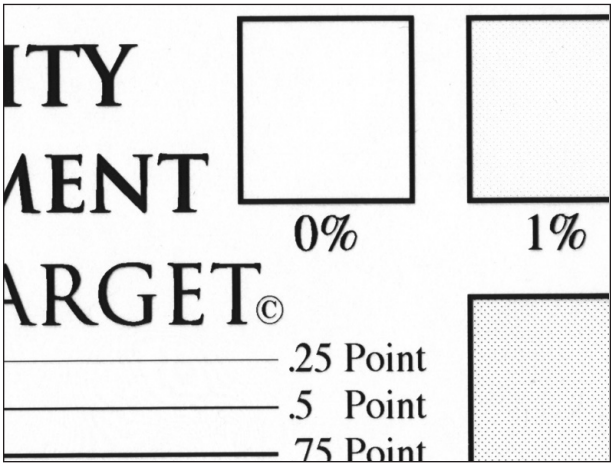

Figure 6

Details of an inkjet-printed film.

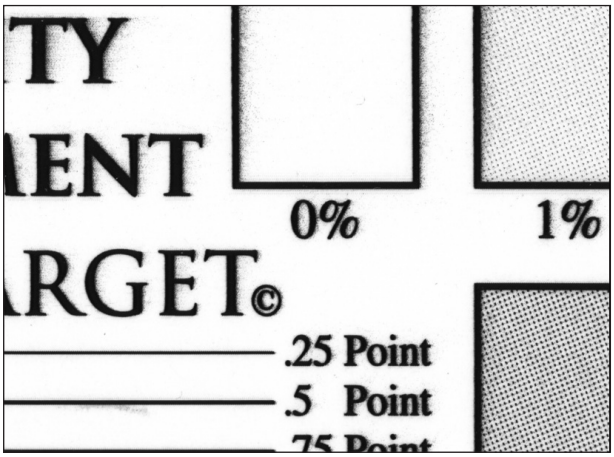

Figure 7

Conclusions

Photographic methods to prepare image carriers using photographic films are not environmentally friendly due to development chemicals and metallic silver present in waste fixer, but they can achieve high quality and may be best for high-resolution line or halftone artwork. Methods of inkjet printing films are more environmentally friendly, but they have quality issues such as high dot gain and lack of clarity on non-image areas. Therefore inkjet films may best be limited to general printing applications devoid of fine lines or halftones. This research was limited to the creation of inkjet films based on a single software and material combination of the AccuRIP® and AccuFast® film image carrier. Additional testing for qaulity is warranted as advancements in RIP and inkjet technology become available.

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Digital Large Format Part I: Medium Format Digital Backs and Adaptors

by Chris Lantz, Ph.D. • Western Illinois University

Introduction

Even with recent advances and lowering costs of digital-single-lens-reflex (DSLR) cameras, photographers still favor medium and large format digital photography. This is the first in a series of three articles on medium and large format photography. The next two articles, *Digital Large Format Part II: Scanning and DSLR Shift-Backs, and Digital Large Format Part III: Cameras and Lenses,* will appear in the next two issues of the VCJ.

Photographers with older medium and large format camera equipment are usually excluded from using current digital camera backs because of their cost ($7,000–$30,000). Older medium format film based equipment is much lower in cost but only some of it is compatible with the new digital medium format backs. The costs for the new backs is out of proportion with the value of the older camera equipment. Schools often have this older medium and large format camera equipment and would like to find a low cost digital capture solution for it. A used medium format back makes a good solution to this problem. This paper will detail the use and workflow of these older systems. This study does not detail all the available manufacturers and possible options, but rather focuses on one solution. However, there is enough detail provided so a graphic arts program could replicate the camera configurations presented here. Part II of this series will cover scanning backs and DSLR shift-backs and part III will detail lens and camera options for these systems. Some content in this series is advanced in nature and requires a basic understanding of large format photography. The reader may wish to review articles in the Spring 2009 VCJ (Lantz, 2009).

Phase One Lightphase sliding back. A Hasselblad V-mount H5 digital back is attached to the sliding back.

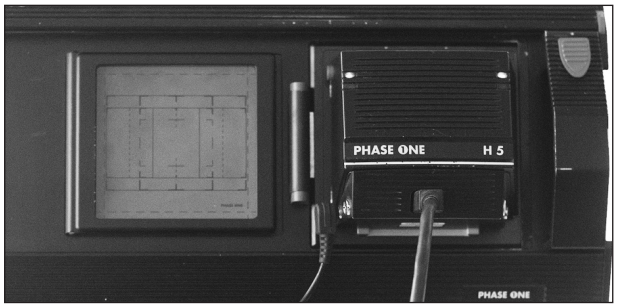

Figure 1

Enlarged image detail from a Phase one H20, 18 megapixel back. A 150mm enlarging lens on a Cambo large format camera was used to create this image.

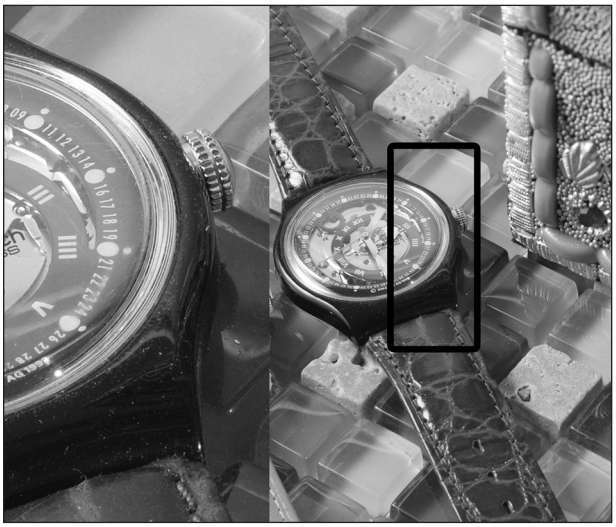

Figure 2

Enlarged detail from a H5 stitched image (top) and a H20 stitched image (bottom). Each image was created from overlapping images and Photoshop photomerge.

Figure 3

This article focuses on the use and advantages of medium format backs. Camera movements can be the most important justification for using medium format when the digital back is mounted on a large format camera. Camera movements control the sharpness plane, perspective and shape of the subject. Lower cost older backs can be used in conjunction with sliding large format camera adaptors (Figure 1). Such adaptors allow two or three pictures to be taken across the image plane on a 4×5 inch large format camera. This increases resolution and produces a slightly panoramic image as a single row or rectangular proportions for two rows. Back adaptors are available in low cost generic form or more expensive brand name solutions such as the Phase One Lightphase or the Capture Solutions sliding back.

Another justification to use medium format is image clarity. Even older larger sized sensors that have lower pixel counts and lower resolution produce images of distinctive image clarity (Figures 2 and 3). This is especially true when compared with some smaller sized higher resolution sensors used in a DSLR. High sensor resolution is important for large sized prints and high magnifications. Optical image clarity is more important than raw resolution for most printing and publishing applications where the image is not highly magnified. Low cost older backs such as the Phase One H5 were used to illustrate examples in this study and may be within instructional budgets.

The backs were used with bright flash and continuous light in the studio. The resulting images were found to have more image contrast in small details or local contrast than small sensor DSLR imagery (Nikon D3100). This difference in image clarity was attributed to the large size of the sensor with a lower crop factor, lower signal to noise ratio, and the quality of the camera optics used.

Lens options is a further advantage. When mounted on a large format camera the medium format back has hundreds of lens options. There are no proprietary lens mounts on large format lenses. Almost any lens can be used by drilling an appropriate sized hole in a compatible lens board.

Camera Movements

The ability to use camera movements for large format and some medium format cameras is the main advantage of using medium format digital backs. Tilting the front lens board provides control of the sharpness plane (Figure 4). The thickness of the sharpness plane is determined by the

The front lens board is tilted toward a tabletop shot of flat subjects. This conforms the flat thin sharpness plane at a wide-open f-stop to correspond to the flat subjects without the use of additional depth of field. Both shots were at wide-open f-5.6 f-stop.

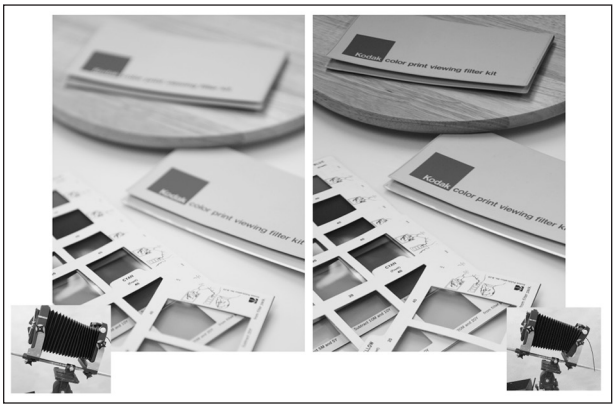

Figure 4

The shapes of the candles were distorted with a rear tilt on the camera (right).

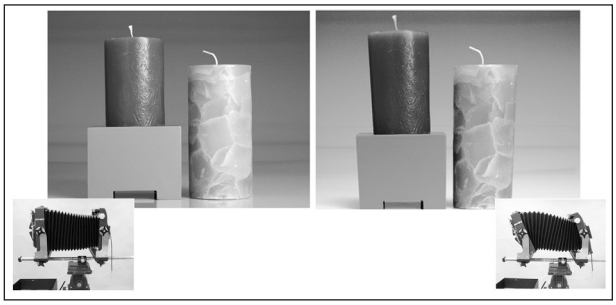

Figure 5

The perspective of the sides of the boxes were corrected (right) with a parallel front and rear tilt (bottom right) on the large format camera that corresponds to the plane of the product linear elements or sides.

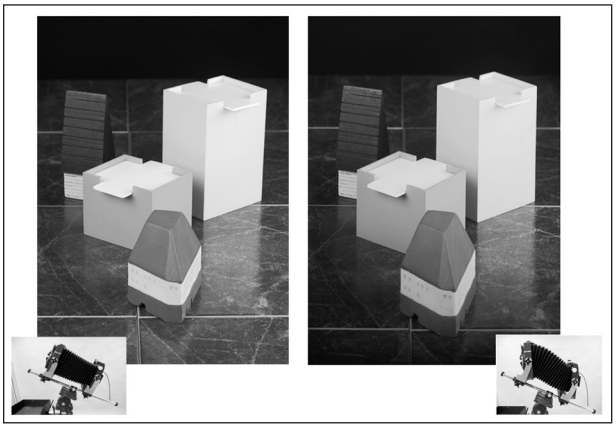

Figure 6

f-stop and depth of field as it is with a fixed lens DSLR camera. Medium format backs on large format cameras produce less depth of field than smaller format cameras for a selective focus effect. Tilting the back of the camera can further reduce the sharpness plane in a specific area or can distort the shape of an object (Figure 5). Using both the front and back camera movements together and in parallel can control perspective. Two of the most common perspective control applications are tabletop product photography with a straight-sided product such as product packaging (Figure 6) and architectural photography of tall buildings (Figure 7). With a standard fixed lens digital camera with the camera pointed down to include the top surface of the product, the sides of product boxes would be keystoned (Figure 8). To correct perspective the front and back standards are tilted so they are parallel with the sides of the product box. Similarly, the sides of the building would be keystoned with the camera pointed up at a tall building. The perspective is corrected by keeping the camera level and rising the front to include the whole building. Another method is to tilt the front and back standards so they are parallel to the plane of the front of the building with the camera pointed up to include the whole building.

With the camera monorail level (lower left) the foreground detail of a parking garage is in view and the building in the background is not included (left). With extreme front rise and rear fall movements (lower right) the building in the background is centered cropping out the parking garage (right). If the camera was pointed up to include the whole building with no camera movements, (center) perspective distortion would be the same as a fixed lens DSLR.

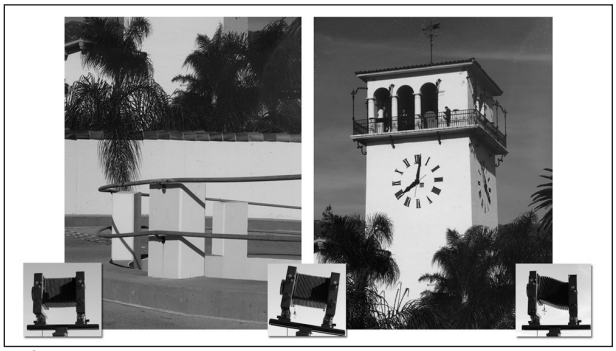

Figure 7

Simple product box perspective correction. Such a movement allows the side of the box to be straight while still including the top of the product with a higher camera angle.

Figure 8

Medium Format Backs

One option for low cost digital capture on medium and large format cameras is the use of older medium format digital camera backs. These backs are low in cost ($500–$1000). They are tethered to a computer via firewire and only portable on laptop battery power or external battery kit. Despite these disadvantages they have larger physical sized sensors than DX or full 35mm frame sized DSLR camera sensors. Examples include the medium format Phase One H Series backs (Figures 9 and 10). The 6–18 megapixel resolutions of the backs produce imges that can be scaled up for many web and print based applications. The large size of the medium format sensors (typically 37×25mm–37mm×37mm) uses a larger part of the projected image size of the lens when compared to DSLR camera adaptors for large format. Lower crop factor gives higher optical quality out of existing lenses originally designed for film. A possible disadvantage of the older (1998–2002) large sensors with low resolution (such as the H5) is a moiré interference effect with fabrics and small patterns in products. This does not typically happen with the higher resolution H10–H25 backs. Older backs also have lower light sensitivity but this problem is easily

Images captured with the H25, H20 and H5 Phase One backs. The proportions of the frames indicate the progressively smaller sensors in the less expensive H series backs.

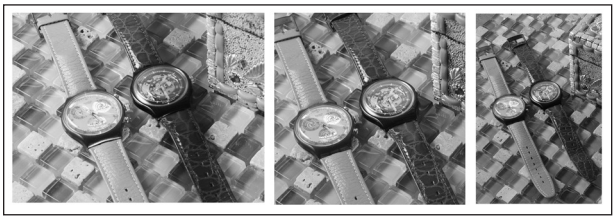

Figure 9

solved for studio work by adding more light. One advantage of the older and larger sensors is a greater dynamic range. This provides greater corrective possibilities for over and underexposed areas, with less noise and a cleaner image compared to the smaller higher resolution sensors in DSLR's. For the highest quality, the backs should be used with plenty of light at ISO 50 and 16-bit mode.

The mounting connections on medium format camera backs are mainly of two types. One type is for the standard Hasselblad-V mount, which does not have electrical connectors from the back to the camera. The other type of back connection is proprietary and has electrical connections. Proprietary backs interface with specific medium format camera systems such as the Mamiya 645 autofocus cameras, Hasselblad-H mount and the now discontinued Contax cameras. Used backs with the Hasselblad-V mount are the most useable because they can be adapted to almost any large format camera with a suitable standard adaptor. The other less common back types may be adapted to large format cameras with available new sliding back adaptors, but additional expensive custom cables may be necessary.

Panoramic stitched images created from a H25 (top) H20 (middle) and H5 (bottom). The size of the stitched images that were created from three overlapping exposures indicates the progressively smaller sensors in the three backs.

Figure 10

Medium Format Workflow

This section provides the workflow for a specific brand of older lower priced digital backs. Phase One was chosen because they fully support older products with their current software that runs on the newest Mac or PC operating systems. Other brands have a similar user experience. However, brands such as Leaf do not support older backs with current software. Some older digital backs, such as the Sinar-23, are run from a proprietary PCI card that fits in a Macintosh G4 tower running Mac OS 10.3–10.4. The Sinar backs are more expandable, with specialized hardware that is designed specifically for Sinar cameras. This hardware provides live previews and adds high dynamic range capability. The Sinar backs have a special external power supply and fiber optic interface on the PCI interface card. Special cables and unique interface cards can be hard to locate as spares. Such systems can be a good value if they are complete because the software is still available for free downloads. Phase One medium format backs use Capture One software for tethered capture. No interface card nor power supply is required and it is a much more compact and simple to set up. It is convection cooled with a solid aluminum shell.

The three backs used in this study have 50,000, 80,000 and over 100,000 exposures. It is the firewire plug and PC sync cord terminal that have a tendency to wear out. The "as-is" backs that have a broken PC sync cord flash terminal can be a good choice for a lower cost. The PC sync terminal on the camera shutter can be split with one end going to the camera and the other to trigger the strobes. The backs were shipped with the digital back DB version of Capture One software that only functions with Phase One medium format digital backs. The full version of Capture One Pro 6 software (not DB) has evolved to serve a greater market as raw capture software for DSLR cameras as well as digital backs ($399).

If a used digital back is purchased without software, one can contact Phase One email technical support and they will provide a free DB license. They will require a serial number for the back to answer technical support questions. The DB version of the Capture One software has all the features of the full product except that it will only work with a Phase One digital back.

The most common and lowest price Phase One H series backs require a firewire cable (Figure 11). These are not

special firewire cables, but they have thin plastic insulation around the plug. If a small length cord is found that is compatible it can be combined with a longer repeater firewire extension cord or a firewire hub to increase its length. Another less elegant solution is to file down the plastic around the connector so it will fit in the recessed plug space. The firewire connector itself powers the H series backs. An additional cable is needed for the H series backs. This cable has a pc flash X-sync connector on one side and a 2.5mm micro plug on the other. This is a standard cable used for some portable flash systems. This 2.5mm micro plug is connected to the back and the pc X-sync plug is connected to the shutter on the large format or medium format lens. If a flash is used, this is attached to the pc X-sync terminal on the digital back. To take a photo on a medium and large format camera the "capture" button is pushed in the Capture One software to wake up the back as indicated by blinking green lights, and then the shutter release cable is used on the shutter to take the photo. The raw TIFF file is transferred to the computer and is displayed as a thumbnail. To perform automatic white balance, an eyedropper color balance tool can be used to sample a gray card in the test shot or a neutral color tone in the subject. This white balance for the current lighting condition can then be applied to subsequent photos. Images that are color balanced can then be processed into a final Tiff file by using a "processing" button.

If the medium format back is used on a large format camera, a sliding back is available called the Phase One Lightphase. The Lightphase sliding back is found with mounting plates for Sinar, Linhof, Cambo and other large format camera makers. If a used Lightphase back is purchased with the wrong adaptor plate, a new plate can be fabricated by cutting a square hole in the correct brand lens board and then mounting with four screws. The Lightphase back is slid on this adaptor so that two or three overlapping images are taken (Figure 12). These images are then stitched together with a Photoshop script. Capture One software has had dedicated photomerge functions years before they were available within Photoshop. Less expensive new sliding backs are available on Internet eCommerce sites and these have the advantage of using the universal Graflock connection available on many different large format cameras. Not all 4×5 cameras have the universal back, but most do (Figure 13).

The firewire plug is in a recessed cavity on H series Phase One backs that requires a firewire cable with a thin plastic insulation to fit.

Figure 11

Computers for Tethered Medium Format

The original firewire 400 specification on older digital backs required powered firewire ports. Older firewire interfaces such as on a Powerbook G3 Pismo and G4 Titanium laptops power the backs even on internal battery power for portable applications. A 15-inch Titanium

Three images (top) captured on a H20 mounted on a Lightphase sliding adaptor. These were stitched together in Photoshop photomerge (bottom).

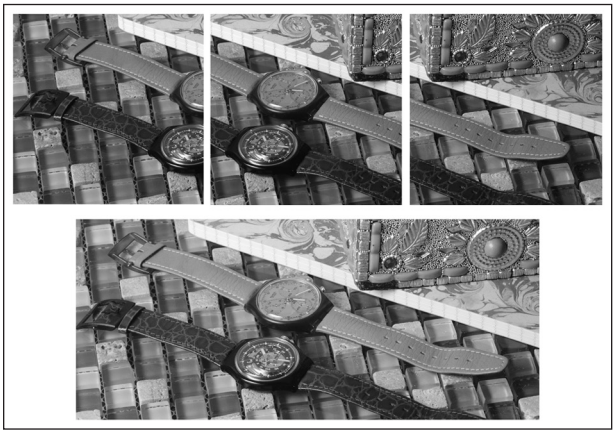

Figure 12

Universal or Graflock backs contain sliding locks that retain a medium format adaptor to the back of a large format camera. They were originally created for roll film backs to use medium format film on a large format camera.

Figure 13

G4 Powerbook with a new aftermarket battery makes a low cost portable solution for an older digital back. G3 through G5 towers have the older powered firewire. PCI firewire 400 cards for PC or Mac have powered firewire. Some Cardbus cards for PC laptops and Apple Powerbooks have an external AC power plug for powered firewire. If portable use is not needed, the better solution is to use a powered firewire 400 hub with current firewire Macs or PC's. New Macs will require a standard firewire 800 to firewire 400 cable or adaptor.

Medium Format Cameras

Fuji GX 680 III

The Fuji GX 680 III is a 6×8cm film camera that can be fitted with generic digital back adaptors and a sliding adaptor made by Capture Solutions (Figure 14). This camera and the older versions (680 GX and GX II) can be used with digital backs with an adaptor cable made by Capture Solutions. This adaptor plugs into the electronic cable release and the flash sync terminals on the camera body. The adaptor has a control box that is set to the shutter speed used on the camera and a button that triggers the camera. No pre-triggering with the capture button is needed in the Capture One software. The advantage of the Fuji GX cameras is that they have built in lens tilt, front rise, shift and swing movements. There is also a lens adaptor that allows large format lenses to be mounted on the camera. The GX has an add-on long bellows extension rail for close up work and a bag bellows for wide-angle lenses. It is a large size camera but smaller than most 4×5 cameras. It is perhaps the most versatile medium format camera considering its camera movements and large format lens adaptor.

Mamiya RZ

Phase One has an adaptor solution for the original Mamiya RZ camera (Figure 15). Most other older backs require the newer Mamiya RZ Pro II camera. The Mamiya RZ is a common camera with many inexpensive used lenses available. The back adaptor consists of a Hasselblad-V mount back to RZ back plate with electrical contacts that interface with the Mamiya RZ camera body. An electronic cable release cord is also attached to the adaptor plate. A separate 2.5mm mini plug to flash pc X-sync cable is provided. The electronic release cable from the plate is connected to the camera and the flash X-sync cable is plugged from the back to the PC sync terminal on the lens. The RZ has a built in bellows for close up work but does not have camera movements without a rare and expensive adaptor.

Fuji GX680 camera and Capture Solutions control box.

Figure 14

Phase One Mamiya RZ adaptor solution for H series digital backs.

Figure 15

Hasselblad-V Mount

The Hasselblad-V is the original back mount for the very common 500 series cameras such as the 500C, 500CM and 500ELM. The ELM will require a motor drive cable. The standard 2.5mm mini plug to X-sync cable is all that is necessary for the 500C or 500CM. The V-mount is the most common on older medium format digital backs. In this case study V-mount digital backs were selected but Fuji and Mamiya cameras were used with them. This was because the Fuji has camera movements and the Mamiya RZ has a large supply of low priced lenses. Hasselblad has some common lower cost lenses but most of the lenses are more expensive than Mamiya.

Sinar Auto Shutter with a DB mounted lens. A DB lens contains the lens cells that were often screwed off a standard shutter and then converted to the auto shutter. It is called an auto shutter because the internal f-stop in the DB is automatically stopped down upon taking the picture. This shutter was made for Sinar cameras but can be converted to others such as this Deardorf.

Figure 16

Lightphase Sliding Back on Monorails

The Phase One Lightphase sliding adaptor is available for several monorail 4×5 cameras, but Cambo and Sinar were tested for this study. A monorail refers to a camera that has a single tube or other shaped rail that the front and back of the camera slide on for focusing. A rail clamp is usually in-between the front and rear standards of the camera and contains the mount for a tripod. Monorails are more bulky and usually heavier than woodfield or press folding cameras designed for fieldwork. Camera types will be discussed in more detail in Part III of this series. Sinar was selected because they make a shutter system called the Auto Shutter (Figure 16) that is needed for lenses without a shutter (barrel lenses). The Cambo camera was selected because it is a simple camera that does not contain many plastic parts and does not wear out easily with heavy student use like the Sinar can. Both Sinar and Cambo cameras are very common and many low cost accessories are available such as the necessary bag bellows (Figure 17 and 18) and recessed lens boards (Figure 19). Bag bellows allow camera movements when the front and rear standards are close together for short focal length lenses. A standard bellows in a compressed position is rigid and does not allow movements. Monorail cameras generally make the best cameras for digital medium format in the studio. Monorails are inexpensive, have rear shift movements and most have interchangeable bellows. The Sinar cameras have a specially designed small profile bag bellows available for digital camera applications. Some folding wood field camera systems have wide-angle bellows such as ShenHao, but not many.

One limitation of monorail cameras is that the rail clamp is usually between the camera front and rear standards. This puts a far focus limitation on short focal length lenses such as 90mm or smaller. This home made dual rail clamp configuration for a Cambo camera gets the standards closer together for far focus and adds stability to the camera.

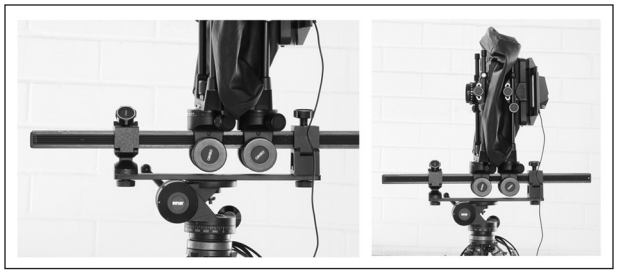

Figure 17

Large Format Universal Back

Almost any large format camera that has a Graflock or universal back can be used with a medium format digital back with an adaptor. Such adaptors can be fixed or with a shift option. The shift-backs are useful for compact press or technical cameras that do not have rear shift movements. A fixed back adaptor can be less expensive and is suitable for almost all monorail cameras. The Lightphase back is much heavier and harder to work with on a copy stand or in a portable configuration than the smaller universal digital back adaptors.

Front and rear of a Cambo camera with a bag bellows and a Lightphase sliding adaptor. The bag bellows allows camera movements with the standards close together such as with a 135mm enlarging lens in this case.

Figure 18

Recessed lens boards are often necessary for digital medium format on large format cameras. Short focal length lenses are needed for a normal angle of view. Short lenses require short distances between lens and camera back.

Figure 19

A home-made camera designed for the shortest focus distance between lens and digital back.

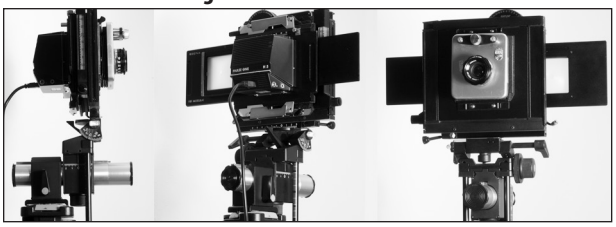

Figure 20

One portable digital solution for short focal length lenses (50–75mm) was made using a universal back adaptor because of its small form-factor for field use. A generic medium format V-mount back adaptor, a Sinar front standard, a Sinar Auto Shutter, an adjustable focus lens board and a rail clamp were used (Figure 20). This camera has no bellows or camera movements but provides a distant tabletop angle of view with short focal length lenses. The 50mm and 75mm distance is so short that there is no room even for a bag or wide-angle bellows considering that the adaptor itself introduces some space between the back and adaptor.

Conclusion

Large format cameras are the ultimate system cameras with modular components being adaptable to a wide variety of lenses and digital capture options. Medium format cameras also have extensive system components but most are less versatile because of a lack of camera movements. The advantage of medium format cameras is that they are very numerous and low in cost. Pre-owned digital capture systems for this camera equipment can be a good investment because it depreciates slowly.

Transferring a digital back from one camera to another on a cart in the studio can extend existing equipment. The ultimate in resolution is not always the most important criteria for selecting photo equipment for educational purposes. A recommendation is to give students exposure to a variety of normally very expensive professional camera systems at a low cost. Older surplus professional equipment is the best solution. Even if a state-of-the-art medium format digital camera system is available, perhaps these older systems are still useful in increasing the capacity of the educational photo studio.

Reference

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A Peircean Analysis of Apple's Logo: From the Beginning to Its Current Version

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Introduction

The purpose of this study is to examine the evolution of Apple's logo—from its inception to the newest version of the graphic emblem today. The objective is to determine the meanings that the logo has had for Apple, Inc.'s identity, mission, and relationships, as well as the messages that the logo conveys to viewers. By "evolution" of the logo, the researchers mean "ongoing transformation." The semiotic model used in this analysis is Charles Sanders Peirce's (1958 [1931]) semiotic framework. Peircean semiotics are made up of a three-part paradigm of signification: the "represntamene" (or the sign itself), the object or "referent" (what the sign refers to), and the interpretant (the effect on the viewer, or the viewer's interpretation). An important conclusion is that the communicative intent of Apple, Inc., through its logo, tends to take a long time to develop. Apple's ideal identity has been built over a long period of time, which makes the notion of logo improvement "evolutionary" in nature. Communication has played a major part in Apple's logo improvement.

Rationale for Conducting this Semiotic Analysis

Over the past two decades, corporate researchers have shown significant interest in the meaning of logos. To varying degrees, many of their works have been based on semiotics. These studies are published in (a) journal articles (e.g., Arnold, Kozinets, & Handelman, 2001; Bishop, 2001; Brannen, 2004; Hirschman, 1988; Holbrook & Grayson, 1986; Levitt, 1997; Levy, 1981; McQuarrie & Mick, 1999; Pinson, 1988; Sherry & Camargo, 1987; Thompson & Haytko, 1997; Zakia, 1986); and (b) books and book chapters (e.g., Boutaud, 1998; Csikszentmihalyi & Rochberg-Halton, 1981; Fiske, 1989; Gottdiener, 1995; Holbrook & Hirschman, 1993; Jensen, 1995; Leiss, Kline, & Jhally, 1986; Schroeder, 2002; Solomon, 1988; Vihma, 1995). All of these authors looked at the semiotics of logos from a narrow perspective, namely the meaning of a corporate logo "for the time being," or what it means at the moment.

However, none of these authors looked at the evolutionary meanings of logos – how they change over time and why these changes were made. For example, Arnold et al. (2001) viewed corporate logos as symbolic acts. More specifically, by analyzing Wal-Mart's logo, the authors provided a broad-based semiotic analysis of the company's communication strategies – e.g., the use of metaphors, icons, slogans, and signs. From this perspective, not only was their study a skin-deep analysis of corporate identity but, also, it did not make the Wal-Mart logo the centerpiece of their analysis. Likewise, McQuarrie and Mick's (1999) study mostly centered on the visual rhetoric of logos, a long-established semiotic tradition that offers no new niche or gaps to fill in the field of corporate communication. The main gist to their research was investigating the role of imagery in creating consumer response.

In this analysis, the researchers set out to determine, from a semiotic perspective, the reasons for all logo changes – from the inception of the Apple company until today. A logo tends to take on a completely different representation decades later than when it was first conceived. This is where an important gap would be filled. To be effective, the logo of Apple, one of the most successful companies in world history, has been restructured and revamped over the years to represent the true values of the corporation and to be easier to perceive by consumers (viewers). Hence, corporate identity has a propensity to be evolutionary in nature. It would be too naive or "one-dimensional" to constrain this analysis of a logo to its daily use by a U.S. corporation. As Coombe (1998) argues, it is indispensable to investigate "multiple moments" (p. 17) of a corporate logo.

Definition of Logos

Logos are symbols that differentiate one model or brand from another. They serve to recall a certain brand in a consumer's mind, and are typically designed to be easily recognizable. Rather than looking for brand names, consumers are familiar with, and look for, corporate symbols as visual shortcuts (Selame, 1988). Logos serve as a particularly crucial means of identification (Bennett, 1995), as well as one of the most important depictions of a company's verbal and visual promotion strategies. They serve as a communication intermediary between the company and its consumers, who are ultimately responsible for the business's financial success (Heilbrunn, 1998a; Lipovetsky & Roux, 2003; Scott, 1993; Zhang, 1997). A logo differs from a brand in that the latter is the materialistic representation of a product. A logo, on the other hand, has a

larger meaning; it is a graphic symbol that represents the true values of a corporation (Heilbrunn, 1998b).

More than just a mix of dyeing and printing, the logo serves as a visual front for the relationship between the producer and the consumer (Black, 2009). It is an emotional expression, which has been used as an indication of brand ownership, origin, and association. Logos also help facilitate brand recognition and loyalty among their consumers, which ultimately leads to development of brand equity (Muphy, 1990). Therefore, logos are highly important assets for which firms spend a lot of money and time promoting (Anson, 1998). The investment is made by management with the understanding that it will generate returns in the form of enhanced brand reputation and corporate image. These allow for a greater competitive marketing positioning, which is vital for the long-term success of the corporation (Chen & Uysal, 2002).

Logos serve as visual representations of both public and private businesses, to convey their content and purpose. They serve as identification – ideally, instant identification – through their use on their posters, advertisements, buildings, signs, and outdoor displays (Considine & Haley, 1992). The logo's purpose is to identify itself (and the corporation) as a quality producer of goods and/or services. Logos are part of the sign system used to communicate a company's identity, both internally and externally, and are somewhat comparable to a signature on corporate materials.

The logo is one of five elements of corporate visual identity, the other four being name, typography, color, and slogan (Silva-Rojas & Roast, 2006). Logos are typically a combination of shape, color, pictures, and graphic design. Logos may contain words (e.g., for a grocery store) or may not contain words (e.g., the current Nike logo), yet both are meant to convey, to the viewer, what is sold inside (McGee, Lomax, & Head, 1988).

Semiotic Perspectives

The method of analysis in this study is semiotics. Semiotics refers to the study of signs and symbols, particularly their processes and systems (Sebeok, 1976, 1991). Semiotics is "the exchange of any messages […] and the system of signs that underlie them" (Sebeok, 1991, p. 60). Fiske (1990) contends that the generation of meaning needs to be included in this definition. Messages contain signs, which are transmitted through sign systems. These sign systems are called codes. Meaning emerges only to the degree that the message receiver comprehends the code (Moriarty, 2002). Semiotics is centered on the comprehension of sign functions and their perception of meaning by the receiver, a process which includes both affective and motivational aspects (Nöth, 1990). This study focuses on the communicative role of a sign, particularly a nonverbal sign.

Charles Sanders Peirce's (1958 [1931]) semiotic framework has deep roots in the field of philosophy. It is made up of a three-part paradigm of signification: the representamen (or the sign itself), the object or "referent" (what the sign refers to), and the interpretant (the effect on the viewer, or the viewer's interpretation). According to Peirce, semiotics refers to the sign-object relation. Peirce's view of semiotics comes from the cognitive-philosophical realm. Thus, his view is largely centered on the examination of meaning interpretation and modes of cognition. Peirce's framework is one of two dominant paradigms that have been used for semiotic analyses of consumer and marketing issues (the other being that of Saussure) (Nöth, 1990; Pinson, 1988, 1993). Saussure's (1986 [1916]) framework is grounded in language, and is largely centered around arbitrary codes (Mick, Burroughs, Hetzel, & Brannen, 2004). Unlike Saussure's (1986 [1916]), Peirce's semiotics goes beyond this, as evidenced by his "representamen-object-interpretant" analysis of the sign.

Representamen

According to Peirce's "representamen-object-interpretant" model, the representamen is the actual sign itself. A sign is that which stands for something else: an object or a concept (Eco, 1979, 1986; Hoopes, 1991). Representamen means a thing that represents something to an interpreting mind. It can be best described as *something which represents* (Peirce, 1958 [1931]). The representamen has meaning to a person; it forms in the person's mind a corresponding image, or possibly a more developed meaning. The representamen stands for an object, as referenced to a type of idea (Popper, Shearmur, & Turner, 2008). A representamen signifies a given object. It is comparable to Saussure's "signifier" (see next section) (Silverman, 1983).

Peirce denotes three distinct types of signs: iconic, indexical, and symbolic signs. Iconic signs are explicit imitative representations; they stand for what they represent at face value. For example, a triangle is a geometrical icon. Indexical signs denote and imply cause-and-effect relationships, or physical connections (Johansen & Larsen,

2002; Neumann-Held & Rehmann-Sutter, 2006). For example, a footprint is indicative of a person having walked by. Likewise, bullet holes in a piece of wood mean there was a gun shot. An indexical sign serves as evidence of something. In the symbolic sign (e.g., school colors or a certain flag), the meaning, aka the sign-object relation, is arbitrary, similar to how language is open to interpretation (Peirce, 1958 [1931]).

Object

The sign symbolizes its object. To be a representamen, it must be representative of something else: an object. According to Peirce (1958 [1931]), an object is something that a person can derive meaning from. This element corresponds to Saussure's (1986 [1916]) signified, while the sign, as mentioned previously, corresponds with Saussure's signifier. The object is the meaning or concept – what the sign is referring to, or the referent. Let us take, for example, the Soviet flag. The signifier is the flag as it exists (i.e., the piece of red cloth with the yellow hammer and sickle; this is something that that one can see and touch). The aspect that is signified is what the flag symbolizes and represents (e.g., Stalinism, communism, Leninism, etc.) (Matusitz, 2007).

The representamen does not provide acquaintance with the object; rather, it serves only to represent the object. Peirce distinguishes two objects: the dynamic object (the actual reality of the object) and the immediate object (as represented by the representamen). For example, a piece of green paper that serves as a sample (= representamen) of the actual paint inside a can (= object) shows the shade of green only, as it is implied one is already acquainted with all of paint's characteristics (i.e., its contents, consistency, that it is used for covering, etc.).

Interpretant

The interpretant is the meaning or idea of the concept when it is decoded. It is the resulting thought/emotion created by the sign (Hoopes, 1991). The interpretant is the resulting effect in the mind of the interpreter as brought about by the sign. It is the interpretation or signification the sign holds for the receiver. The representamen brings about a response (i.e., that which is interpreted) based on how it relates to the object (Short, 2009).

Additionally, the interpretant can be categorized into three segments: (1) that which is represented by the representamen, or the immediate interpretant, (2) the interpretant that is actually formed by the representamen, known as a dynamical interpretant, and (3) the interpretant as it would be if it were understood correctly by representamen, or the final interpretant (Peirce, 1958 [1931]).

Apple, Inc.: A Brief Description

Apple, Inc. is a U.S. multinational corporation (MNC) that creates and sells consumer electronics, media, computer software, and personal computers. Apple's renowned hardware products include its Macintosh ("Mac") computers, iPods, iPhones, and iPads. Established on April 1, 1976 in Cupertino, CA, and incorporated on January 3, 1977, Apple, Inc. was previously named Apple Computer, Inc., during the first 30 years of its existence. On January 9, 2007, the word "Computer" was removed (Sparks, 2011). In May 2010, Apple became one of the biggest companies and the most valuable technology corporation in the world, surpassing Microsoft. At that time Apple was estimated to be worth $222.12 billion, while Microsoft was worth $219.18 billion. The only U.S. corporation valued higher was Exxon Mobil – in 2010 at $278.64 billion (Helft & Vance, 2010). *Fortune* magazine named Apple, Inc. the most admired company in the U.S. in 2008, and in the world in 2008, 2009, and 2010 (Colvin, 2009; Fischer, 2008; World's Most Admired Companies, 2010).

Peircean Analysis of Apple's Logo

Among many other factors, Apple's creative aesthetic design and logo have contributed to the company's distinctive reputation in the consumer electronics industry. Apple's logo was chosen in this analysis because it was at one time reported to be sixth among the most recognized logos in the world (Gobé, 2001). With a very strong following, and devout brand loyalty, the logo engenders great emotionality among consumers (Kahney, 2004, p. 5). The logo is strongly attributed to the company's success with its products. In the early 2000s before Apple's great surge, Gobé (2001) stated, "the power of their [the logo's] branding is all that keeps them alive. It's got nothing to do with products" (p. 1).

The Apple company was created as "Apple Computer Co" in 1976 (Biricik, 2006). The original logo is said to have broken the IBM mold, depicting a rainbow apple symbol in stark contrast to the existing technology scheme of IBM's blue block letters (Olins, 1990). Apple Computer's

history is defined as that of being a challenger – going against established norms, defying industry rules, and branching out on its own set of assumptions (de Chernatony, 2001; Hem & Iversen, 2004; Rijkens, 1992). There is speculation over Steve Jobs' choice of the apple as the logo. In brief, Jobs spent a summer working in an apple orchard and thought very highly of the apple, equating it with perfection (Lemke, 2006). In doing so, Jobs created a symbolic representamen as trying to portray the "perfect" corporation. It is said he was also a fan of the Beatles, and their label was "Apple Records," creating yet another symbolic representamen between his corporation and success. Indeed, the Beatles were extremely popular and renowned for many chart-topping records. Jobs apparently saw it fit that the Apple would be announced as the corporation's logo for lack of anything more inspiring (Norton, 2011).

The most primal Apple logo (see Figure 1) was drawn up by Ron Wayne in 1976 (Linzmayer, 2004). The representamen, or the sign itself, depicts a portrait of Sir Isaac Newton under an apple tree with ribbons encircling the frame, reading the title of the company.

The words on the perimeter of the portrait read "Newton… a mind forever voyaging through strange seas of thought" (Young & Simon, 2005, p. iii). This interpretant in the viewer is one of breaking convention, with the word "strange" meaning "foreign" or unexplored, yet untapped, whereas the term "forever" signals to the viewer a longitudinal perspective of new insights that occur among a "strange" world of possibility. The color selection was iconic, at face value for the viewer, in that it was a black and white image in the style of "early century drawings" (Birick, 2006, p. 57). The vignette depicted Newton with the slogan, "one of the greatest scientific minds of all time." This created an object for the referent of the vignette itself. The logo also symbolized Newton's conception of the apple falling from the tree as the inception of the rudimentary cognition of gravity, and the universe's function as that of clockwork. There is a strong symbolic parallel here of the beginnings of groundbreaking innovation, discovery, and genius in depicting this occasion in the midst of the logo.

Seemingly, this logo lacked style and could not be scaled down (i.e., reduced to a smaller image size) while maintaining the integrity of the logo. It was also said that this logo contributed to the less-than-overwhelming success in sales of Apple's first computer (Linzmayer, 2004). Not long after, Steve Jobs took action, believing the logo to be

The first Apple Computer Co. logo in early 1976.

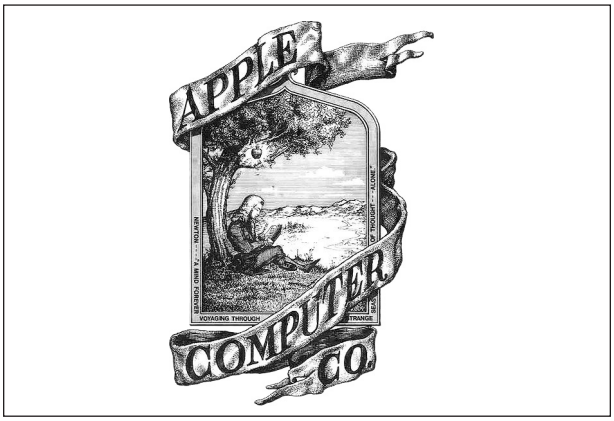

Figure 1

"too intellectual" for a brand, and much too intricate with details. Jobs reasoned that the logo had to be enlarged in size in order for a viewer to read it (Linzmayer, 1999). To represent a brand, the logo needed more style (Moritz, 1984). In April 1977, Jobs contracted an advertising agency, Regis McKenna Advertising, to come up with a logo redesign. The agency had a history of having helped several other well-known computer companies come up with their logo design, such as Compaq, Intel, and America Online (Biricik, 2006). This logo would be debuted with the release of the Apple II, which was launched on April 17th, 1977 (Lynn, 1998).

The silhouette of the 1977 logo (depicting an apple with what looks like a bite taken out of it) was thought up by Rob Janoff (see Figure 2). This silhouette of a bitten apple signals continuity in the company, as it remained essentially the same for more than 30 years (Robard, 2009), making it a strong interpretant between the company and its stakeholders.

The inspiration for this logo came directly from the representamen at its core. Janoff, commissioned to help Steve Jobs, went first to the local grocery store to purchase apples (Linzmayer, 1999). Upon slicing them up, he gazed at them for a long while. The object, or "referent," he came up with was in part symbolic: "The fruit of his labor: a simple 2-D monochromatic apple, with a healthy bite taken from the right side" (p. 12). The idea for the bite may have derived from the play-on-word used with marketing the Apple I – that of a computer byte. This signal for the interpretant was that it spoke to computer-savvy people, who made the connection with the double-meaning and found it fun and clever, as opposed to logos that

tend to be very serious (Linzmayer, 2004). The object may refer to the religious aspect of the apple – i.e., taking a bite out of the forbidden fruit that came from the tree of knowledge. Without a doubt, the bite taken out of the apple symbolically recalls the Biblical reference of the forbidden fruit and further typifies Apple Company's position as a challenger of established norms (de Chernatony 2001; Hem & Iversen, 2004; Rijkens, 1992). Mollerup (1997) signifies the appropriateness of the logo,

Apple Logo in 1977

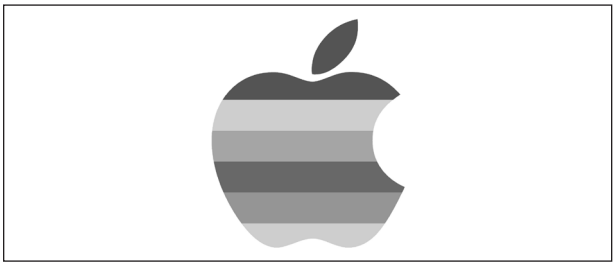

Figure 2

with the apple symbolizing knowledge and lust, crossed out with the spectrum of rainbow colors in the wrong order. He claims that this logo is appropriate in signaling knowledge, hope, lust, and anarchy as the object in the logo itself.

Though Janoff suggested the color be black with a white background to save cost on printing, Steve Jobs argued that color was essential to "humanizing the company." Jobs was insistent upon adding them regardless of printing costs and hassles (the colors would seemingly overlap) (Linzmayer, 1999). From a Peircean semiotic standpoint, the representamen, or sign itself, added the iconic element of colors in what would be considered the wrong order (see Figure 2 again). With complete disregard to the rainbow prism, the colors were laid out based on Jobs' individual thoughts on the order in which they should be laid out (Robard, 2009). The misaligned color spectrum further portrays the company's refusal to conform to established rules (de Chernatony, 2001; Hem & Iversen, 2004; Rijkens, 1992).

Typically, when a logo contains more than just one color, it is not recalled as well and, hence, harder to identify. Yet, for Apple, this was not the case. This is due to the interpretant recognizing the brand for its further meaning as being "Creative. Different. Diverse" (Olins, 1990). Similarly, the object of "playfulness" in the mark brings about, in the eyes of the receiver, the interpretant of how children see color, and that the colors shown in the representamen signified versatility and approachability. Indeed, in that time, computers were not standard in homes, and many people did not feel comfortable with them. The newly designed logo was meant to reduce the fright factor in its market and increase the user-friendly playful appearance to foster approachability. The new logo was a key contributor to Apple's success (Fluck, 2010). A more technical approach is taken by Lizmayer (1999), who suggested the colors were added to showcase the Apple II's color possibilities, which was timely for the logo's release. This was instrumental in creating a corresponding object for the representamen, which would hopefully serve as an interpretant in the minds of consumers.

Overall, there lies much symbolism behind this version of the Apple logo, beginning with Biblical times. The book of Genesis depicts the story of God instructing Adam and Eve not to eat from the tree, and when the serpent taunts her for hiding away, he says that eating it will open her eyes and she will become "as the gods, knowing good and evil" (Genesis 3:4–5). The apple was depicted by painters to be the forbidden fruit in the story of Genesis, and continues to resonate as such in this culture. This is a strong symbolic interpretant in that the company is willing to not only violate but also completely disregard norms and restrictions to convey its sense of independence and unwillingness to conform. In doing so, it also brings about a symbolic interpretant of the company by providing knowledge that would otherwise be forbidden to consumers (Biricik, 2006).

Another symbol is the apple as a symbol of knowledge. Eating the apple signifies the acquisition of understanding, as the Biblical story implies that knowledge is corruptive. The corresponding object is that knowledge brought to the masses through computers suggests the start of creation. The object is that computers are user-friendly and can be a natural part of spreading knowledge to the world. The interpretant in the image is a personal one, and can be interpreted based on one's cultural and Biblical schemas.

The rainbow logo was used from 1976 to 2002. In 1998, a monochromatic logo (one-color logo) was released with the new iMac, depicting a white apple with a sleek design, its object portraying a more futuristic, individualistic streamlined "new era of the Apple." Nevertheless, Steve Jobs' goal of maintaining the iconic apple shape had been long established in his company (Robard, 2009). Given

the popularity and obsessive culture of Apple users, there is a very strong association between the representamen and its interpretant. There is evidence for a very strong emotional effect on the viewers, due to the logo's symbolic conveyance of innovation, creativity, and nonconformity. Profound brand loyalty is displayed by consumers affixing Apple logo stickers to their cars, and even getting Apple haircuts and tattoos (Kahney, 2004).

Implications of Apple's Logo on Viewers

In a world cluttered with mass media messages, instant brand recognition through a given symbolic representamen is crucial. Viewers must be able to get a glimpse of the corporation in its entirety, and what it stands for. For Nadaff (2004), "logos are often the most visual, most used, and most recognized form of branding" (p. 1).

Current Apple Logo, since 1998

Figure 3

Logos must not only have a visual presence; they must also portray a message consistent with the overall brand (Naddaff, 2004).

Today, Apple has a very strong following, and its identity among viewers is extremely prevalent given its cohort of loyal followers (Kahney, 2004). To varying degrees, people have identified with the Apple brand. In a sense, they have also adopted it as their own based on the symbol of the apple with the bite taken out of it (as we can see the Apple stickers on people's vehicles). The creation of Apple's logo has contributed to its viewer identity in creating a representamen of the striped apple logo intended to convey a sense of approachability and user-friendliness as well as a reduction in the fear associated with the use of a computer.

Another facet of Apple's identity with its viewers has to do with its marketing technique of giving out free decals with the purchase of a new machine, which began in the 1970's and continues on through today. These decals are displayed and recognized throughout the U.S. They are in high demand in other countries, so much so that they have been used for payment in lieu of money (Khaney, 2004). As Khaney (2004) remarked, "it's almost guaranteed that proud owners of brand-new Macs will affix a decal on their car, boat, bike, skateboard or storefront window. The representamen of an apple with the bite taken out of it has so much meaning among its loyal followers, consumers, and even average computer users, that it has incredible emotional appeal, and in essence has established a remarkable identity among its viewers.

Discussion and Future Directions

What this analysis has demonstrated is that, having been streamlined over the course of almost four decades, Apple's iconic logo (i.e., the apple shape) has a long history, which has helped it build recognition and has served to distinguish it from competitors. As such, when one sees Apple's logo on a piece of technology, there is no mistaking the brand associated with it (Robard, 2009). The Apple brand has utilized the same logo silhouette since 1977, and it makes a remarkable statement on the establishment, contiguity, and, ultimately, the recognizability and distinction it has attained over time. What is significant about the logo is consistency along each step of its evolution. Maintaining some consistent elements can aid in preventing loss of viewer recognition, instability, or a new viewership.

In line with these contentions, Apple's logo exemplifies the notion of "direction toward the future" by using the releases of the company's computers to debut a new logo, taking a future-oriented approach in planning the message that would stand to accompany the products. This allows Apple to send an even stronger brand image in having the new logo coincide with the release of a new product, e.g., this was particularly evident when the debut of Apple's second logo coincided with the emergence of the Apple II (Lynn, 1998). This lends itself to a more direct representamen-object-interpretant correlation in the consumers' minds (the product-brand association). More importantly, there have been several instances of this future-orientation among the Apple brand, as its latest logo was first depicted on the Apple iMac upon its release (Robard, 2009). Tactics like these express the sense of a new age of Apple that is constantly revolutionizing into the future.

Truly, Apple had a strong hold on its identity as an innovator, and its products justified it in "breaking through the blue block letters" (i.e., of the IBM scheme) to create a different, diverse, and creative brand with a sense of humanity (Kahney, 2004). Due to its strong brand recognition and sheer amount of fans and followers who are

loyal to the Apple brand (Olins, 1990), Apple's corporate identity is not only communicated to the viewers; it is also conceived in their minds (as the interpretant) of having encompassed the entire brand identity in alignment with all aspects of the corporation itself.

For future research, it might prove interesting to study the effects of the evolution of logos on viewers. So far, we know a lot about the intentions of corporations such as Apple, Inc. to streamline their logos over the years. Yet, little is known about the actual or measurable impact of logos on consumers. To this effect, scholars could administer surveys and ask people about their perceptions of current corporate logos by comparing them with their older versions. For example, the brand new Apple logo may not engender the intended effect based on the representamen (and the corporation's objectives).

It is the researchers' hope that this analysis has informed readers on the importance of understanding the evolution of a U.S. corporate logo. Many opportunities are waiting for semiotic scholars to improve our understanding of the practical aspects of corporate communication and corporate identity.

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