

VISUAL COMMUNICATIONS

JOURNAL 2003

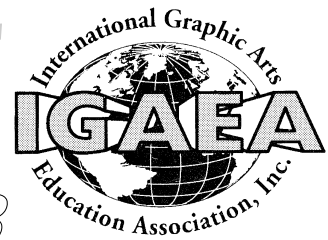


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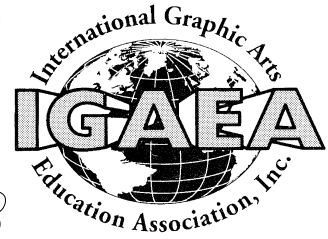
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Printing, Bindery, and Distribution

Gene Van Roy, Janet Oglesby, and
Western Wisconsin Technical College Students

How We Produced the Journal

All articles were submitted electronically in the Microsoft Word format. All photographs were submitted digitally and were edited and converted to grayscale using Adobe Photoshop. Graphs and tables were created from Adobe Illustrator or QuarkXpress. Page design and layout were accomplished using QuarkXpress. The file was converted to a press-optimized PDF which was then e-mailed to Western Wisconsin Technical College for imagesetting, platemaking, printing, and binding.

About the Journal

The Visual Communications Journal serves as the official journal of the International Graphic Arts Education Association, Inc., and provides a professional communicative link for educators and industry personnel associated with design, presentation, management, and reproduction of graphic forms of communication. Manuscripts submitted for publication are subject to peer review by the Association, and the views and opinions expressed herein are those of the authors and do not necessarily reflect the policy or views of the IGAEA.

Article Submission

Please follow the guidelines provided at the back of this Journal.

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EDITOR'S NOTE

Congratulations to all the authors whose articles are being published in the 2003 *Visual Communications Journal*. I believe you will agree that they have done an excellent job of providing useful and timely information to others in the profession. It is especially noteworthy that in keeping with our name, we are truly "international" in this issue, with several articles from Taiwan and one from the United Kingdom. I hope we continue this trend in future issues.

With the exception of student articles, all of the manuscripts are blind reviewed by a jury of graphic communications professors. Based on the jury response, the accepted articles are designated as edited, juried, or refereed. In the case of student articles, the editor makes a decision on acceptance.

THE 2003 ARTICLES

The first article in the 2003 *Visual Communications*

Journal, by Jerry Waite at the University of Houston, provides an overview of research conducted to compare conventional offset-lithography and direct digital printing devices. This is a timely topic for both industry and education as we make decisions about replacing aging equipment. Jerry provides some important information and recommendations in this article.

Thomas Tyberg and Hans Kellogg, both from Ball State University, provide an analysis of interpolation methods found within Photoshop, an important topic since digital images are frequently resized. This research sheds light on an often used but less often understood method used in graphic communications.

Yung-Cheng Hsieh from the National Taiwan University of Arts shares information about the dot reproduction capabilities of CTP plates. Four types of plates are compared in this

study, and I think you will find the results very informative.

Tsung-Yu Hao is from another Taiwan university, Shih-Hsin University. He provides a synopsis of his research on important content for Graphic Communications programs in the United States. This information will be especially valuable for postsecondary faculty and curriculum developers.

LaVerne Abe Harris and Mary Sadowski, both from Arizona State University, have suggestions in their article that can help us all develop more effective graphs. Read it and you will have useful knowledge on "graph etiquette" for your next paper or presentation.

Susan Miller from Purdue University tackles the problem of developing and evaluating a web page for an academic program that will be contemporary in design and provide a

unifying design for all parts of an academic program. The procedure followed and results will be of interest to anyone trying to develop a unique WWW identity for a program.

John Proctor, from Leeds College of Technology in England, discusses an award-winning online print program that was developed in response to identified needs in the printing and packaging industry in the United Kingdom. Those that are contemplating development of e-learning programs will find this article especially useful.

John Leininger from Clemson University introduces the topic of activity based costing and how it can be used for keeping track of all the cost variables associated with printing presses. This is a critical topic for all printers working in today's highly competitive environment, and will help ensure company profitability.

What are the cost differences between traditional and waterless lithography? Devang Mehta, from North Carolina A&T State University, has studied this topic and presents his findings in his article. This is yet another important article to help us make informed decisions when looking at printing methods to use in education or industry.

Several faculty members from Western Wisconsin Technical College, Gene Van Roy, Deb Slaby, and Michael Foster, help us understand barriers to adult learning in their interesting article. The results of their research should provide insights all of us can use to help learners in our classes. By the way, Gene also does the printing for the *Visual Communications Journal*, so congratulations Gene on now being an author in VCJ!

Ben Lee from California State University, provides an overview of an innovative Graphic Communications

Program (2+4+Career) that integrates high school and university graphic communications experiences with careers. This program has proven to be highly motivational for students and is credited with not only keeping students in school but also with providing highly trained employees for the graphic communications industry.

Cynthia Carlton Gillispie-Johnson and Nancy Glenz, faculty members from North Carolina A&T State University, generously share their experiences with developing industry internships in their article. Details are provided for creating a guide which describes the internship program.

There are two student articles in this year's Visual Communications Journal. Li-Yi Ma, a doctoral student in the Department of Industrial Technology at the University of Northern Iowa, provides an overview of halftone reproduction

methods. This is a wonderful overview for students. Mengtsung Tai, another doctoral student in the Department of Industrial Technology at the University of Northern Iowa suggests that PDF can be an effective tool for conducting online surveys. Anyone doing survey research should take a look at this. Thanks to both of these students for submitting their articles for publication.

THE PEOPLE WHO MADE THIS JOURNAL POSSIBLE

This year's jurors are Z. A. Prust, Dan Wilson, and Eric Weisenmiller, well known professors in the graphic communications field. I know that each of these people were actually too busy to assist with the review process, but helped out anyway because of their sense of professionalism. Thanks to each of you for your dedication and hard work.

I also need to thank the design and printing team for this year's journal. The design and layout, with the exception of the cover, was done by University of Northern Iowa students Mengtsung Tai, Li-Yi Ma, Wendy Loeffler, Madonna Thoma, Melanie Weis, and recent graduate, Dacia Halford. I also gave Mengtsung the title of Assistant Editor for the many extra hours he spent on the journal. I simply could not have done this without the invaluable help from the students. I was amazed to watch them work on the design, and pore through each article to assure consistent style.

Gene Van Roy, with the help of his students at Western Wisconsin Technical College, has printed most of the *Visual Communications Journals* since 1991, and has contributed untold hours to the International Graphic Arts Education Association. It becomes a family affair at

crunch time and his wife Kathy and daughter Sarah help with manually collating the journal, as well as preparing the journal for mail out, which is a huge job. We owe each of these individuals a huge debt of gratitude.

Janet Oglesby is an instructor in the Electronic Imaging and Printing Program at Western Wisconsin Technical College and has also put in countless hours on the *Visual Communications Journal*. She is in the prepress area, and assisted this year with film output, as well as final journal assembly and mail out. Thanks for all your hard work Janet.

Speaking of Western Wisconsin Technical College, April Bartelson, a Graphic Design student, is to be congratulated for designing the 2003 *Visual Communications Journal* cover. This is excellent work, and another fine example of the capabilities of our students. Thanks is also

extended to Barb Fisher, the instructor at WWTC who coordinates the cover contest.

As you can see, this journal is certainly a team effort, and I appreciate all that each person accomplished. I am deeply honored to be able to work with such a fine group of professionals. Thanks again for all your effort.

Charles D. Johnson, Editor
2003
Visual Communications Journal

CONVENTIONAL OFFSET LITHOGRAPHY AND DIRECT DIGITAL PRINTING DEVICES: HOW DO THEY COMPETE ON PRINT CHARACTERISTICS?

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INTRODUCTION

During a presentation to the International Graphic Arts Education Association membership in 2000, George Ryan, President of the Graphic Arts Technical Foundation, predicted that digital printing technologies will produce 35% of all printing by 2006 (Ryan, 2000). In his view, the growth of digital printing will come primarily from a reduction in the relative market share of conventional offset lithography. As digital printing's market share continues to increase, it is reasonable to expect that print buyers will require digitally-printed items to be produced at the same quality level—or higher—as compared to conventional offset lithography. Indeed, when speaking of customer expectations for digitally-printed

items, Wolfgang Pfizenmaier, President of Heidelberg Digital LLC, states (Pfizenmaier, 2002):

I believe the range of products and services delivered by suppliers will change. But, customer expectations will remain the same. They will expect and demand:

- Equipment that is based on the reliability and quality standards of the printing industry, not the copier industry;
- Around-the-clock service from the point of sale and beyond...;
- ...The necessary components that complement their equipment smoothly without downtime. I refer here to inks, toners, substrates, and plates;
- ...Expertise to build, support, and maintain print communication networks.

It is clear that as digital printing's market continues to expand, the quality level produced by digital equipment must also increase to meet customer expectations. Those expectations appear to be based on the reliability and quality standards of conventional printing. Therefore, it is prudent to examine the performance by digital printing machines in comparison to attributes commonly measured and controlled in conventional offset lithography.

METHOD

In an effort to ensure that graphic communications students from the University of Houston are exposed to digital printing technologies, Paul Crane, Vice President of Marketing for Océ (an international manufacturer of printers, copiers, and digital presses) agreed in late 2001 to loan an Océ 3165 (or its equivalent) digital press to the University for about one month each semester. Under the terms of the agreement, Océ will deliver and install

the machine, provide training for both the instructor and students, provide service and supplies, and remove the machine at the end of the term.

Océ delivered a machine to the UH graphic communications technology laboratory for the first time in early April, 2002. Once the machine was up and running, Debbie Wilson, Centralized Solutions Specialist, and Roger Olson, Applications Engineer, provided a two-hour overview and demonstration of the 3165 digital press to the ITEC 3352, Press Technology class. Subsequently, each member of the class was able to print on-demand variable-data documents in real time by sending files of various types from their computer workstations. By the time the month was over, the unit had produced over 50,000 impressions and had provided the graphic communications technology students with practical experience with a state-of-the-art digital

press while, at the same time, familiarizing them with digital press workflow concepts.

Once the overview and demonstration were completed, the Press Technology students were asked, "If you were the owner of a printing company, what would you like to know about the Océ 3165?" To demonstrate their attention during previous lectures, they quickly responded, "Its fingerprint." In particular, they wanted to know its dot gain, ink density, ink density variations both within and across printed sheets, and maximum and minimum halftone dot sizes at various line screens. They also wanted to know how those characteristics would vary across substrates, how well the machine would register, and the highest line screen that could be specified before banding occurred. Finally, being well-trained technologists, they wanted to compare the Océ 3165's performance to that of the Xerox Docutech 6180 and to relevant GRACoL standards.

Test targets

To answer the students' questions, five test targets were either created or adapted from existing files. Figure 1 illustrates the conventional offset lithographic black-and-white fingerprinting target first described in Waite (1997). Both the Océ 3165 and the Docutech 6180 are 600 dot-per-inch (dpi) devices. So, the conventional offset lithographic target was modified so that screen rulings, measured in lines per inch (lpi), appropriate to 600 dpi output are included. For example, a 600 dpi device can mathematically produce a 75 lpi screen ruling if 64 shades of gray are desired (600 divided by the square root of 64, or 8, equals 75). Similarly, if 256 shades of gray are desired, a 600 dpi device can produce a 37.5 lpi screen. Therefore, both 75 lpi and 37.5 lpi were included on the modified target. Nearby conventional screen rulings, including 65 and 100, were added for comparison. The

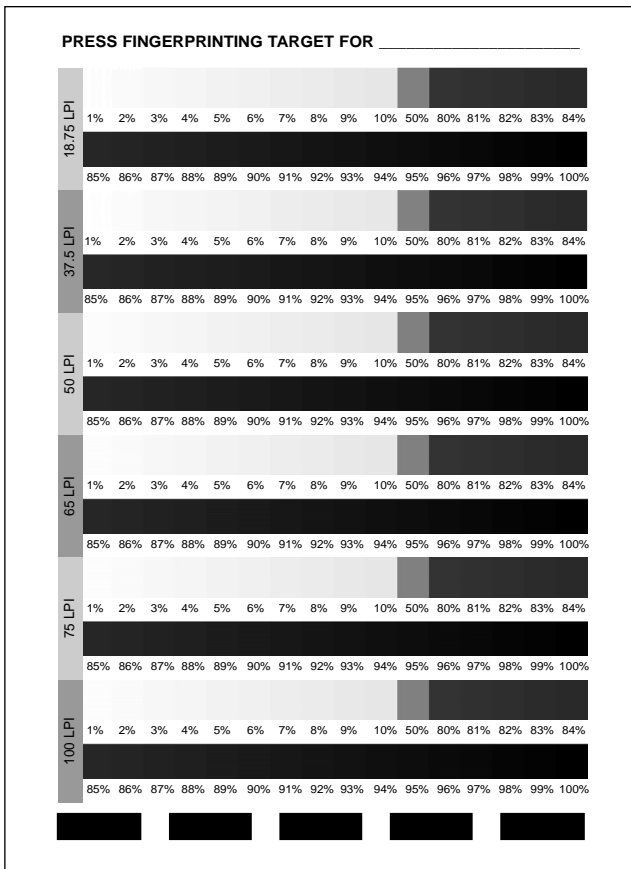


Figure 1. Conventional offset lithographic black-and-white fingerprinting target

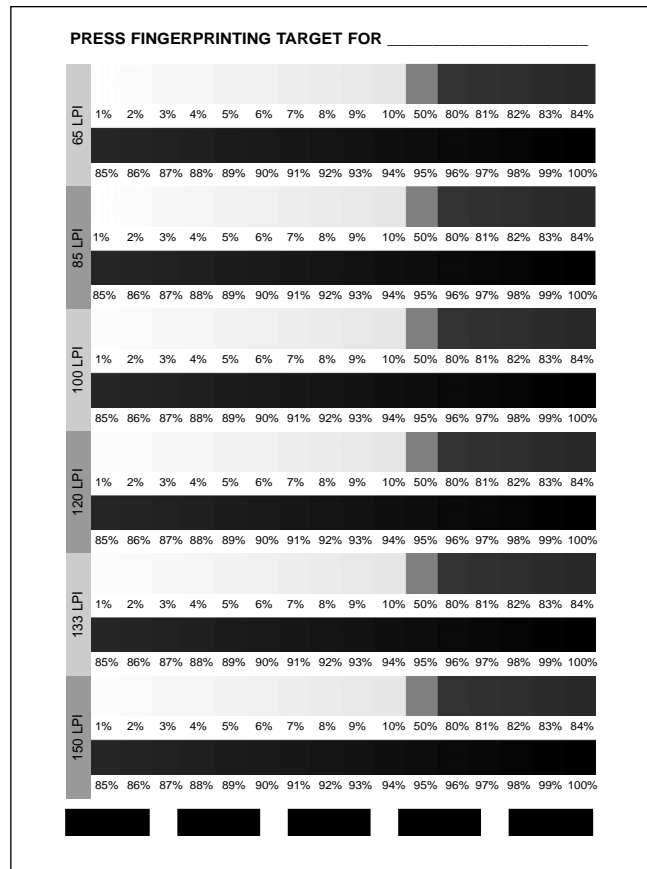


Figure 2. Digital press black-and-white fingerprinting target

modified target is illustrated in Figure 2.

Two new test targets were created for this project. Figure 3 illustrates the banding test target. It was made by first preparing a six-inch wide, 0-100% black-and-white gradient using Photoshop. That image was

then repeatedly inserted onto the test image document page using QuarkXPress. Each image was individually set, using the Picture Halftone Specifications dialog box, to one of the screen rulings used on the fingerprinting targets illustrated in Figures 1 and 2.

The last test form required to test the digital presses was designed to test front-to-back registration. Due to the fact that both tested presses are black-image only devices, no test was devised to check image-to-image registration. However, both machines duplex. So,

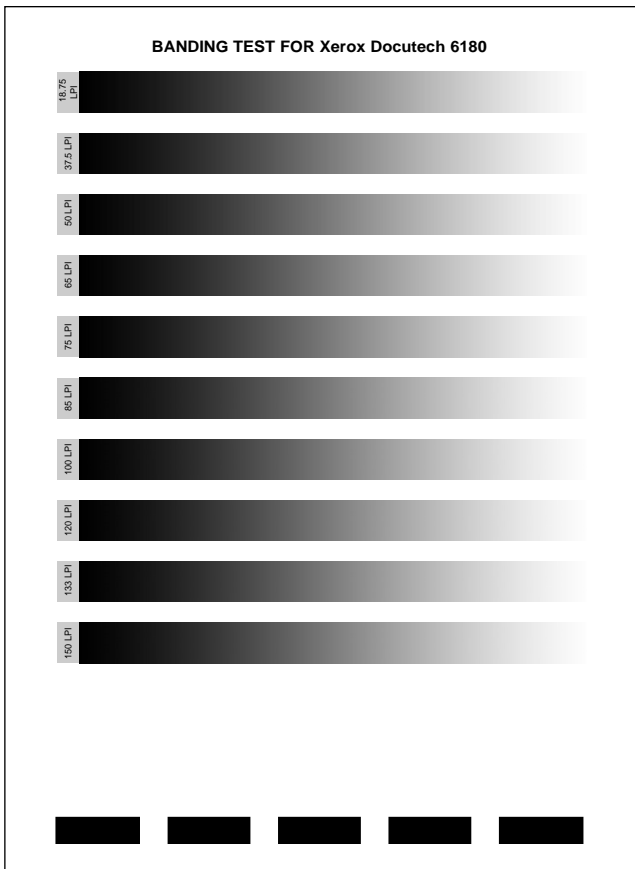


Figure 3. Banding target

front-to-back registration is important and can be tested. A precisely-centered test image, consisting of two solid squares and five register marks, was prepared as a master page in QuarkXPress. The master page was then duplicated to two pages, one for the front and the other for

the back. The only variation in the two images is the heading. The registration target is illustrated in Figures 4 and 5.

Substrates

As the digital press market matures, it is reasonable to expect that customers will

demand a range of paper substrates wider than the uncoated copy paper that has been traditionally employed in copiers. Pfizenmaier (2002) made this point when he emphasized the importance of inks, toners, substrates, and plates that complement digital

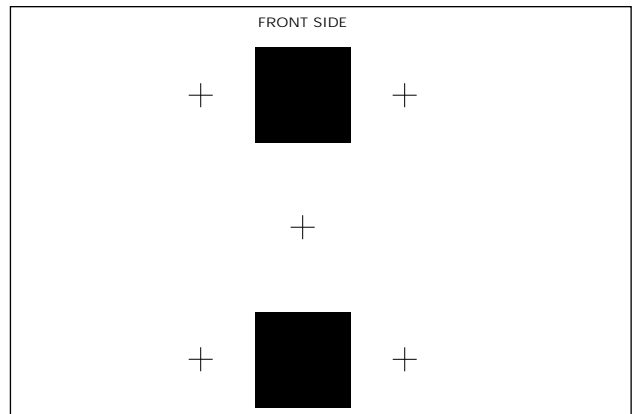


Figure 4. Registration target (front side)

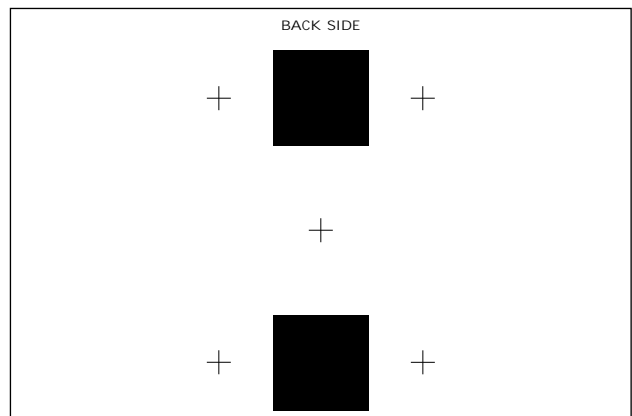


Figure 5. Registration target (back side)

Substrate #	Weight	Grade	Brand Name	Description
1	80#	#2	Corniche	White Gloss Book
2	80#	#2	Corniche	White Gloss Cover
3	32#	#1	Mohawk	White Dull Coated Book
4	80#	#1	Mohawk	White Dull Coated Cover
5	28#	#1	Mohawk Navajo	White Uncoated Book
6	80#	#1	Mohawk Navajo	White Uncoated Cover
7	20#	#5	Econosource	White Bond
8	20#	#5	NCR	CFB White CF Side
9	20#	#5	NCR	CFB White CB Side

Table 1: Substrates used for the study

printing equipment without requiring downtime. Therefore, a range of substrates, consistent with those used in conventional offset lithography, was purchased from Clampitt Paper Company in Houston, Texas. The substrates tested are listed in Table 1.

Printing the targets

Before the targets could be printed, the appropriate print drivers were downloaded from the manufacturer's website and installed on an Apple PowerBook G4 computer. Using the print driver, each machine was set to its highest quality setting. Then, each target was downloaded via ethernet to the digital press' raster image

processor (RIP). Twenty copies of each of the five test targets were produced on each substrate using each of the two machines. The fingerprint and banding tests were each printed single-sided. The front and back registration tests were printed using the machines' duplexing mode. The Océ 3165 tests were completed in the Graphic Communications Technology Image Transfer Lab using the machine lent to the University of Houston by Océ. The Docutech 6180 was tested at Xerox's facility in Houston, Texas. In each case, a service technician was called in if a problem was encountered during the tests. In this way, potential operator errors were eliminated.

Print dialog box user interfaces

The Print dialog boxes for the two machines varied greatly. The Océ 3165 Macintosh driver is quite weak and has controls for only two items: whether or not staples are required and quality level (see Figures 6 and 7). On the other hand, however, the Xerox Docutech 6180 driver is quite robust. The Print Dialog Box (Figure 8) allows the operator to set job parameters (Figure 9), paper stock (Figure 10), covers (Figure 11), and page inserts (Figure 12). The same controls are replicated on the Docutech 6180's machine-mounted user interface.

Evaluating the targets

Each test target was evaluated using instruments and/or by eye. Density and dot gain were tested with a properly calibrated X-Rite 518 spectrodensitometer. Status T density readings were taken and recorded for each of five discrete patches

on one representative test sheet of each paper type (see Figure 2 for the five patches at the bottom of the test target). In addition, the center of the five targets was measured on each of the 20 sheets in the set. In this way, density variations within an individual sheet as well as variation across sheets could be recorded.

Dot gain for each of the screen rulings included on the two fingerprinting targets was measured at 50% on one representative sheet taken from the run of 20 impressions. The X-Rite 518 spectrodensitometer was properly set to the paper's white density as well as the solid black density before measurements were made.

The minimum and maximum consistent halftone dots sizes for each screen ruling on the fingerprint tests were examined visually using a Betamac 20X magnifier. The percent of the smallest consistently printed halftone dot size (i.e. the black dots in the sample were all present and were of reasonably consistent size

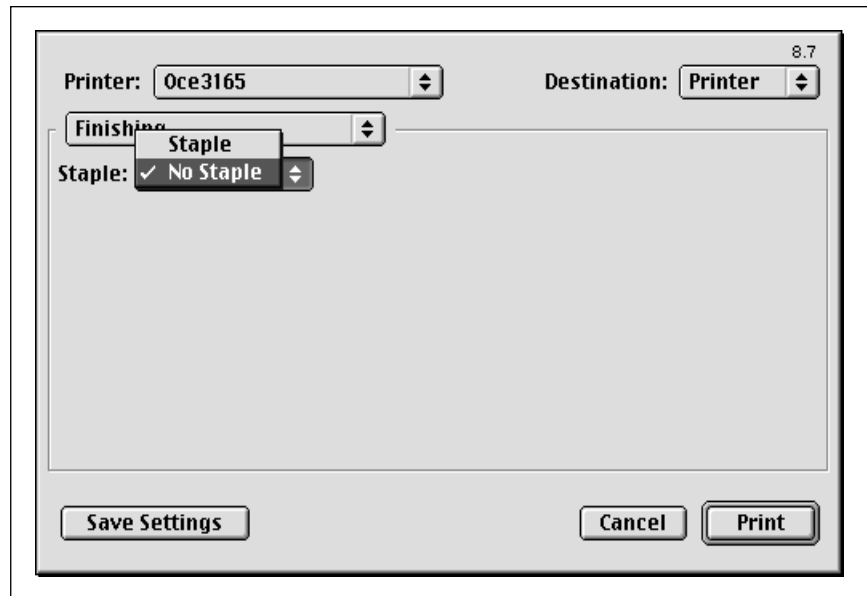


Figure 6. The Océ 3165 Print dialog box Finishing menu

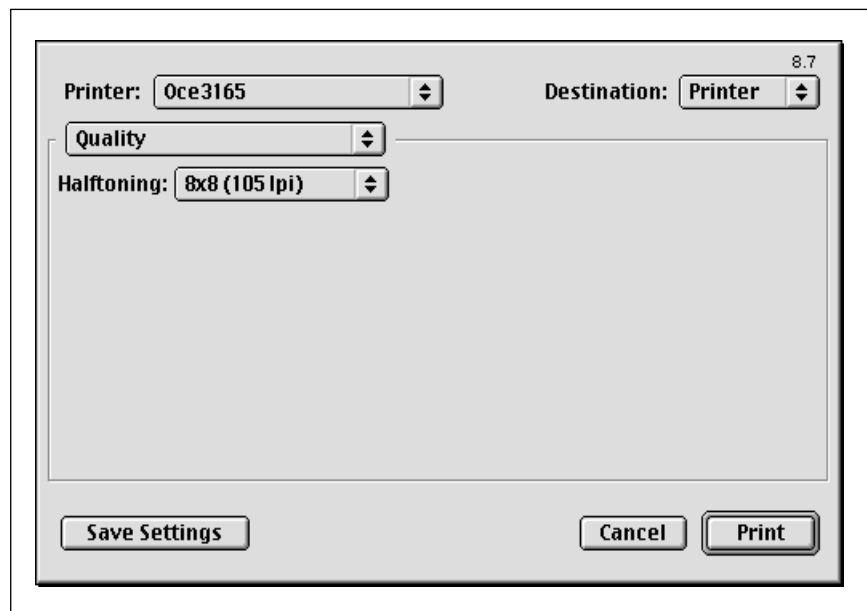


Figure 7. The Océ 3165 Print dialog box Quality menu

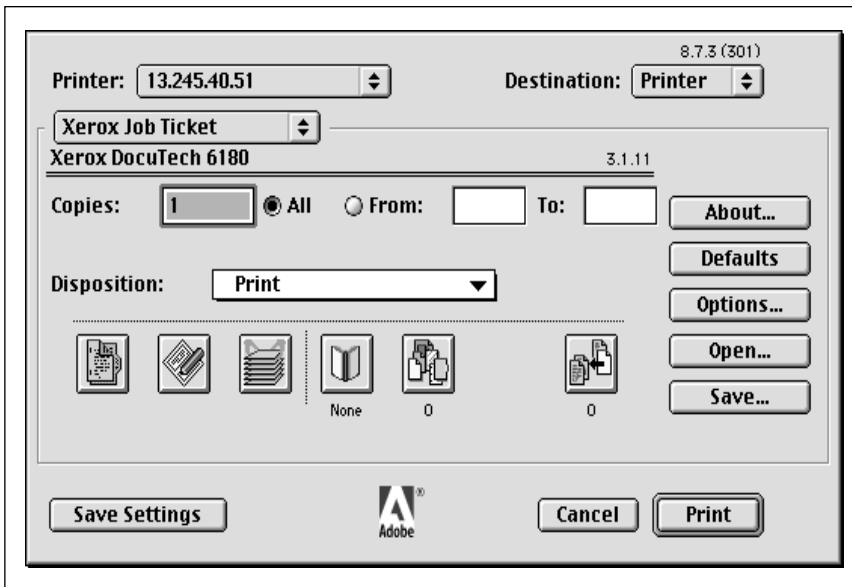


Figure 8. The Xerox 6180 Print dialog box

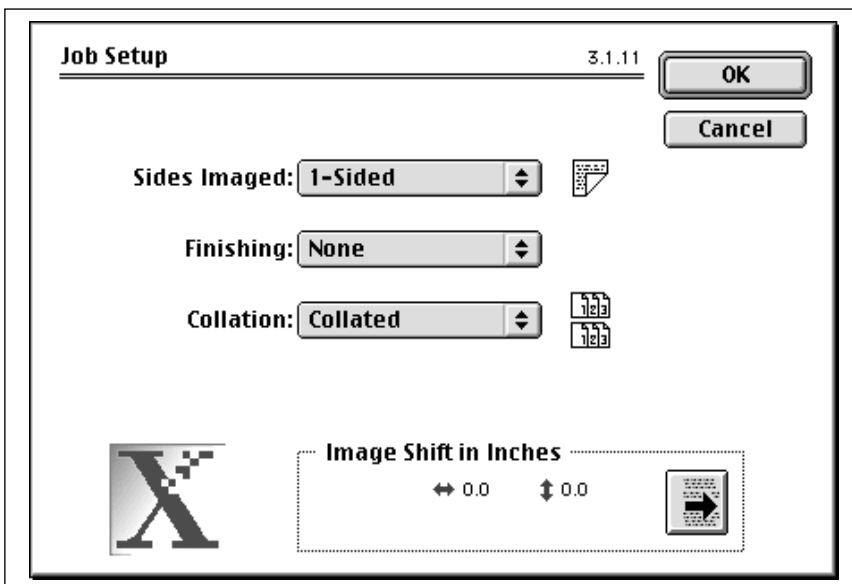


Figure 9. The Xerox 6180 Print dialog box Job Setup menu (note registration adjustment at bottom)

and shape) was recorded for each screen ruling on each substrate. Similarly, the percent of the largest consistent halftone dot (i.e. the white dots in the sample were all present and of consistent size and shape) was recorded for each screen ruling and paper type.

The effect of banding was determined visually. Two screen rulings were noted on one representative printed sheet produced on each substrate: the point where banding first became visible to the trained eye and the point where banding became clearly obtrusive.

Finally, the tenth sheet from the two-sided registration press run on each substrate was examined visually over a light table to determine if the front and back images properly aligned. Variation was measured with a stainless steel ruler. Neither the Océ 3165 print driver nor the machine itself provides the user with a method to change image registration. In fact, registration can only be changed by an Océ technician. The Docutech 6180, however, provides registration adjustments both

on-machine, through the operating interface, and through the use of the print driver loaded on the user's computer (see Figure 9).

RESULTS

The results of the tests are displayed in tabular form in Tables 2 (Xerox Docutech 6180) and 3 (Océ 3165).

Measurements are given in rows while the substrates are displayed in columns. Descriptive statistics, including minimum and maximum values, average value, and standard deviation, are also provided in columns.

Dot gain values are provided in terms of the measured dot value of a nominal 50% dot. Thus, a 55% value indicates 5% dot gain. Values are provided for every measured screen ruling on each tested substrate. The minimum, maximum, and average dot readings, as well as the standard deviation, are provided for each screen ruling across substrates.

The minimum and maximum halftone dot sizes listed are respectively the smallest and largest and smallest

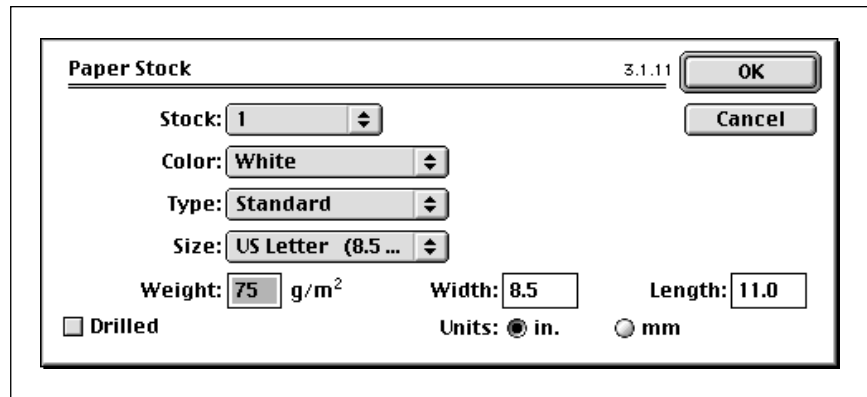


Figure 10. The Xerox 6180 Print dialog box Paper Stock menu

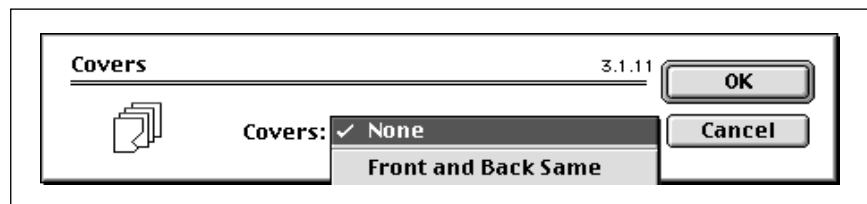


Figure 11. The Xerox 6180 Print dialog box Covers menu

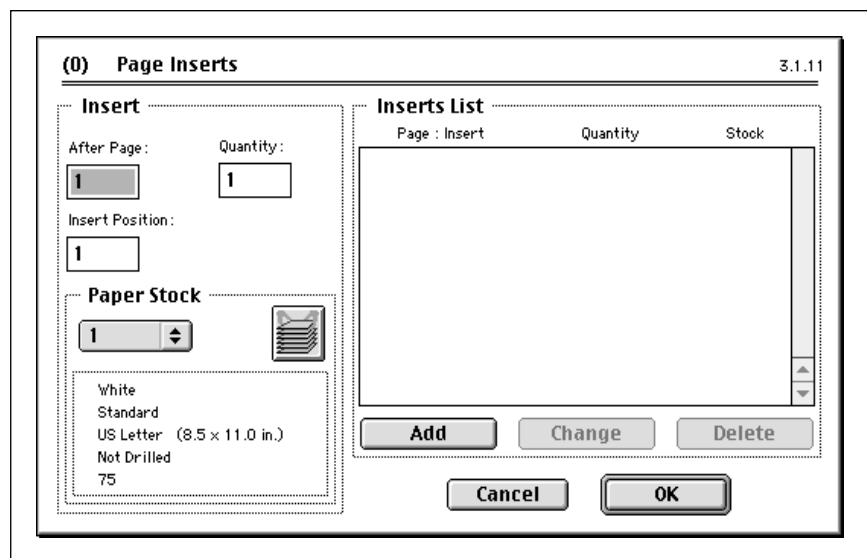


Figure 12. The Xerox 6180 Print dialog box Page Inserts menu

by paper thickness. For example, when comparing the book and cover weights of any tested paper stock, total dot gain on the Docutech 6180 was at most 2% higher for the cover stock as compared to the book weight. Conversely, the Océ 3165 exhibited less dot gain on thick papers. In particular, when comparing the dot gain exhibited on Mohawk white dull coated book with the cover weight, the cover sheet always exhibited at least 2% less dot gain than the matching book sheet.

The implication of these results is important: whenever a black-and-white photograph is prepared for reproduction by a digital press, one must be careful to avoid the use of the 20% dot gain that is applied, by default, to grayscale images in Photoshop 7.0. Instead, a separate profile should be made for each digital printing device. Otherwise, the default dot gain curve applied by default will result in too-light images.

Minimum and maximum consistent halftone dot sizes

Both digital printing devices were able, depending on line screen, to consistently hold both very small and very large halftone dots. Whereas previous tests conducted in the University of Houston image transfer lab repeatedly show offset duplicators capable of holding approximately 5% highlights and 95% shadows, the Docutech 6180 held dots as small as 2% and as large as 99%. Similarly, the Océ 3165 was able to produce as small as 3% dots and as large as 99% dots.

Both the minimum and maximum consistent halftone dot sizes were not appreciably affected by paper stock. In fact, the standard deviation of measurements across the tested papers is, or is close to, zero. However, the halftone dot sizes are substantially affected by line screen. For example, the Océ 3165 could hold a range of 2-99% when using an 18.75 line screen, but could only reliably produce an 8% highlight and a 93%

shadow if a 133 line screen was specified. Similarly, the Docutech held a 2% highlight and a 99% shadow when an 18.75 line screen was used. However, when the screen resolution was increased to 133 line, the range contracted to 10-83%.

It is important to note that the affective range of consistent halftone dots decreases appreciably when the specified line screen exceeds the maximum mathematical resolution of the device. Because both machines are natively 600 dpi machines, each can mathematically produce a reasonable number of tones only if a line screen of 75 or less is specified (see discussion under "Test targets" above). Whenever a line screen above 75 is designated, the machines attempt to create an artificial halftone dot pattern through dithering. The dithering process results in misshapen, overlapped, and inconsistent halftone dots.

Overall, the Océ machine held large and small halftone dots better than the Docutech 6180. In particular, the Docutech

displayed a tendency to fill-in shadow dots. For example, a 100 line screen filled-in at about 89%. As the line screen ruling was increased, the Docutech was not able to produce dots in excess of 82%. In other words, all patches that contained nominal dots of 83% or higher printed solid black. In contrast, the Océ 3165 held 93% dots at 100 line as well as 150 line.

The implications of this test are twofold. First, commanding a digital device to produce resolution higher than its engine can natively provide yields an appreciable decrease in tonal range. Therefore, consideration should be given to the resolution of the output device whenever halftone line screens are specified. Second, to provide the optimum tonal range when reproducing grayscale images, the highlight value should be set no smaller than the smallest dot that the output device can achieve at a given line screen. Similarly, the shadow should be set no higher than a given screen's largest consistently-printable dot.

Density

Both digital machines displayed remarkably consistent solid-ink density readings, within a given sheet, across multiple impressions of the same brand and weight of paper, and across varying types of paper. This contrasts sharply with offset-lithographic specifications (GRACoL, 2002) in which black ink density targets range from 1.05 on newsprint to 1.70 on #1 gloss coated stock. In fact, it would not be at all unreasonable to state that the Océ 3165 produces a density of about 1.05 and that solid blacks printed with the Docutech 6180 will measure 1.40. Tables 1 and 2 do indicate very minor density variations within and across sheets. However, the standard deviations of the readings approach zero.

If one were to compare the solid ink densities of each machine to the conventional offset lithographic black ink densities suggested by GRACoL, a general statement could be made: the Océ 3165 produces images that

are too light while images printed with the Docutech 6180 are too dark. Such a generalization can be made because only GRACoL's newsprint suggested density is as low as that consistently produced by the Océ 3165. Similarly, offset lithographic solid black ink densities only exceed 1.40 if non-porous coated stocks are employed. Therefore, solid black densities appear abnormally dark whenever uncoated paper is printed using the Docutech 6180.

The results of this test imply that documents printed with either of the tested digital printing presses will produce consistent solid ink densities, albeit densities that are too light or too dark in comparison to those produced by conventional offset lithography. This consistency across paper stocks may make images printed by either device seem qualitatively different than those printed by offset lithography. Some customers may not mind this difference; others may find it objectionable.

From a purely visual perspective, the Océ 3165, in particular, will produce

halftones with a shorter tonal range than those printed by offset lithography with higher-density inks. Even though the Océ 3165 can consistently hold extremely small and large halftone dots—which would theoretically increase the tonal range of a given halftone—the too-light density of its solid ink decreases the strength of the halftone’s shadow areas and decreases detail within them.

Banding

Theoretically, both the Docutech 6180 and the Océ 3165 should display visible banding when the available number of gray levels falls below 256. Thus, on these 600 dpi machines, banding should be expected once the line screen exceeds 37.5 lpi. Both machines, however, performed better than expected. Banding became just noticeable on the Océ-printed sheets, no matter what the substrate, at 100 lpi. The banding was objectionable at 133 lpi and higher. The Xerox Docutech 6180 performed slightly worse: banding could be seen at 65

lpi, but was not objectionable until 133 lpi.

Registration

Both the Océ 3165 and the Docutech 6180 are designed to produce single-color black-and-white images. Although it is possible to print pre-printed paper on either machine, the intent of each machine is to print single color images. Thus, image-to-image positioning and alignment is not of interest when examining the registration capabilities of the machines. However, both machines duplex, meaning they can automatically print on both sides of the sheet before it is delivered. Over many years, certain conventions regarding front and back printing have developed. These include: front and back margins should be the same so that columns of text are aligned front to back; folios (page numbers) should align on both sides; and running headers and footers should align on each side. Therefore, any digital printing device that

prints on both sides and is used to compete against offset lithographic presses should be able to hold consistent front-to-back registration.

Neither the Océ 3165 nor the Docutech 6180 can register front-to-back. Even when software-based registration adjustments were applied on the Docutech (no such software adjustment is available using the Océ 3165’s interface), no front image on any sheet printed with either machine aligned with the back image on the same sheet (see Figures 4 and 5). Specifically, neither machine could consistently print an image in the same horizontal or vertical location on every sheet. Thus, what offset press operators refer to as “bounce” was universal. Even worse, the Docutech 6180 routinely produced images that were crooked. It should be noted that a service technician was called in during the test period to fine-tune the registration system of each machine. Neither machine could be made to register.

Conclusions and recommendations

The digital printing presses examined in this article have several characteristics that compare very favorably-and, in many cases, exceed-those of offset lithography. Most of the positive attributes of these presses, such as plateless reproduction, simplicity of operation (from the operator's perspective), minimal or no makeready, ability to produce variable-data output, simplified production workflow, and quick job turnaround time, are given, well known, and were not examined by this study. However, if one is to accept the growing demand for digital printing and Pfizenmaier's prediction that buyers will demand offset-lithographic quality from digital printing devices, one must look beyond the work-saving attributes of digital printing and examine quality from the aesthetic perspective as well.

The traditional technological means of ensuring high aesthetic quality on

press include attention to the halftone dots, solid ink-film density, and registration. The digital presses examined by this study compete very well with offset lithography with regards to halftone dot reproduction-if, of course, one does not specify a line screen that exceeds the mathematical capability of the machine. Dot gain is, indeed, minimal and very consistent. In addition, both presses can easily hold very small and very large dot sizes. Because the halftone reproduction characteristics of these machines vary from those typically experienced when using conventional offset lithography, prepress operators are advised to adjust their tone curves accordingly.

It is suggested that the manufacturers work to increase the dpi resolution of their devices. Doing so would allow the use of finer line screens (higher lpi's) as well as decrease banding. Film imagesetters or platesetters, which are used to pre-

pare plates for offset lithography, are 2,400 or higher dpi devices and can easily produce fine halftones made with screens that meet or exceed 150 lpi. To truly compete with offset lithography in terms of halftone resolution, digital press resolution should be increased.

Unfortunately, both machines fail the density and registration tests. With regards to density, the Xerox Docutech 6180 fares better than the Océ 3165. Even though its average 1.40 density is higher than offset lithography produces on uncoated papers, that density does not substantially vary from GRACoL norms. However, it is strongly recommended that the engineers at Océ improve the solid ink density of their black toners. An average density of 1.05 is too low to produce quality halftones, especially in the shadow areas.

Engineers at both Océ and Xerox should immediately address the extremely

poor registration exhibited by their machines. Inconsistent front-to-back registration seriously limits the quality that the respective machines can produce.

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THE AFFECTS OF INTERPOLATION METHODS ON MINIMAL PIXEL DIGITAL IMAGES WITHIN ADOBE PHOTOSHOP

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INTRODUCTION

Images used in the Graphic Communication industry are manipulated on a daily basis. These manipulations often include changing the size of the image. This resizing can take the form of cropping the image to a smaller size or reducing a larger image to fit a smaller area. Frequently, the request is to enlarge the image, increasing the size of a smaller image to fit a larger space. This can be accomplished by enlarging the image or recreating the image, i.e. rescan or creation of the image. When an enlargement of the image is chosen an interpolation method must be selected. This is where difficulties often arise. How does one maintain the image quality while increasing the size of

the image? This is also a difficult concept for students to understand.

While the act of resampling or resizing of images is typically discouraged, increased use of digital imaging mandates that these interpolation methods be addressed. The creation of an exclusive image for output of each medium, i.e. the Internet, a photography project, a commercial printing job, and, or an image for magazine has become a thing of the past. Current images must be created with repurposing in mind. The original image created for a client must now include the "correct" resolution for use with all mediums. In a technologically savvy environment, these original repurposable images would be created once. The image

would be created so that any change in resolution could be done without loss of quality within the newly converted file.

The scenario mentioned above requires a perfect world. Planning and forethought are paramount with the client coming to the table to help identify the multiple requirements for a particular image. Without this proviso, additional image resizing will needlessly degrade the image. The client is the only one that can truly define the "conditions of use" for a particular image. Without their input a smooth image workflow will not exist.

Deadlines can place a crimp in the imaging scenario requiring images be repurposed beyond their intended resolutions. A realistic assessment of this workflow acknowledges times when a less than perfect image is acceptable. It is important to note that there are several options if a resized sized image is required.

Digital imaging programs like Photoshop, PaintShop Pro, and other raster image programs use a variety of methods to accomplish image resizing, resampling, and interpolation (Bouton, 2000). Third party vendors have also produced software interpolation plugins such as Genuine Fractals Print Pro 2.5, by LizardTech Software, Inc. Interpolation, is defined as “a mathematical procedure which estimates values of a function at positions between listed or given values” (Howe, 2001). It can also be described as estimating “a missing value by taking an average of known values at neighbouring points” (Collins, 2000). Each method uses a mathematical model, an algorithm, “a step-by-step problem-solving procedure” (American Heritage, 2000), to interpolate the image by calculating the missing points, in order to increase the size of an image while trying to maintain the quality.

The intent of this project was to understand the inter-

polation methods available within Adobe Photoshop and evaluate these techniques without the use of intense mathematical equations. The hope is to visually model what actually happens to the pixels within an image as each of the interpolation methods is applied.

To accomplish this, a test target was developed specifically for the evaluation of resampling interpolation methods. The target included a photographic image as well as a linework image. This linework portion of the target was created with single width pixels drawn in horizontal, vertical and diagonal lines. The rationale for the main portion of the target, the single pixel linework, was to provide a visual understanding of the various interpolation methods (see Figure 1). The reduced size of $1/4 \times 3/4$ of an inch was designed to allow the target to accept extreme enlargements as the images were interpolated to the different sizes. The photographic

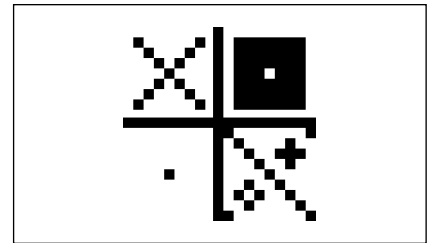


Figure 1. Minimal Pixel Portion of Test Target

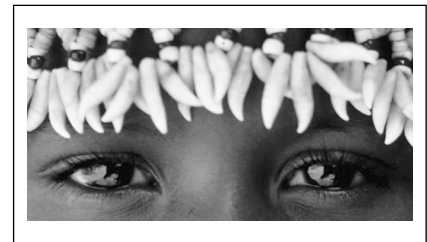


Figure 2. Photographic image of South Sea native girl

image within the target provided a reference to the types of images that typically are used for resizing, require the different interpolation methods (see Figure 2). Chosen for its wide tonal range and extensive detail, the image of the South Pacific native girl yields a strong image to visually evaluate each interpolation method.

Several interpolation resampling methods were applied to this test target. The resampling methods utilized are those present in Adobe Photoshop (versions

5.5, 6 and 7.0), and consisted of the nearest neighbor interpolation, bilinear interpolation, bicubic interpolation. An alternative to the options available with Adobe Photoshop, the plug-in Genuine Fractals Print Pro 2.5 was also used. The resulting images were evaluated to determine what changes actually occurred to the pixels within each of the images. This information was then compared and analyzed to determine the results.

BACKGROUND

A brief clarification is in order to help define sampling theory and the interpolation methods used in this project. This will aid the process of understanding of how each interpolation process works. Also, the term anti-aliasing must be defined as this function is the basis for all interpolation methods.

When one enlarges an image using an interpolation method, pixels are added between known points of the image. This is to say that the

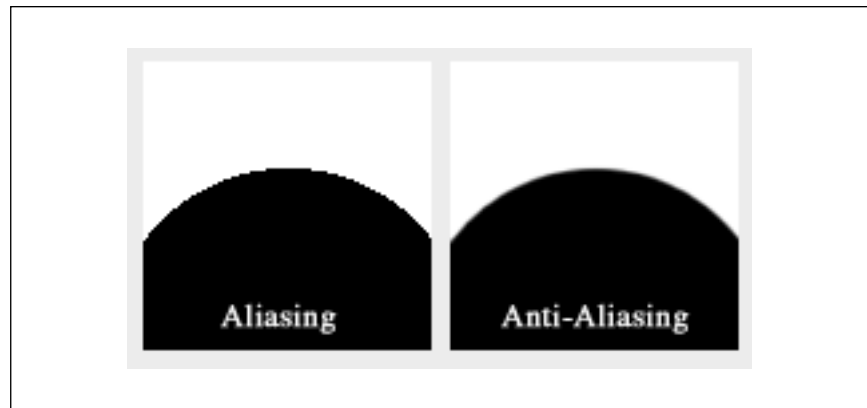


Figure 3. Example of aliasing and anti-aliasing of images

software being used for the resampling has to interpolate how each of the new pixels will be defined. Each of the different methods will allow for an image that is larger than the original but to eliminate the jagged affects of increased image size a process call anti-aliasing is employed. This method of smoothing is the core of the interpolation process and understanding this point is critical for the comprehension of the different interpolation methods.

Anti-aliasing

In theory, anti-aliasing is a method smoothing the jagged pixel edge of an

image by producing a new edge that is slightly out of focus (see Figure 3). In reality what happens is that the additional pixels are colored with tones of decreasing values to smooth out the jagged edges of the image. These additional toned pixels are used to fill in between the jagged edges of the image and the decrease tonal values provide a softer, blurred edge to the image. This blurred smoothing affect is what defines the term anti-aliasing. It produces an optical illusion of a smoother edge. How the additional toned pixels are achieved defines the method of interpolation used.

Sampling theory

According to George Wolberg (1992), resampling suffers from two problems. The first problem, are there enough samples in the input signal, image pixels, to sufficiently describe the image and if so, can the signal be reconstructed from this original. Signal reconstruction is the term used to define these two problems. The answer to these problems resides in the frequency of the original image, its resolution, and the method of analysis used to examine or resample the data, image pixels.

Image resampling

“Image resampling is the process of transforming a sampled image from one coordinate system to another” (Wolberg, 1992). The original image has a coordinate system, or frequency or tone range or color range that defines it. The resampled image has a separate coordinate system that needs to be mapped to the first. These two coordinate

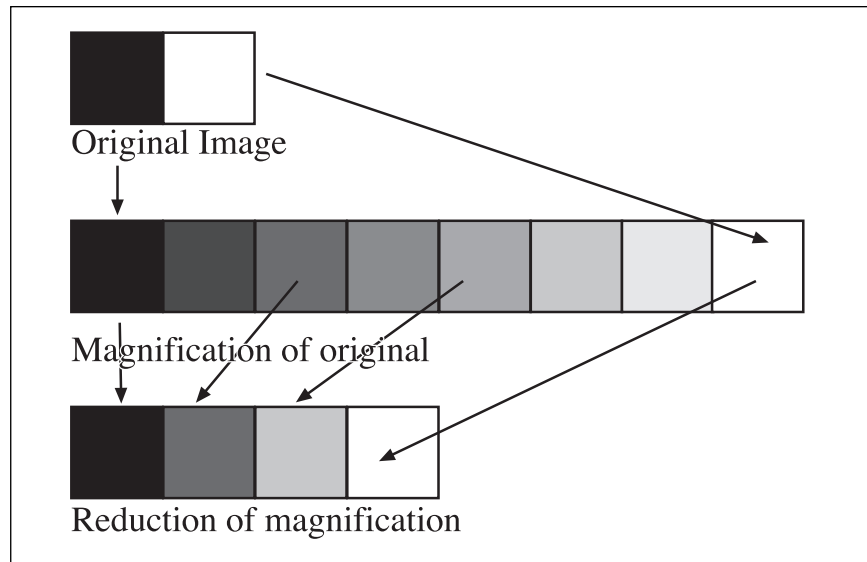


Figure 4. Example of interpolation grids not matching

systems are mapped to each other allowing for a straightforward resampling procedure to occur. This process has one problem, the two grids that result, one from each coordinate system often do not match point for point.

The most frequent type of resampling in the graphic arts is that of resizing, magnifying or reducing an image. An example of the grid systems not matching is shown in Figure 4.

The top portion of Figure 4 demonstrates the

interpolation required to resize the image through magnification. The steps between the black and white tones must be calculated and interpolated. The bottom portion of the image indicates what needs to be done to reduce the image through interpolation. To compress the pixels within the reduced image tones must be discarded.

Nearest neighbor interpolation

Nearest Neighbor is the simplest form of resampling. “Each interpolated output

pixel is assigned a value of the nearest sample point in the input image" (Wolberg, 1992). The pixels are replicated to magnify the image. With large magnifications, blocky images may occur and the shift error of up to one-half pixel may occur. These images are exact replicas of the original data as if the initial pixel spacing was the size of the output. No new pixel colors or tone values are generated in this method of interpolation. A one pixel image of 100% gray yields a four pixel, 100% gray square image when enlarged by 200%. The image produced is what can be generally defined as a pixelated image (see Figure 5).

Bilinear interpolation

Using the same single pixel element and enlarging the image by 200% yields a different result with the bilinear method of interpolation. Using an x and y axis, the bilinear interpolated method averages the tones that are directly adjacent in a vertical

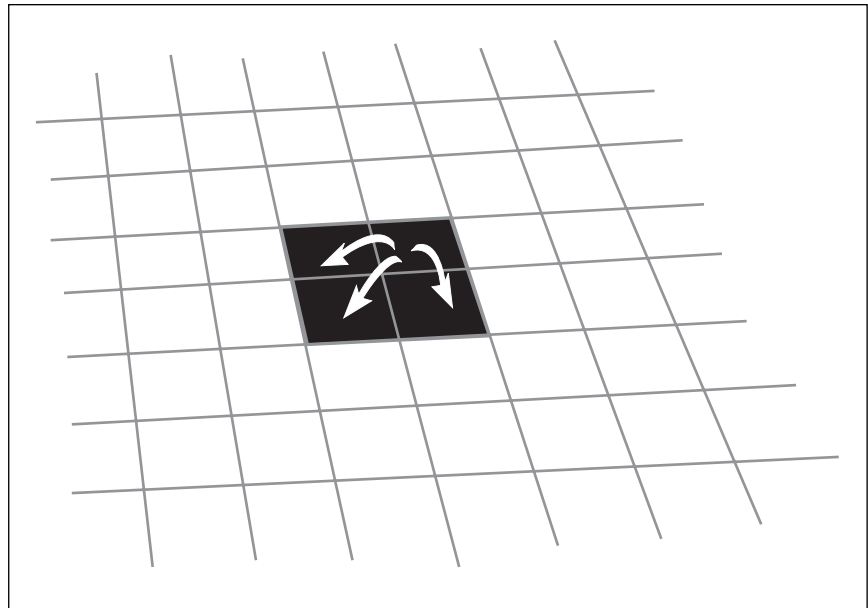


Figure 5. Nearest neighbor interpolation

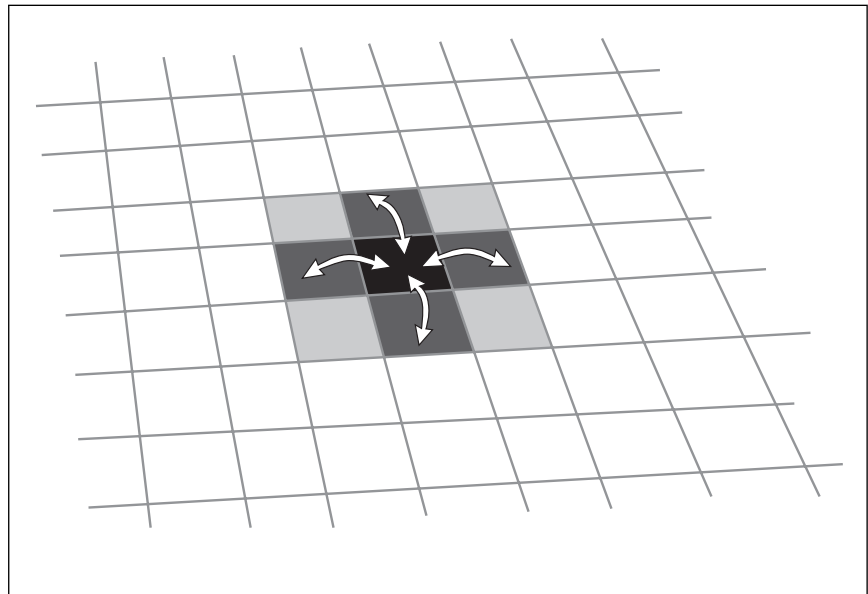


Figure 6. Bilinear interpolation

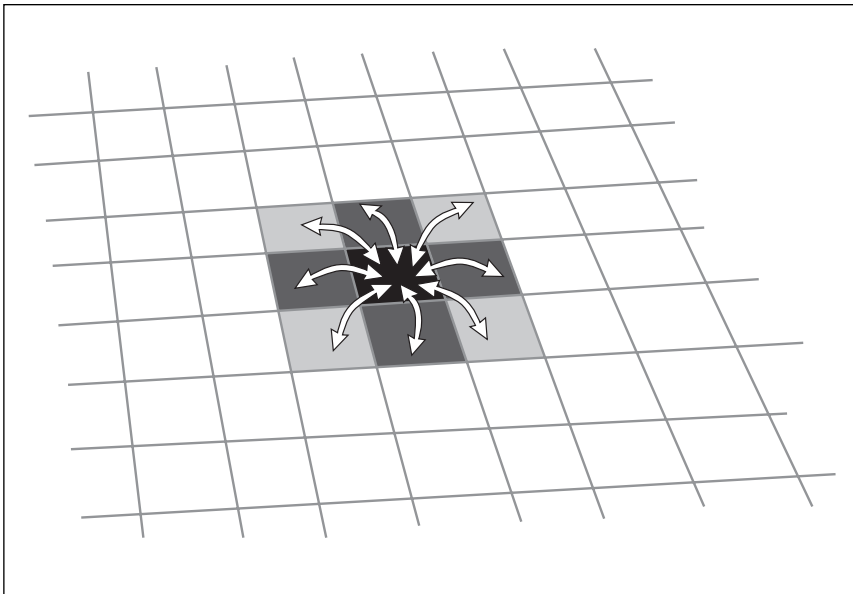


Figure 7. Bicubic interpolation

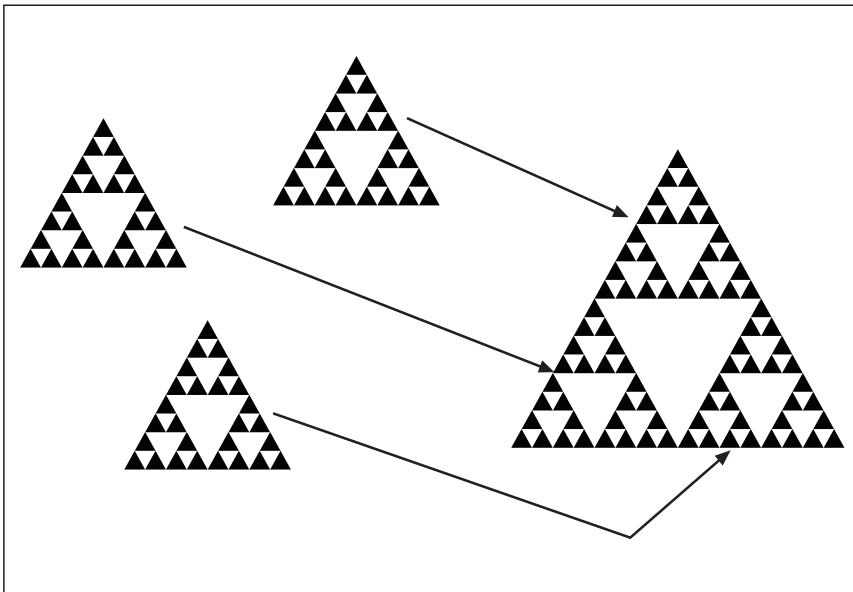


Figure 8. Sierpinski's triangle

and horizontal path. Because the method produces an average of adjacent pixels, the additionally toned pixels will decrease in value. These newly toned pixels then are averaged to the other adjacent pixels and a smoothing affect is produced. With excessive enlargements a blurring of the image can occur (Bouton, 2000) (see Figure 6).

Bicubicinterpolation

Bicubic is the most intensive interpolation currently available within Adobe Photoshop and one that is typically recommended. This method samples and averages adjacent pixels similar to bilinear but includes pixels that are also adjacent on the diagonal (see Figure 7). This method will also create a blurred effect to the image if the enlargement extends outside of the acceptable range of interpolation (see figure 8).

Fractal interpolation

Fractals are geometric objects that are composed of

smaller versions of the same object making similar forms and patterns in different sizes. "Fractals are self-similar geometrical objects, or what often is heard: several parts of a fractal look similar as the entire image" (Schouten, n.d.). Large fractal images are made up of smaller parts identical or almost identical to the larger object.

There are two important properties to the process of replicating these fractal images. As the process of replication of smaller images occurs, more detail results. The second property of these fractals is that the original image is unimportant; the process of replication in the pattern is (Schouten, n.d.).

An example that is often used to demonstrate these principles is Sierpinski's Triangle. The triangle can be copied three times upon itself and it still looks like itself (see Figure 8).

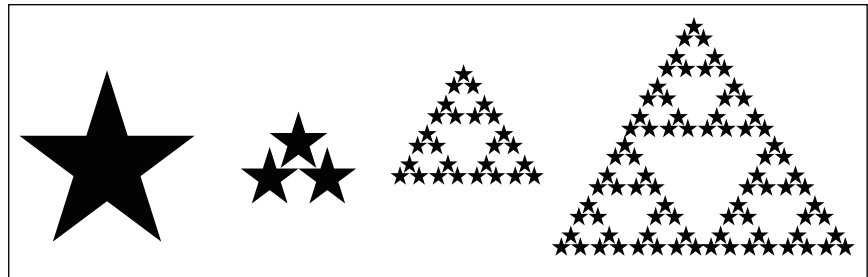


Figure 9. Sierpinski's triangle with an alternative initial image

This iterative process, with a different image, is shown here in Figure 9. A different initial image following the Sierpinski Triangle process results in a similar triangle.

What makes this process strong for image resizing and interpolation is that the image can be deconstructed into fractals and modified with fractals representing the image. Only a single copy of the fractal and any information about its position and modifications needs to be saved in a smaller file. This deconstructed image can then be reconstructed using the same parts in larger replicated patterns without a significant loss of detail.

To give an example, if there are several areas of an image that contain similar shape of different sizes, say and ear lobe and a chin and a cup handle, the same fractal shape is saved once and only size, location and color modification information needs to be saved. Fractals usually work best on images that have naturally occurring subject matter in order to have the patterns.

PROCEDURE

This project was designed to gather information about the effect of several different interpolation algorithms on a simple target image. It required design of a target, application of various interpolation methods to the target and comparing the results of each method.



Figure 10. Minimal pixel test target

Characterizations of the resultant images were also made.

Several basic assumptions were made. Initial images were a single or minimal pixel and the evaluation of the "sample square." This is to say that any measurements or determinations of shape would be square with a best fit for density present in the new resized image. A Macintosh computer running System 9.2.2 was used to generate the target image and the target was stored as a Tagged Image File Format (TIFF) file. A Windows XP computer running Adobe Photoshop v6 was used to generate the interpolated files. Default settings were used on each computer for the software programs. The same original file was used

for each interpolation of the image. No concern was given for file size of the resulting images. Concern, however, was given to the appearance of the images. Images were viewed on several monitors, but only one 21" Diamondtron monitor was used to determine the screen percentages of each image and Photoshop 6 software was used for the evaluation.

Target development

The first step in the research was to develop a test target that would provide a visual image as well as a simple pixel level target which to evaluate (see Figure 10).

The selected target provides several basic image types, a single positive pixel, a horizontal line one pixel thick, a vertical line one pixel wide, a reversed single pixel

in a black background, a diagonal line of one pixel width and several multi-pixel images graphic images.

Image interpolation

After establishing the test target, it was saved as an original file. Then the file was reopened and each interpolation method within Photoshop, Nearest Neighbor, Bilinear, and Bicubic was applied with the resulting files saved as TIFF. The Genuine Fractals images require the image to be saved as a STiNg where the desired file can be saved as a lossless or virtually lossless format. Lossless is an encoding that produces a digitally exact reproduction of the original, if decoded to the same size as the original, and Visually Lossless encoding produces a smaller file size and a visually indistinguishable reproduction of the original when decoded. (Genuine fractals, 2000). Both were used to determine if a difference could be noticed between the two encoding methods. Once

the file was reopened the enlargement size was selected and the files were saved as TIFF files.

Each interpolation method was used to generate two images, one at 250% of original size and a second at 500% of original size. The resulting files were all stored as TIFF files, including the processed Genuine Fractal files. Each of these files was then evaluated for changes in the number of pixels, image density (gray percentage), and shape of the resulting image. Comparisons were made for the size of the single positive pixel, the single negative pixel, the horizontal line width, the vertical line width, and square area over the center of the diagonal line. Table 1 lists the image sizes for the single positive pixel and diagonal line while Table 2 lists the square characterizations for the three shapes.

RESULTS

Each of the interpolated images gained image size

Interpolation	Image portion	250X pixels	250X Pixel square	500X pixels	500X Pixel square
Nearest Neighbor	Positive single	9	3x3	25	5x5
	Diagonal, square	9	3x3	25	5x5
Bilinear	Positive single	25	5x5	81	9x9
	Diagonal, square	25	5x5	81	9x9
Bicubic	Positive single	25	5x5	81	9x9
	Diagonal, square	25	5x5	81	9x9
Genuine Fractals VL	Positive single	36	6x6	144	12x12
	Diagonal, square	36	6x6	144	12x12
Genuine Fractals LL	Positive single	36	6x6	144	12x12
	Diagonal, square	36	6x6	144	12x12

Table 1. the image sizes for the single positive pixel and diagonal line

Interpolation	Image portion	Image Shape
Nearest Neighbor	Positive pixel	square
	Negative pixel	square
	Diagonal	normal diagonal
Bilinear	Positive pixel	square
	Negative pixel	square
	Diagonal	normal diagonal
Bicubic	Positive pixel	square
	Negative pixel	square
	Diagonal	normal diagonal
Genuine Fractals VL	Positive pixel	skewed square
	Negative pixel	skewed square
	Diagonal	normal diagonal
Genuine Fractals LL	Positive pixel	skewed square
	Negative pixel	skewed square
	Diagonal	normal diagonal

Table 2. the square characterizations for the three shapes

when resizing. Nearest neighbor did the next best thing to 2.5 times larger by going to 3 times larger and 5 times the size for 5 times the resizing. The Bilinear and Bicubic both increased by as much as twice the ini-

tial image resizing with 5 times and 9 times the number of pixels. The Genuine Fractals interpolations greatly increased the number of pixels and size of the image square used to represent the resized image. The

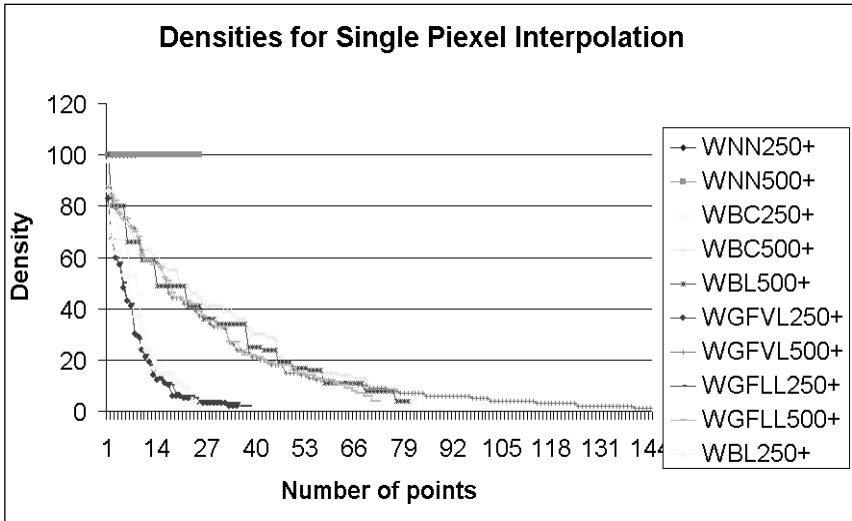


Figure 11. Densities for single pixel interpolation

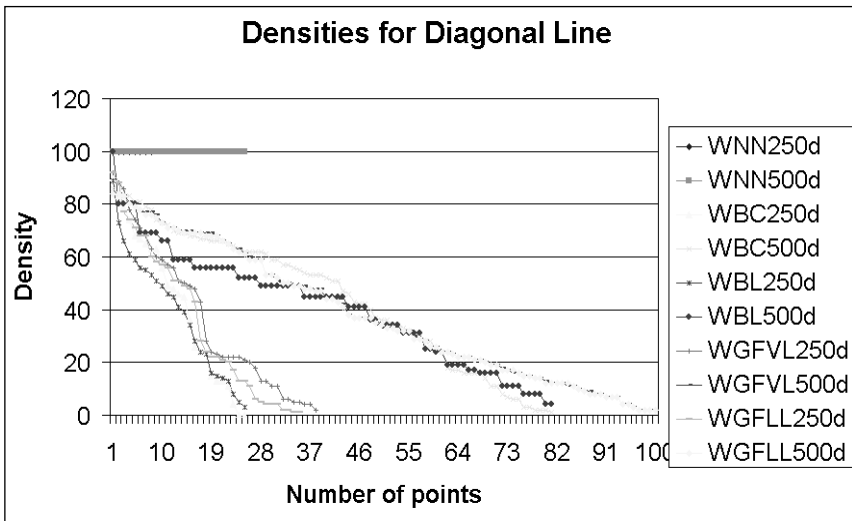


Figure 12. Densities for diagonal line

Genuine Fractal images were twice the size of the Nearest Neighbor interpolation at the 250 percent increase in size.

The characterization of images shapes indicates that Nearest Neighbor for minimal pixel images are almost duplicates in proportion and

tone value. They stay at the 100% density level. Each of the other methods, especially the Genuine Fractal images begin to distend and grow more in a somewhat lower right-hand direction when viewed.

The density curves provide some interesting information. Figure 11 indicates that each of the 250% image resizing provides a similar increase in the number of different densities as does the 500% image resizing group (see Figure 12).

CONCLUSIONS

Each of the interpolation methods except Nearest Neighbor increases the number of densities associated with a single density original image. Nearest Neighbor interpolation does not provide any anti-aliasing for the image therefore did nothing to feather the edges of the lines on the target.

The 250% and 500% versions of each of the interpolations provide very similar density curves at each level

of resizing. Based upon this information, the interpolation method does not make much difference for the single pixel images provided.

Additional research

Additional research questions are listed below.

Is there a statistical visual difference between the interpolated images with regards to the photographic image? Would an image that included more pixel area provide a difference in the data? Does the hardware platform play a role in the evaluation of the interpolated images? How does the image content (natural or man-made) play into the role of interpolation? Would larger images retain the shapes that were in the original images or are they modified by the interpolation method?

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A CAPABILITY STUDY OF DOT REPRODUCTION FOR CTP PLATES

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INTRODUCTION

In lithographic printing systems, computer-to-plate (CTP) is generally defined as exposing an offset printing plate directly from an electronic master. Indeed, a complete CTP system would include the following digital procedures: 1) using a software application to compose several single-page layouts, 2) utilizing an imposition software to accomplish the overall job layout based on the desired finish size and binding requirements, and 3) employing a platesetter to output the plates by exposing dots directly onto the plates using a laser light source, and the plates are developed and ready for printing.

The trend in the printing industry is toward shorter run lengths, which means

changing plates more often. CTP technology seems to be the primary method for conventional lithography to cope with the continuously growing demand for short-run printing and increased productivity (Adams II & Romano, 1999). One of the major advantages of using CTP is that it eliminates the prepress steps of exposing and developing films, stripping films and platemaking; most are manual tasks. Going filmless eliminates the need to dispose of used photographic chemicals and silver-based films, as well as the cost of new supplies, the equipment and maintenance of that equipment (GCA Technical Committee Meeting Summary, 1998). Figure 1 compares the CTP process with the traditional platemaking process.

NEED FOR THE STUDY

Southworth (1996, February) stated that when choosing a CTP unit, three things to consider are dot size variation, resolution, and image line width. Among them, dot size variation is the most critical factor affecting color balance, gray balance, and clean color. In addition, many authors agree that one of the most important factors of choosing a CTP unit is its process consistency, and dot size variation is the key to the process consistency. According to GRACoL 4.0 (General Requirements for Applications in Commercial Offset Lithography version 4.0) published by GCA in 2000, there are three crucial input variables for the offset printers to achieve optimum output print characteristics: solid ink density, print contrast, and total dot gain. These three characteristics are the most commonly measured values associated with dot size variation for lithographic printers. Therefore there is a great

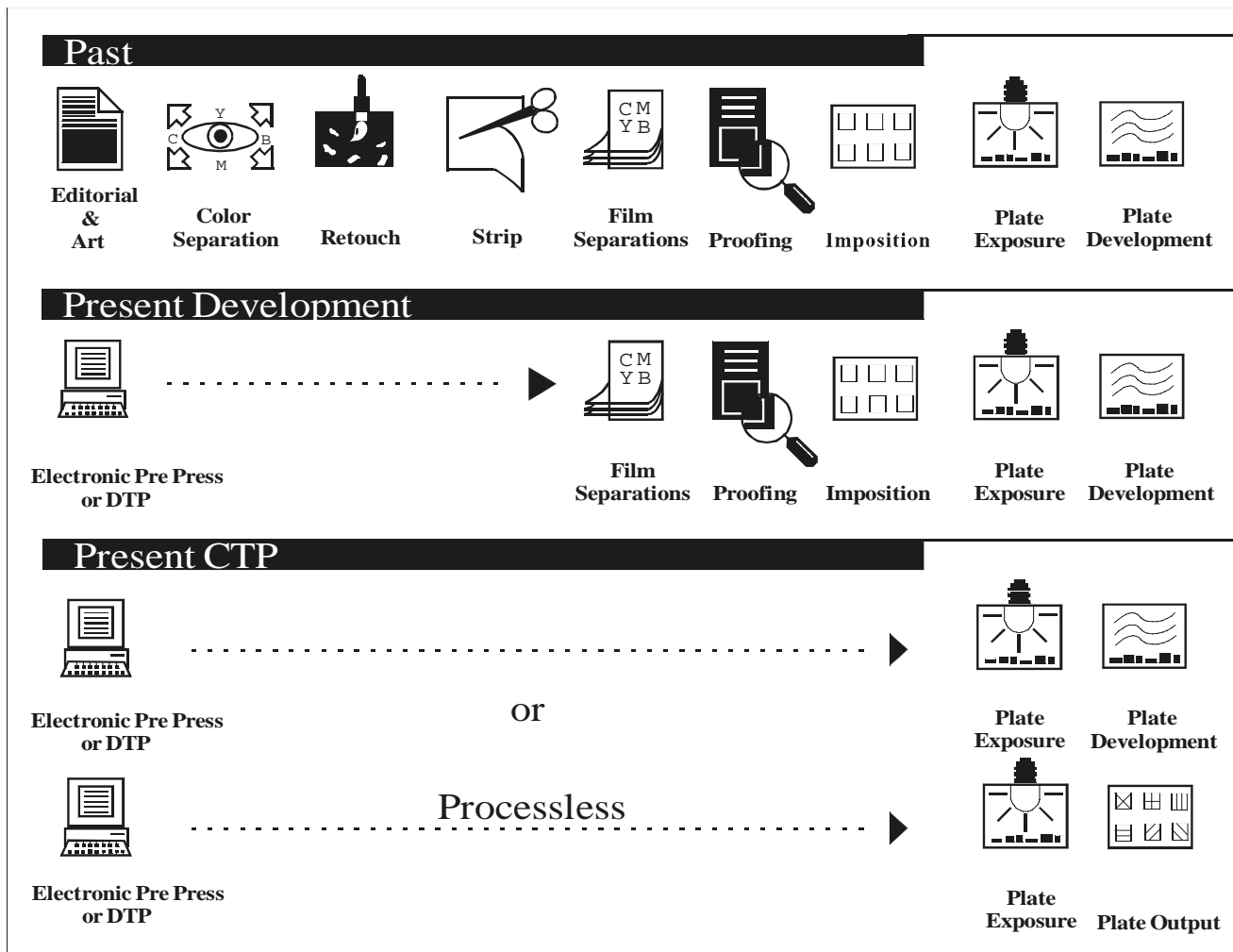


Figure 1. The comparison between the conventional and CTP platemaking process

need to investigate the process capability of commonly used CTP plates in terms of their solid ink density (SID), print contrast (PC), and total dot gain (DG).

PURPOSES OF THE STUDY

The main purposes of this study were: 1) explore the differences in dot reproduction quality for the widely used CTP and conventional

PS (Pre-sensitized) plates in Taiwan, 2) investigate the process capability for the commonly used CTP plates, and 3) compare the process capability of CTP plates with that of conventional PS

plates, in terms of solid ink density, print contrast, and total dot gain. The CTP plates used in this experiment were silver-halide, photopolymer, and thermal aluminum-based plates. One widely used pre-sensitized plate was also studied for the purpose of comparing its performance with that of the CTP plates.

ASSUMPTIONS AND LIMITATIONS OF THE STUDY

Two assumptions were made in the study: 1) There were no operator effects on dot-reproduction quality although each of the four systems was operated by only one well-trained operator and 2) The plates used in the study were all stored and shipped under the standard conditions by the manufacturers before they were used for the experiment. In addition, the following limitations are important to interpret the conclusions and recommendations of this study: 1) All dot area

values on the plates were measured by the Murray-Davies equation and the measuring procedures were determined based on the recommendations of the densitometer manufacturer and 2) The material, production, and labor costs for the plates were not studied. The main interest of the study was on the dot-reproduction capability for the plates.

METHODOLOGY

This experimental research investigated the differences in process capability among three major CTP plates and one conventional PS plate. A digital test form and control bar was designed for the three CTP plates, and a film generalized from the digital test form was prepared for exposing the PS plates. In addition, the imagesetter to output the film for making the PS plates was linearized and not applied any compensation curves to the test form. The correct amount of time to expose the PS plates

was determined by an UGRA Plate Control Wedge.

Forty plates for each of the four plates were made. After collecting all 160 (4*40) plates, an X-Rite 528 spectrodensitometer was applied to measure the solid ink density (SID), dot gain (DG) on the 25%, 50%, and 75% tints, and print contrast (PC). Each specific patch on the plates was measured five times for the purpose of reducing measuring error. Thus, the analyses were made based on the average of five readings for each observed attribute. The Cp indexes based on SID, DG, and PC were determined statistically. It should be noted that other non-relevant variables, such as room temperature, relative humidity, operator, were held constant for each process during the experiment to reduce the experimental biases. Table 1 exhibits the plate output conditions and equipment for this experiment.

Plate Type	Environmental Condition	Output Devices
Conventional PS	Room temperature, Relative Humidity: 45%~55% Room light	PS-32HBB-2 plate explorer, Fuji PS800ES platesetter, Fuji DU800 drier, Exposure time: 30 seconds, Developing time: 40 seconds Drying time: 40 seconds at 85°C
Silver halide (AgX) CTP	Temperature: 25°C, Relative Humidity: 40%~50% Dark room (red safelight)	Agfa Galileo / Platemanager CTP platesetter, Developing temperature: 22°C
Photopolymer CTP	Temperature: 25°C, Relative Humidity: 40%~50% Dark room (red safelight)	Cymbolic Sciences PlateJet8 Platesetter, Fuji LP-850P developer, Developing temperature: 30°C
Thermal CTP	Temperature: 25°C, Relative Humidity: 45%~55% Room (yellow) light	Creo/Trandsetter 3244 CTP Platesetter, Kodak Quartz CTP Developer Pre-heat: 140°C, Developing temperature: 25°C

Table 1. The plate output conditions and equipment of the experiment

RESULTS AND FINDINGS

Table 2 shows the descriptive statistics for all the dependent variables. It indicates that mean solid ink density of the PS and photopolymer plates are very close (.915, .914), followed by the thermal (.8958) and silver halide plate (0.718).

Generally speaking, a small percentage of dot gain is desirable for printers. For the mean dot gain percent-

age at 75% tint, as shown in Table 2, the thermal plate has the least amount of dot gain (.77%), followed by the silver halide (4.94%) and PS (6.46%). The photopolymer plates yielded the greatest amount of dot gain (11.66%). For the mean dot gain percentage at 50% tint, the thermal plate has the least amount of dot gain (.61%), followed by the silver halide (4.40%) and PS (8.87%). Again, the photopolymer

plates yielded the greatest amount of dot gain (13.34%). For the mean dot gain percentage at 25% tint, the thermal plate has the least amount of dot gain (.46%), followed by the silver halide (2.53%) and PS plate (3.92%). The photopolymer plates delivered the greatest amount of dot gain (7.27%).

Print contrast is an increasingly popular process control parameter because it is a value that printers wish

	Plate Type	n	Min.	Max.	Mean	Std. Dev.
Solid Ink Density	PS	40	.895	.980	.9150	.0124
	Sliver Halide	40	.610	.750	.7178	.0231
	Photopolymer	40	.898	.940	.9145	.0100
	Thermal	40	.860	.910	.8958	.0108
75% Dot Gain	PS	40	5.740	7.120	6.4610	.3397
	Sliver Halide	40	1.000	10.800	4.9400	3.0450
	Photopolymer	40	7.860	12.480	11.6605	.8931
	Thermal	40	.100	2.300	.7700	.4542
50% Dot Gain	PS	40	7.100	9.840	8.8705	.5472
	Sliver Halide	40	.800	9.600	4.4025	2.4363
	Photopolymer	40	10.640	14.120	13.3370	.6170
	Thermal	40	.000	2.000	.6050	.3803
25% Dot Gain	PS	40	2.580	5.720	3.9150	.6706
	Sliver Halide	40	.600	4.400	2.5255	1.1411
	Photopolymer	40	5.320	8.020	7.2695	.5430
	Thermal	40	.100	1.900	.4550	.4188
Print Contrast %	PS	40	30.220	31.440	30.8255	.2963
	Sliver Halide	40	23.800	31.200	27.5350	1.4318
	Photopolymer	40	19.280	21.420	20.4750	.4455
	Thermal	40	25.600	28.000	27.0350	.5582

Table 2. Descriptive statistics

to maximize (Stanton & Hutton, 1999). Indeed, it represents the tonal range of shadows. It is computed as shown below:

$[(DSID - D75) / DSID] \times 100\%$; where, DSID is the density of solid, and D75 is the density of the 75% tint

According to Table 2, the conventional PS plate has the greatest amount of print contrast (30.83%), followed by the silver halide (27.54%) and thermal plate (27.04%). The photopolymer plates produced the least amount of print contrast (20.48%).

PROCESS CAPABILITY ANALYSES

This section provides an analysis of the process consistency and capability of the observed attributes for the four types of plates. The tools used to analyze the consistency for each variable are Individual Control Chart (I Chart), Moving Range

Charts (MR Chart), and Capability Analysis. Process capability ratio (PCR or Cp index) is a measure of how capable a process is for meeting specifications. A Cp index of 1 means that a process is exactly capable of meeting specifications, while less than 1 means that it is outside specification limits. Ideally, one would like to see a Cp much larger than 1, because the larger the index, the more capable the process. Some practitioners consider 1.33 to be a minimum acceptable value for this statistic, and few believe that a value less than 1 is acceptable.

Determination of the lower specification limits (LSL) and upper specification limits (USL)

Due to the lack of historical parameters of LSL and USL for the observed attributes, a method of determining the proper LSL and USL is necessary. In this study, the LSL and USL for each attribute are determined based on the following procedures (Montgomery, 1997):

1. Construct the trial I and MR control chart of each attribute for the four plates.
2. Examine every control chart; if it is in control, then use the lower control limit (LCL) and upper control limit (UCL) as the LSL and USL. If it is in out-of-control condition (for most cases), reconstruct the control chart after eliminating all out-of-control points in the initial charts to obtain the revised values for mean, LCL, and UCL.
3. For each attribute, the difference between revised LCL and UCL of each plate obtained in the previous step is computed and named $6\sigma_{\text{revised}}$, i.e., $UCL_{\text{revised}} - LCL_{\text{revised}} = 6\sigma_{\text{revised}}$. Then $3\sigma_{\text{revised}}$ of each plate is computed for the purpose of obtaining the "average $3\sigma_{\text{revised}}$ " of the four plates, $3\hat{\sigma}_{\text{revised}}$ namely, i.e.,

$$3\hat{\sigma}_{\text{revised}} = (3\sigma_{\text{revised/PS}} + 3\sigma_{\text{revised/AgX}} + 3\sigma_{\text{revised/Photopolymer}} + 3\sigma_{\text{revised/Thermal}}) / 4$$

4. For each attribute, the final LSL and USL are obtained by subtracting from and adding to the $3\hat{\sigma}_{\text{revised}}$, the revised mean of each plate, i.e.,

$$LSL_{\text{final}} = \text{Mean}_{\text{revised}} - 3\hat{\sigma}_{\text{revised}}$$

$$USL_{\text{final}} = \text{Mean}_{\text{revised}} + 3\hat{\sigma}_{\text{revised}}$$

5. The LSL_{final} and USL_{final} were used to assess the relative Process Capability Ration (PCR) for the revised individual measurement control chart (I-Chart) of each attribute for the plates.

The LSL_{final} and USL_{final} for each plate attribute are exhibited in Table 3.

Capability analysis for solid ink density (sid)

The capability analyses of solid ink density for the plates are exhibited in Figure 2, Figure 3, Figure 4, and Figure 5. As shown in those figures, the thermal plate has the largest relative PCR ($Cp = 1.22$), followed by the PS ($Cp =$

	PS		Silver Halide		Photopolymer		Thermal	
	LSL	USL	LSL	USL	LSL	USL	LSL	USL
SID	0.88784	0.93914	0.69615	0.74745	0.88815	0.93945	0.87105	0.92235
75% dot gain %	3.76582	9.15618	2.24482	7.63518	9.21482	14.60518	0.00000	3.40048
50% dot gain %	6.5713	11.2607	2.0583	6.7477	11.0953	15.7847	0.0000	2.9139
25% dot gain %	2.09505	5.76495	0.67505	4.37495	5.50405	9.20395	0.00000	2.23415
Print Contrast	29.510	32.150	26.220	28.860	19.160	21.800	25.810	28.450

Table 3. The LSL_{final} and USL_{final} of each attribute for the plates

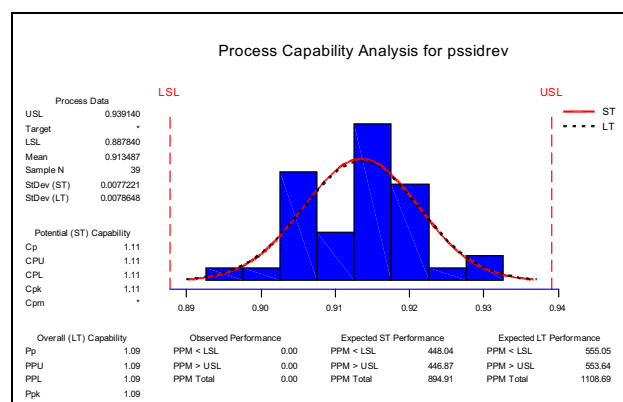


Figure 2. Process capability analysis of solid ink density for the PS plate

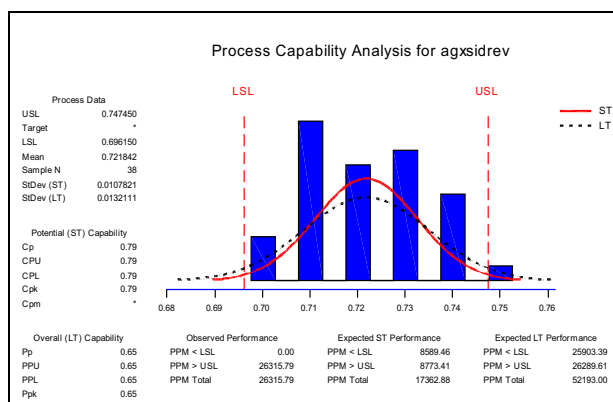


Figure 3. Process capability analysis of solid ink density for the AgX plate

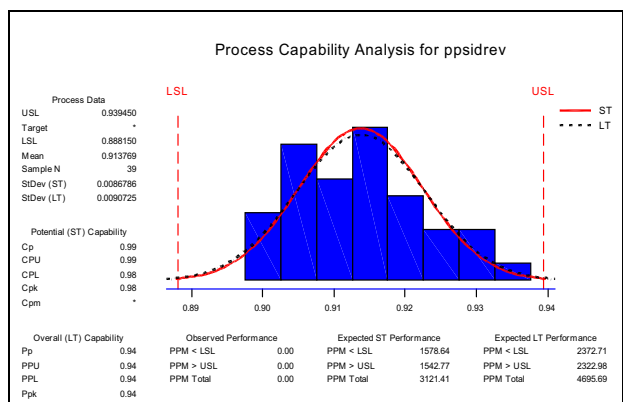


Figure 4. Process capability analysis of solid ink density for the photopolymer plate

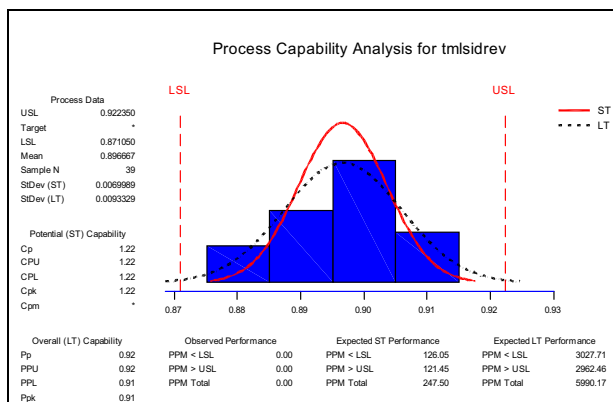


Figure 5. Process capability analysis of solid ink density for the thermal plate

1.11), photopolymer ($C_p = .99$), and silver halide plates ($C_p = .79$). Therefore, this study concludes that the thermal plate was the most capable plate for producing consistent solid ink density

among the four in terms of relative PCR.

Capability analysis for dot gain at 75% tint

The capability analyses of dot gain at 75% tint for the plates are exhibited in

Figure 6, Figure 7, Figure 8, and Figure 9. As shown in those figures, the PS plate has the largest relative PCR ($C_p = 2.47$), followed by the photopolymer ($C_p = 2.16$), thermal ($C_p = 1.79$),

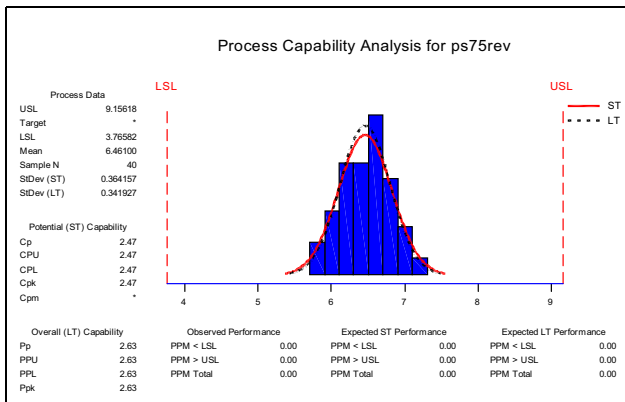


Figure 6. Process capability analysis of 75% dot gain for the PS plate

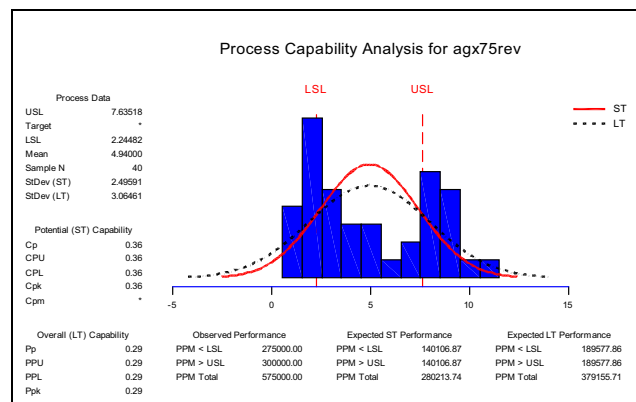


Figure 7. Process capability analysis of 75% dot gain for the AgX plate

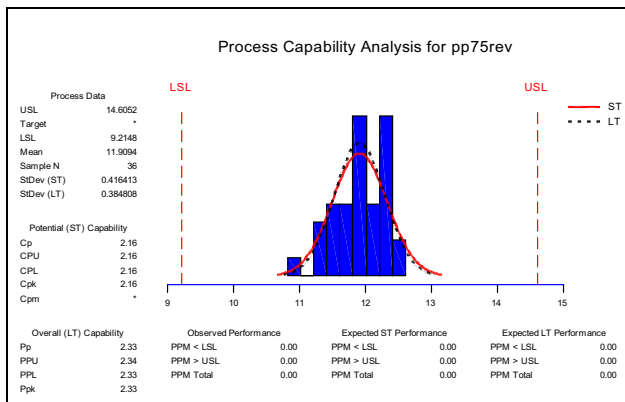


Figure 8. Process capability analysis of 75% dot gain for the photopolymer plate

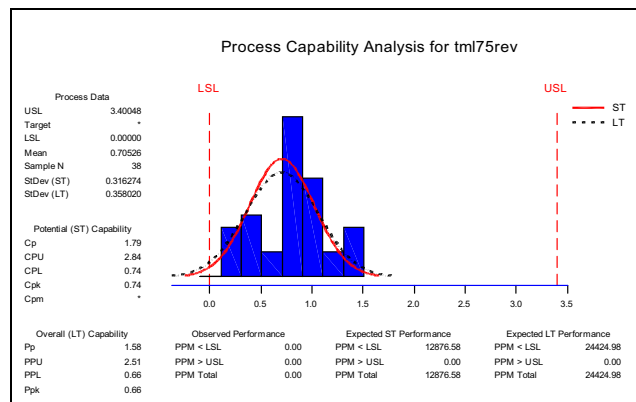


Figure 9. Process capability analysis of 75% dot gain for the thermal plate

and silver halide plates ($C_p = .36$). Therefore, this study concludes that the conventional PS plate was the most capable plate for producing consistent dots at 75% tint among the four in terms of relative PCR. In

addition, the thermal plate yielded the smallest dot gain size and its dispersion at the 75% tint, according to Table 2. The silver halide has the worst performance in this category.

Capability analysis for dot gain at 50% tint
Figure 10, Figure 11, Figure 12, and Figure 13 provide a graphical presentation of the capability analyses of dot gain size at midtone for the plates. As shown in those figures, the photopolymer plate

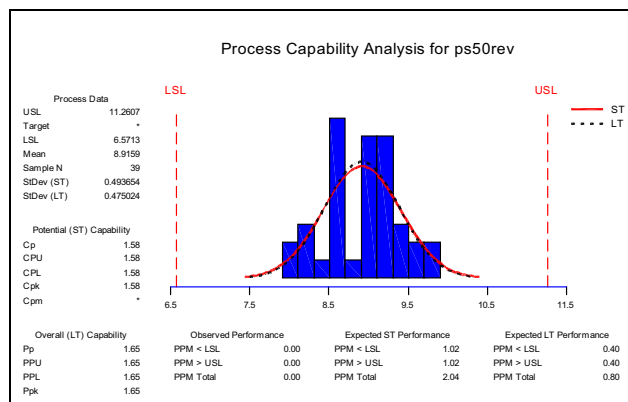


Figure 10. Process capability analysis of 50% dot gain for the PS plate

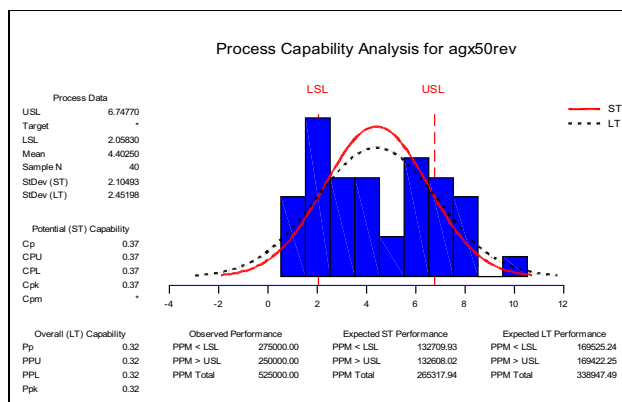


Figure 11. Process capability analysis of 50% dot gain for the AgX plate

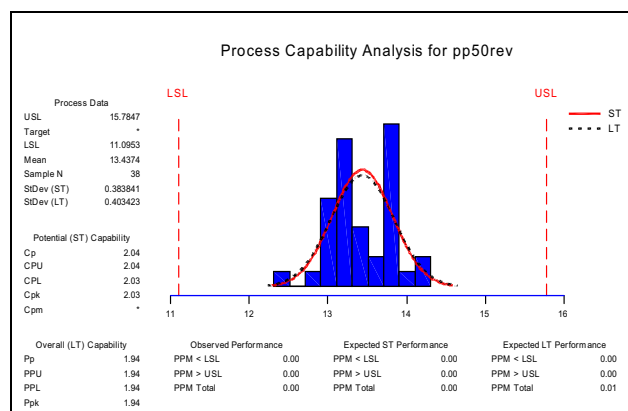


Figure 12. Process capability analysis of 50% dot gain for the photopolymer plate

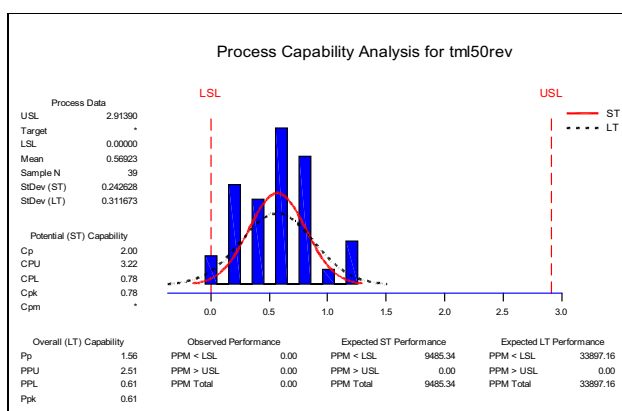


Figure 13. Process capability analysis of 50% dot gain for the thermal plate

has the largest relative PCR ($C_p = 2.04$), followed by the thermal ($C_p = 2.00$), PS ($C_p = 1.85$) and silver halide plates ($C_p = .37$). Therefore, this study concludes that the photopolymer plate was the most capable plate for producing consistent midtone dots among the four types of

plates in terms of relative PCR. It is interesting to note that the relative PCR of the photopolymer, thermal, and conventional PS are greater than 1.33 at the midtone area. The silver halide plate was incapable of delivering the consistent midtone dots.

Capability analysis for dot gain at 25% tint

Figure 14, Figure 15, Figure 16, and Figure 17 provide a graphical presentation of the capability analyses of dot gain size at 25% dot area for the plates. As shown in those

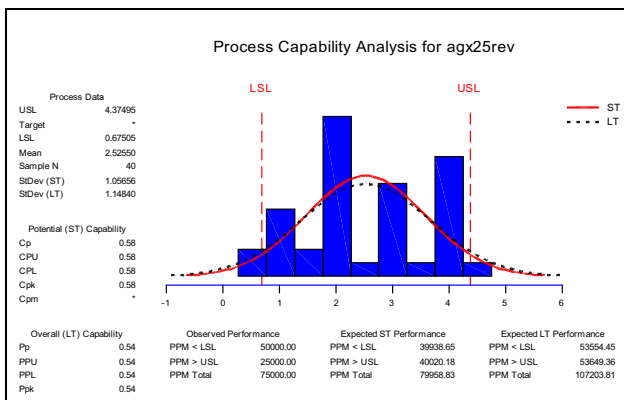


Figure 14. Process capability analysis of 25% dot gain for the PS plate

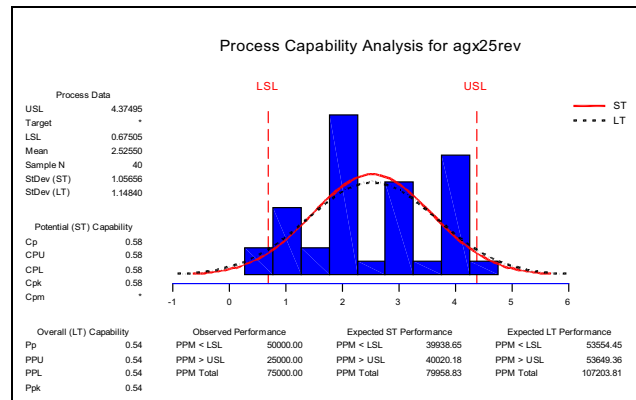


Figure 15. Process capability analysis of 25% dot gain for the AgX plate

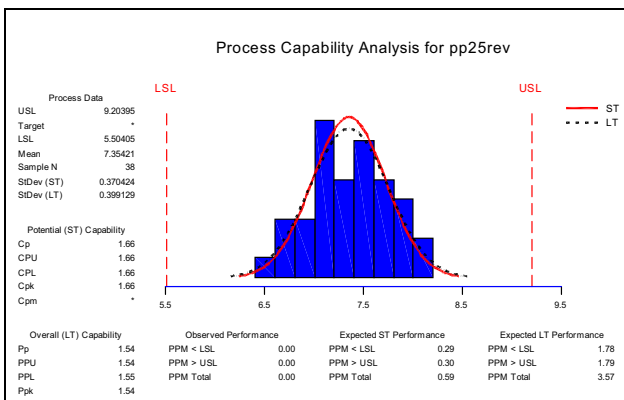


Figure 16. Process capability analysis of 25% dot gain for the photopolymer plate

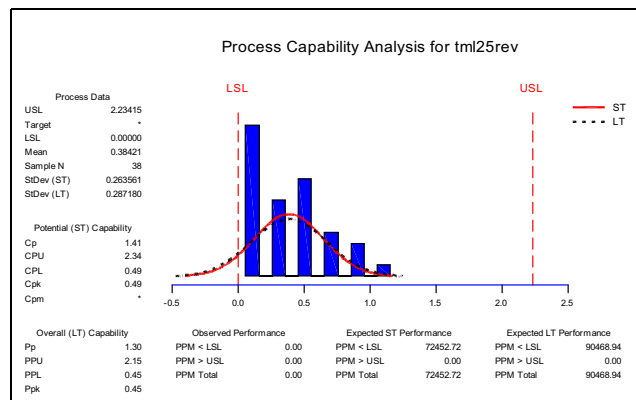


Figure 17. Process capability analysis of 25% dot gain for the thermal plate

figures, the photopolymer plate has the largest relative PCR ($C_p = 1.66$), followed by the thermal ($C_p = 1.41$), PS ($C_p = .79$) and silver halide plates ($C_p = .58$). Therefore, this study concludes that the pho-

topolymer plate was the most capable plate for producing consistent quarter-tone dots among the four types of plates in terms of relative PCR. It appears that the photopolymer and thermal plates outper-

formed the conventional PS and silver halide plates in terms of delivering consistent quarter-tone dots. This phenomenon is comparable with the result reported in Table 2, i.e., the dispersion of quarter-tone dot gain for

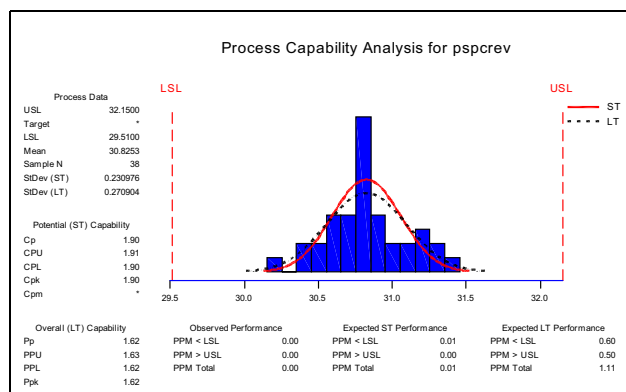


Figure 18. Process capability analysis of print contrast for the PS plate

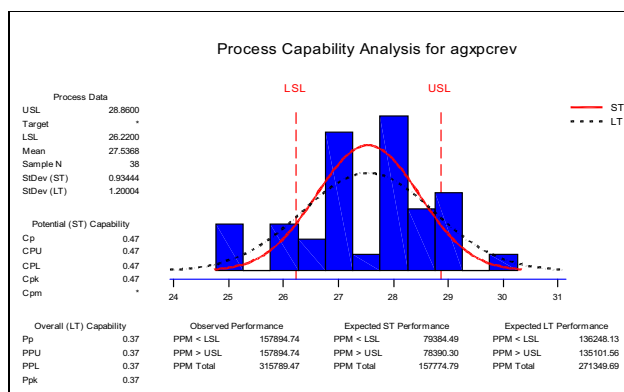


Figure 19. Process capability analysis of print contrast for the AgX plate

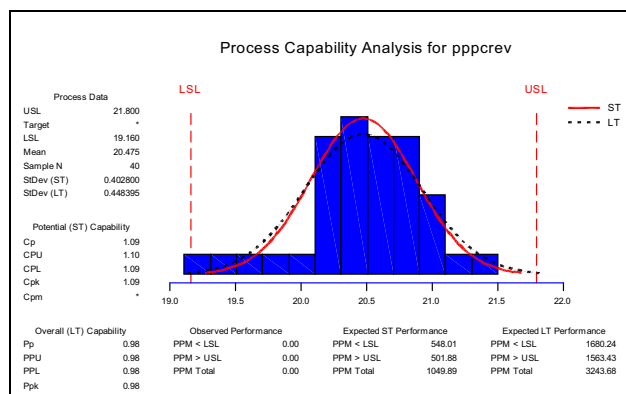


Figure 20. Process capability analysis of print contrast for the photopolymer plate

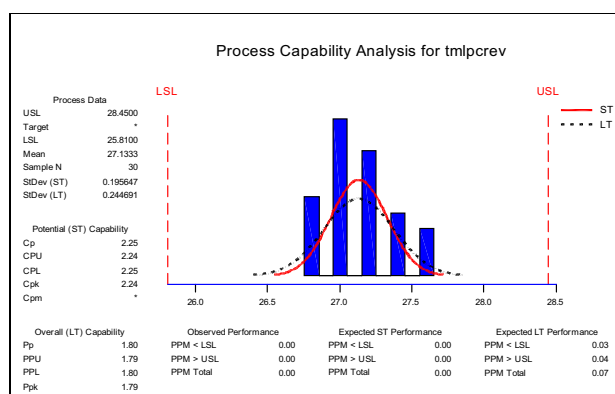


Figure 21. Process capability analysis of print contrast for the thermal plate

Cp Value	PS	Silver halide	Photopolymer	Thermal
Solid Ink Density	1.11	0.79	0.99	1.22
75% Dot Gain	2.47	0.36	2.16	1.79
50% Dot Gain	1.58	0.37	2.04	2.00
25% Dot Gain	0.79	0.58	1.66	1.41
Print Contrast	1.90	0.47	1.09	2.25

Note: **Bold** indicates the best in the group.

Table 4. Relative PCR (Cp Value) of the plates

the photopolymer and thermal plates is smaller than that of PS and silver halide plates.

Capability analysis for print contrast (PC)

Figure 18, Figure 19, Figure 20, and Figure 21 provide a graphical presentation of the capability analyses of print contrast for the plates. As shown in those figures, the thermal plate has the largest relative PCR (Cp=2.25), followed by the PS (Cp=1.90), photopolymer (Cp=1.09), and silver halide plates (Cp=0.47). Therefore, this study concludes that the thermal plate was the most capable plate for producing consistent print contrast among

the four types of plates in terms of relative PCR.

CONCLUSIONS AND IMPLICATIONS

This study evaluated the consistency and capability performance on solid ink density, dot gain, and print contrast for three increasingly adopted CTP plates and one widely used conventional PS lithographic plate in Taiwan.

Based on Figures 2 to 21, Table 4 summarizes the capability performance of the plates, in terms of relative Cp indexes, in SID, three-quarter tone, mid-tone, and quartertone DG, and PC. According to Table 4, this study concludes that the silver halide plate had the poorest performance

(smallest Cp value) in any of the observed attributes. Furthermore, its Cp values for the attributes are all smaller than 1.00; it implies that the silver halide was the least capable plate for producing consistent results in solid ink density, three-quarter tone, mid-tone, and quartertone dots, and print contrast. Table 4 also implies that the thermal plate was the most capable plate for producing consistent solid ink density among the four plates in terms of relative PCR, and the conventional PS plate was the most capable plate for producing consistent dots at 75% tint. The photopolymer plate was the most capable plate for producing consistent midtone

Observed Attributes		PS	Silver halide	Photopolymer	Thermal
SID	Mean of Solid Ink Density	.92	.72	.91	.90
	S. D. of Solid Ink Density	.012	.023	.010	.011
Dot Gain	Mean of Dot Gain at 75% Tint	6.46	4.94	11.66	.77
	S. D. of Dot Gain at 75% Tint	.340	3.045	.893	.454
	Mean of Dot Gain at 50% Tint	8.87	4.40	13.34	.61
	S. D. of Dot Gain at 50% Tint	.547	2.436	.617	.380
	Mean of Dot Gain at 25% Tint	3.92	2.53	7.27	.46
	S. D. of Dot Gain at 25% Tint	.671	1.141	.543	.419
PC	Mean of Print Contrast	30.83	27.54	20.48	27.04
	S. D. of Print Contrast	.296	1.432	.446	.558
PCR	Cp of Solid Ink Density	1.11	0.79	0.99	1.22
	Cp of 75% Dot Gain	2.47	0.36	2.16	1.79
	Cp of 50% Dot Gain	1.58	0.37	2.04	2.00
	Cp of 25% Dot Gain	0.79	0.58	1.66	1.41
	Cp of Print Contrast	1.90	0.47	1.09	2.25

Note: **Bold** indicates the best performance in the group.

Table 5. Summary of the observed attributes for the plates

dots, the photopolymer and thermal plates outperformed the conventional PS and silver halide plates, and the thermal plate was the most capable plate for producing consistent print contrast among the four types of plates in terms of relative PCR.

Table 5 summarizes the overall findings of the experiments. In the three-quarter-tone area, the thermal plate had the least

amount of dot gain, followed by the silver halide, PS, and photopolymer plate. In the midtone dot area, the thermal plate yielded the least amount of dot gain, followed by the silver halide, PS, and photopolymer plates. In the quartertone dot area, the thermal plate delivered the least amount of dot gain, followed by the silver halide, PS, and photopolymer plates. The sil-

ver halide plate produced the greatest amount of dot gain variation in all three tints among the four plates. Finally, this study recommends further research on finding the correlation strength between the plate and print performance on dot reproduction quality and consistency in more quality attributes for more CTP plates.

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A STUDY OF COURSE CONTENT IN GRAPHIC COMMUNICATIONS PROGRAMS

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INTRODUCTION

The printing industry has been called a “sunset industry” by Wall Street Journal (Romano, 1997, p. 1), but the worldwide market does not reflect this. Printing sales are estimated to reach \$1 trillion by 2004, up from \$800 billion in 2000 in the world market (“Worldwide Printing,” 2000). Statistics in “Printing and Publishing” (1999, 2000) show that the United States is the world’s largest market (largest importer and exporter) for printed products, with \$178 billion shipped in 1998 within the country (estimate), \$184 billion in 1999 (estimate), and \$188 billion in 2000 (forecast). This data reflects that the printing and publishing industry is one of the top five industries in the United States (Romano, 1997).

Since the beginning of the 20th century, society has been changing at an ever-accelerating rate due to the rapid development of new technologies and innovations (Bobbitt, 1997). The printing industry has not been immune to these new developments, many of which have contributed tremendously to the printing business. While new technologies have resulted in great benefits to the industry, they have also necessitated a change in the nature of the workforce.

In the last decade, the printing and publishing industry has recruited well educated and skilled employees from colleges and other educational programs but the printing industry is still experiencing trouble finding the qualified employ-

ees it needs (Dailey, 2000; Paparozzi, 2000; Roth, 1993; Webb, 2000). Ratcliff (1997) states that there is a growing realization that the gap must be bridged between the content of graphic communications (GC) programs and the real life occupational needs of the graduates. A feasible program should be maximally effective and efficient so as to minimize the gap between college programs and industry needs (Ferren, 1997).

There are at least 132 GC programs offered at community colleges or four-year colleges and universities in the United States to support the needs of printing and publishing industry (Flecker & Groff, 1998). GC programs may become obsolete if universities/departments only focus on short-term job training rather than on skills required for future job security and the long-term health of the industry as a whole (Goff, 1997). The ultimate goal of a GC program is to provide the knowledge and skills students need to be

successful in their chosen career (Kurian & Molitor, 1996).

A major influence on program as well as curriculum content is technology. Changes in printing business and technology affect curriculum content in GC programs (Paparozzi, 2000). Technology has become so pervasive that faculty members must continuously reassess its place in curriculum content (Farmer, 1997). As new technologies are integrated, the GC program may take on new purposes, meanings, and a broader scope (Farmer, 1997).

The purpose of this study is to use the opinions of educators to determine the content to be included in GC programs for four-year colleges or universities to meet future needs. This study provides information to GC faculty about subject areas to teach, purchase of equipment, and future faculty recruitment. The findings of this study can help curriculum designers, developers,

planners, and researchers in universities develop feasible and appropriate GC programs for students and the industry.

REVIEW OF THE LITERATURE

The graphic communications industry

The printing industry has more manufacturing plants than any other industry in the United States (Romano, 1997). One decade ago, there were 65,000 printing establishments; by 1998, an estimated 70,000 printing establishments existed ("Printing and Publishing," 1999, 2000). Over 128 printing-oriented associations are based in the United States, excluding regional networking groups (Flecker & Groff, 1998). These statistics show that the printing and publishing industry occupies an important position in industry in the United States.

The development of printing is of crucial importance to many other societal

functions since printing plays a major role in spreading information, knowledge, and ideas (Pacey, 1996). The general public probably does not understand the importance of the printing industry because it has been underrated and underestimated for its contribution to the production of knowledge and to civilization (Levenson, 2000). Most people simply take it for granted that printed material will always exist but rarely take note of the fact that the books, magazines, and newspapers they read are a result of advances in printing technologies.

The printing industry maintains its important role in society and continues to evolve just as civilization and humanity advance swiftly due to technologies (Bobbitt, 1997). From yesterday's world of mechanized labor to today's world of digital unification, the printing industry has sought to improve upon every advance and move towards the goal of increasing efficiency and

versatility ("Job Definition Format," 2000). The printing industry has rapidly and continuously adopted the newest technologies and applied them to practical production to produce the quality products that fulfill the needs of the general public and reach people in today's multimedia environment (Vision 21, 2000).

Graphic communications technologies

New technologies are helping the printing industry solve practical printing problems and improve the processes of production derived from scientific research or practical experience (Clark & Sugrue, 1990; Mitcham, 1994). The printing industry is adding more computerized and automated systems, and the innovative use of equipment and processes will be the key to industry success (Vision 21, 2000). When technology is used properly, it increases production efficiency, helps printers meet customer

needs, allows printers to stay in business, and enables new customer-focused service. However, technology does not necessarily give printers a long-term competitive edge, assure customer loyalty, develop new markets, impress customers, or make printers consistently profitable (Roth, 2000). For example, print buyers do not buy technology, but they buy what technology creates (Paparozzi, 2000). Printer buyers do not care what equipment or new technologies printers use; they only care that quality jobs can be done cheaply and on time. Even with these drawbacks, most printers take the business risk of using new technologies.

Printing has entered the Information Age and Digital Age ("Digital Roadmaps," 2000). New printing technologies have created several new market niches, such as variable data printing, and short-run and on-demand printing markets, which traditional printing technology

could not make cost-effective and efficient with acceptable quality. Technological advances have greatly improved many operations in the printing industry (Zwang, 1998). This has forced the industry to take further steps in adopting new technologies, innovations, and equipment.

IDENTIFYING RELEVANT PROGRAM CONTENT

Program content

Content can be defined as specific types and areas of knowledge within a particular field of study (Martin, 1979). Program content is a major component in developing curriculum (Ediger, 1995). Curriculum planners must understand the nature and structure of content thoroughly in order to provide students appropriate and meaningful learning activities (Griffin, Dodds, & Rovegno, 1996). Educators in curriculum planning are charged with selecting and organizing content in ways

that generate and broaden students' interests, social context, or both (Hunkins, 1980).

William Chandler Bagley believes that the school curriculum should be relatively stable, and "a continuously changing curriculum should not be in evidence once essential content has been identified and taught" (Ediger, 1995, p. 269). Content should be relevant to current times and the future; it should last over an extended period of time because content "contributes to the development of particular learning abilities, skills, processes, and attitude formation" (Hunkins, 1980, p. 221).

Identifying program content

Identifying program content is important in curriculum development (Morse & Corcoran-Perry, 1996). Educators have the expertise to decide what content should be included in programs because curriculum

has traditionally relied on what they want to offer and is useful for students to acquire information and skills they need (Ferren, 1997; Johnson, 1981; Kendall & Marzano, 2000). Voelker's (1973) method to identify the curriculum content of combination approach, analyzing existing materials and formulating a questionnaire and sending it to professionals, was used in this study.

The current curriculum in the GC programs is one of the major sources of existing materials to identify and analyze program content. The textbooks and reference books can also be examined for content identification (Siegel, 1954). Other existing materials include information from presentations at seminars or conferences, reports from printing organizations, and articles in professional magazines and journals. The resulting materials can be assembled for use in identifying the GC program content (Olson, 1958).

METHODOLOGY

Population and sample characteristics

This study was to determine the appropriate professional content for an undergraduate GC program by soliciting the opinions of educators in four-year colleges or universities. Two groups of participants were in this study. An Expert Panel made up of chairpersons or coordinators in GC programs who maintain an active *Technical Association of Graphic Arts (TAGA)* Student Chapter. Secondly, GC faculty who are actively teaching GC courses in four-year colleges or universities. Five educators were recommended by TAGA in the Expert Panel and 156 qualified educators were selected for surveying faculty (generated through institutional websites during fall 2000) as the population.

Research instrument

Survey questionnaires served as the data collection instrument for this study.

Two major instruments were used in the study: (a) the Expert Panel Questionnaire, and (b) survey questionnaire. Content items and subject categories on the Expert Questionnaire were obtained by reviewing current GC curricula, GC textbooks, studies and dissertations on curriculum, and various public and private businesses and organizations with publications related to GC.

An Expert Panel was used to identify important GC content. Two rounds of the Expert Questionnaires and one pilot test were conducted to ensure the validity and reliability of the content items and subject categories and gain a better response. A questionnaire was developed for GC educators using this content. The survey questionnaire with a type of Likert-scale was then used to obtain ratings on importance of content items and subject categories with ratings of 1=No Importance; 2=Low Importance;

3=Moderate Importance; 4=Fairly High Importance; and 5=Very High Importance. The final questionnaire of 68 content items in 15 subject categories was generated.

Data collection procedure

Data collection was divided into three phases. The first phase dealt with the response from educators in the Expert Panel using e-mail and the postal service. The second phase involved sending the draft questionnaire to two educators who were asked to review it as a pilot test. The last phase, hard-copy questionnaires were mailed by postal service to 156 educators. In addition, e-mail message were sent to all the participants with a questionnaire in the form of an e-mail attachment and a hyperlink to a personal website containing a questionnaire that could be completed on-line. After collecting 99 responses from the participants, the data was tabulated.

Data analysis

After the questionnaires were returned, data analysis began. The Statistical Package for Social Sciences (SPSS) was used to perform data analysis. The statistical analysis was based on responses to the questionnaire from GC faculty. The importance of content items as rated by the Expert Panel and GC faculty was studied.

FINDINGS

A total of 156 survey questionnaires were sent out to GC faculty with three options for responding to this study. A total of 99 questionnaires were returned.

The mean scores and standard deviations for each subject category as rated by the GC faculty and Expert Panel are shown in Table 1. The mean scores for every subject category are determined by computing a grand mean for all the content items within the subject category.

Subject Categories	Expert M	Expert SD	Expert Ranking	Faculty M	Faculty SD	Faculty Ranking
A. Science & Mathematics	3.23	.28	15	3.31	.71	15
B. Basic Communication Techniques	4.25	.87	7	4.41	.49	2
C. Graphic Design	4.01	.77	10	4.21	.67	6
D. Prepress	4.78	.29	1	4.53	.46	1
E. Press	4.60	.57	3	4.15	.62	8
F. Digital Printing Technology	4.60	.45	3	4.33	.59	3
G. Postpress	4.20	.45	9	3.93	.71	11
H. GC Past & Future	4.70	.45	2	4.15	.62	8
I. Safety & Health	4.60	.89	3	4.30	.77	4
J. Fundamental Marketing	3.83	.88	13	3.99	.62	10
K. Business & Management	4.00	1.02	11	3.90	.69	12
L. Production Management	4.25	.88	7	4.25	.66	5
M. Digital Media Publishing	4.30	.67	6	3.60	.78	14
N. Computer	3.60	.98	14	3.68	.63	13
O. Others	4.00	.60	11	4.20	.66	7

Table 1. Mean scores and standard deviations of subject categories for Expert Panelists (N=5) and Faculty (N=94 to 99)

Graphic communications faculty rated 68 content items within the 15 subject categories, the range of mean scores being from 4.75 to 2.56. Forty-one of the content items received a mean score of 4.0 or above. Twenty-four of the content items received a mean score between 3.0 and 4.0. Only three content items received a mean score below 3.0. The grand means for subject categories ranged from 3.31 to 4.53. Ten subject categories had a mean rating of 4.0 or

above. The top five subject categories rated by GC faculty are: Prepress, Basic Communication Techniques, Digital Printing Technology, Safety and Health, and Production Management.

CONCLUSIONS AND DISCUSSION

Conclusions

This study investigated important content for undergraduate GC programs in four-year colleges and universities. Content was initially identified by a panel of experts (two rounds). This content was then rated in importance by GC faculty in four-year colleges and universities. Based on the findings of this study, the following conclusions can be made.

1. The 15 subject categories and 68 content items, as identified by a panel of experts are important items for consideration within a general undergraduate GC program. The only content items that might require further consideration

are *Calculus, Programming Language, and Finite Mathematics* since these received a rating below moderately important.

2. Some categories were rated as fairly high in importance (4.0) by both the Expert Panel and faculty. These include *Basic Communication Techniques, Graphic Design, Prepress, and Others*. The subject category *Prepress* was the only subject category rated above 4.5 by both the expert panel and faculty. Within the subject category *Prepress*, five of the six content items were rated above 4.5 including *Preflighting; Imaging Acquisition and Editing; Composition/Imposition; Color Reproduction and Separation; Electronic Prepress (Publishing) System and Desktop Publishing System; and Color Management System*. It appears that this subject category deserves attention when designing a program.
3. Three subject categories were rated below 4.0 by both the Expert Panel and faculty. These include *Science and Mathematics, Fundamental Marketing, and Computer*. The *Computer* category contains content items such as *Database, Networking, Programming Language, Information Systems/Information Technology, and Internet*. *Internet* is rated as fairly high in importance but the others in this category are considered less important.

Discussion

Important GC content was identified by an Expert Panel and rated in importance by GC faculty nationwide. Responses by faculty were statistically analyzed to determine if the 68 content items in 15 subject categories were appropriate.

Even though the Expert Panel was given two opportunities to change and rate subject categories and content items, it might be useful to increase the size of the Expert Panel and complete a Delphi study which would result in additional refinement of subject categories and content items. It might also be helpful to compare the ratings by the Expert Panel and faculty.

It is observed that many content items identified as important for GC programs are concerned with newer technologies. This is a reflection of the changes occurring in industry and perhaps a reflection of students' interests as well.

Management in GC is playing a more important role than in the past according to this study. Two subject categories are related to management, which are *Production Management and General Management*. *Production Management* is perceived by faculty as being more important than *General Management*. When individual content items within the *General Management* category are analyzed, it is noted that several of these content items received comparatively low ratings by faculty, including *Finance, Accounting, and Law*. However, these content items certainly deserve consideration for curriculum change since GC is a business which has financial and legal responsibilities.

For undergraduate students, it is necessary to complete approximately 130 semester credits (including general education) for accomplishing a bachelor's degree. There are 68 content items within 15 subject categories that were identified in this study which covers very broad subject areas in GC. Curriculum designers will obviously need to prioritize when determining what content should be included in a GC program.

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GRAPH ETIQUETTE: A PARADIGM FOR PRESENTING TECHNICAL DATA

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ABSTRACT

Presenting information with graphs can be an effective way to visually communicate quantitative data; however, publications often lack the appropriate pieces to communicate the visual information in the best way possible. Although there are a variety of informational graphing techniques available, communicating the correct interpretation of the data is often a problem. Conventional graphing techniques include bar, fever/line, scatter and pie graphs while graph etiquette involves identifying the correct data to display, choosing the correct type of graph to use, and using proper graphing techniques. Examples in this paper will demonstrate how the application of design concepts to the visual interpretation of data through graphs can add to the understanding and readability of the

selected information. This paper addresses the aesthetics, readability, usability, and formatting of graphs for publications.

INTRODUCTION

If a picture is worth a thousand words, then an "infographic," which is short for "informational graphic," should visually summarize and simplify the critical points of an article to the reader. Educators who write for print publications often are self-taught infographic designers. There are many pitfalls to thinking visually, when one has not been formally trained and one desires the infographic to look professional. This paper will address those issues.

An infographic is not a new phenomenon. Many readers equate infographics

as emerging from the American newspapers of the 1980s, specifically *USA Today*. In reality, infographics pre-date the 100 languages and 5,000 dialects of the world (Holmes, 1985) through the symbolic cave inscriptions of the American Indian petroglyphs, the 2,000 clay-tablet pictographs of the Sumerians in 4,000 BC, and the hieroglyphics of the Egyptians from 3,100 BC to 394 AD (Meyer, 1997).

Charts, graphs, diagrams, and maps are all types of infographics. Because many visual communicators deal with technical data in the form of numerals, a graph is an effective infographic to represent quantitative information. Major problems are in organizing, summarizing, and describing the data. Graphs have the capability to portray the visual communication of abstract data relationships to the reader; in other words, make sense of the data. A graph is framed by the perspectives

of the researcher, who is responsible for gathering the data; the technologist, who uses the software tools and skillfully massages the data; and the perspective of the designer, who integrates the aesthetics with the data. In reality, the self-taught infographic designer must wear all three hats.

In order to learn to think visually and create an effective infographic, several potential pitfalls must be overcome. One must determine what kind of graphic to use and also when to use it. Identifying the best data to use in an infographic needs to be determined, as well as how to organize the data. The designer must examine the best way to integrate the graphics with the technical data.

WHAT IS THE PURPOSE OF A GRAPH?

A graph is a tool to help readers "see the big picture" (Meyer, 1997). It visually displays numerical informa-

tion that has been digested and simplified for the greater population, since few in our society have the analytical ability, patience, or desire to process a plethora of raw data. The need for graphics stems from an overdose of information, which we commonly refer to as "information overload." With this exhaustive amount of information at our disposal, countered with the limited amount of free time people in our society have available, there becomes an imperative need to simplify data for the reader.

The next question that needs to be addressed is "Who is your audience?" In order to create an effective graph, the audience and their needs must be assessed. Ask yourself: "What is the overall message I want to give my reader? Does the graph actually say what was intended? Is it in the language that the reader can understand? And, how will this information be used?"

HOW GRAPHS ARE READ

In spite of the fact that graphs are generally created after an article or technical paper is written, they are read first by the reader. This is because "... our minds process and store symbols more easily than they decode text" (Meyer, 1997).

Graphs, as a visual journalism tool, should translate the "who, what, when, why, where, and/or how" of the information. A graph is composed of four elements: a graph window, scale indicators, graphic elements, and text. The text is further subdivided into a heading, sub-head, explainer, credit line, and labels.

A graph becomes reader-friendly through the organization of the information, the simplicity and lack of clutter, the contrast, and the aesthetically pleasing nature of the information. The visual display of data should be "interesting, inviting and accessible" (Kostelnick, 1998).

Part of making a graph user-friendly is reflected in the way it is read - as an inverted pyramid. The main point, which is the heading, captures the attention of the eye initially and is the beginning of the graphic story. Then the overview of the secondary points of the story is viewed through the graphic display. Finally, the supporting details are read -- the actual or implied numerical figures. According to the Eye-Trac research from the Poynter Institute, a reader looks at both the graphic for information and the headline of the technical paper, then decides whether or not to read the text (Harrower, 1995).

WHEN ARE SPECIFIC GRAPHS USED?

Since a graph is a form of visual journalism, it stands to reason that the designer would also need to be accountable by addressing the journalistic foundational questions of: Who? What? When? Why? Where? and sometimes How? Not all

graphs address all the questions. Some are better suited for only specific ones. The four specific subsets of graphs addressed in this paper are: pie graph, bar graph, line graph, and the scatter plot graph.

The pie graph compares parts of a whole and illustrates proportions of 100 percent. It measures how much money, population, etc.

The bar/column graph is a type of infographic, usually showing the relationships between more than one element with the same variable, represented in the form of a column. It can also illustrate the activity of one variable over specific intervals of time. The bar graph addresses how much and when. It compares places and things at an explicit time.

The fever/line graph is an infographic addressing trends or change over time. The plotted points connected by lines answer "How much?" and "When?"

Scatter plots, also known as a scattergrams, show the location and amount of densities. Scatter plot graphs, which are often found in technical publications, demonstrate how two sets of data relate. Each observation is independent of the others, so the data points are not linked together. The pattern of the plotted points demonstrates the nature of this correlation. The scattergram can define a positive, negative or absent relationship between the variables. But a word of warning: Just because two variables change value simultaneously, doesn't prove cause and effect. The two variables might be driven by a third variable. Scatter plot graphs can be difficult to interpret and best used with an informed audience with a technical or scientific background.

WHAT IS GRAPH ETIQUETTE?

"Graphical excellence is that which gives to the viewer the greatest number of ideas in

the shortest time with the least ink in the smallest space," states Edward R. Tufte (Harrower, 1995). To establish graph etiquette in presenting technical data, certain guidelines should be followed in content, typography, contrast, grammar, graphic presentation, and ethics.

Content guidelines

When developing the content of the graph, check to ensure that the foremost point is evident in the graphic. Do not force the reader to look for the important points within the paper.

The concept should be clear, evident, and approachable enough for the reader to understand. Where a lot of data has been collected and needs to be displayed more than one graph can be created.

The content should be accurate with true proportions. The data presentation can be skewed intentionally or unintentionally by the use of non-proportional axis. All

information should be labeled clearly.

Add illustrations to the graphs conservatively. If illustrations are added to embellish the graph, they should compliment the data rather than distract from the information being presented.

Typography guidelines

Consistency is the rule when it comes to the use of typography in a graph or series of graphs. Use consistent font styles and sizes. In other words, make all the headings in a series of article graphs the same font, style and size. Make all the credit lines the same font, style and size, etc.

For the source and credit lines, it is suggested that the type be no smaller than 8-point type; otherwise, it is hard to read.

Use a limited number of fonts-preferably no more than one serif and one sans serif family in one graphic. All type should be horizontal for readability. Type should

not be crowded or visually confusing.

Contrast guidelines

In visual communications, contrast determines not only the readability factor of the graph, but also the aesthetics. Use screen densities (tints of gray) conservatively.

Although computer programs like Excel offer a wide variety of fill options, it is better to be conservative with your choices. Black type on dark-gray background screens can impair the readability of the text, unless the type is reversed.

Type size plays an important role in readability on screens and black. Do not use 8-point serif type on a gray screen; it is not readable. If a screen is used, a sans serif bold makes for easier visibility. And above all else, do not screen small text type.

When type is reversed out of black, the letters maintain their integrity; however, a reversed sans serif font is easier to read than a reversed

serif font. Bold and sans serif fonts are the best contrasts to use. Remember that when type is reversed out of a gray screen, the halftone dots break up the type characteristics and often it is difficult to read.

If the publication is on a good quality paper and can hold a 10 percent screen, then a tint becomes an option. Many papers such as newsprint can only hold a 15- or 20-percent screen. A 20-percent screen block is the maximum to use, if text is placed on top of it.

Grammar guidelines

Punctuation and the use of abbreviations in infographics have their own special graph etiquette. Parentheses should be minimal, especially in a heading. Avoid the overuse of quotation marks. If the graph includes a bulleted list, it is not necessary to put a punctuation mark at the end of each bulleted phrase.

Abbreviations that are acronyms are totally

dependent upon the target readership. Acronyms are not generally used if the target audience is at the introductory level. The acronyms do not have to be spelled out, if the audience is acquainted with the subject.

Abbreviations are appropriate when labeling reference value time on graphs - years and months. Use of the four digits of the first year and the last two digits for the remainder of the horizontal scale labels, illustrates graph etiquette. For months, abbreviate one of two ways: 1) Using the first letter of each month, or 2) Applying the rule of labeling the names of the months by using the first three letters, unless the spelling only has four letters. In that case, the name of the month should be spelled out.

Graphic presentation guidelines

Before an infographic is executed on the computer, the overall visual display must

be brainstormed through thumbnail sketches. From that point, the best few ideas are refined and a final version is selected.

Consistency is the rule when it comes to graphic presentations, as is the KISS Rule ("Keep it simple, stupid!"). Avoid graphic overload. Use a consistent style for each graphic in the same presentation and avoid size variations and inaccurate three-dimensional visuals that are out of proportion and misleading. Use three dimensional bars and pies only when the dimensionality lends clarity to the graph.

When executing the graph on the computer, create all related lines within the graph the same thickness. A series of graphs should have the same thickness of borders -- preferably 0.5 point stroke. If drop-shadows are applied, each graph should have the shadow projecting in the same direction, etc. If columns are used, they should be of

consistent width and spaced accordingly.

If data symbols are used in the graph in place of columns, stack the symbols rather than increasing the size to show variances; otherwise, it misrepresents the volume instead of the quantity.

Specific graph guidelines

The pie, bar, line, and scatter graphs each have guidelines specific to their type.

Pie graph guidelines

Foremost on a pie graph, check that all the parts add up to 100 percent. When creating a pie graph, begin at noon and work clockwise with the slices. It is traditional to go from small to large slices. The slices should be limited to a maximum of seven, and the overuse of stripes, dots and checkers should be avoided. The graph begins to look more like a spectacle, than a professional infographic. It is traditional to have a last piece with a combination of what is left over often labeled as 'all others'.

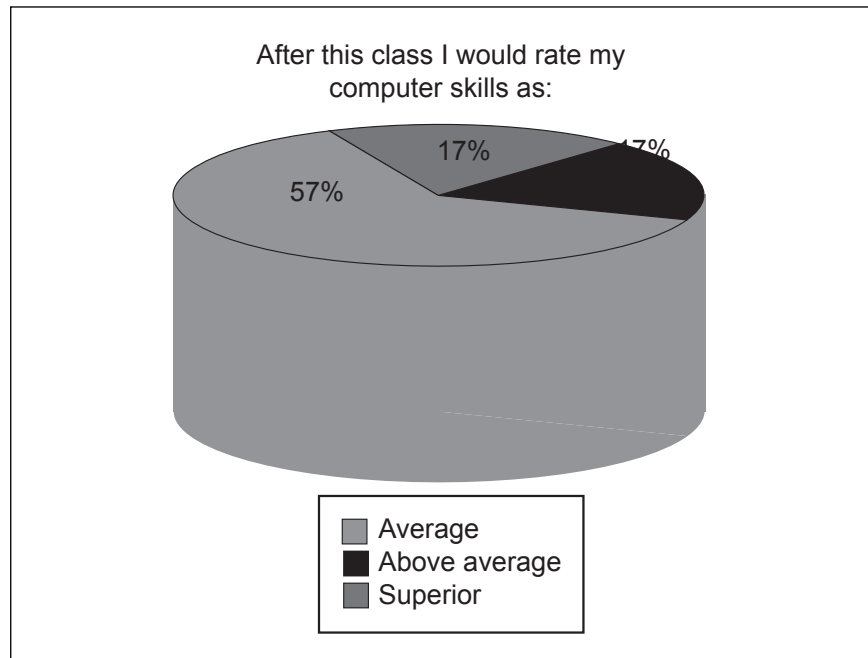


Figure 1. Bad example of pie graph

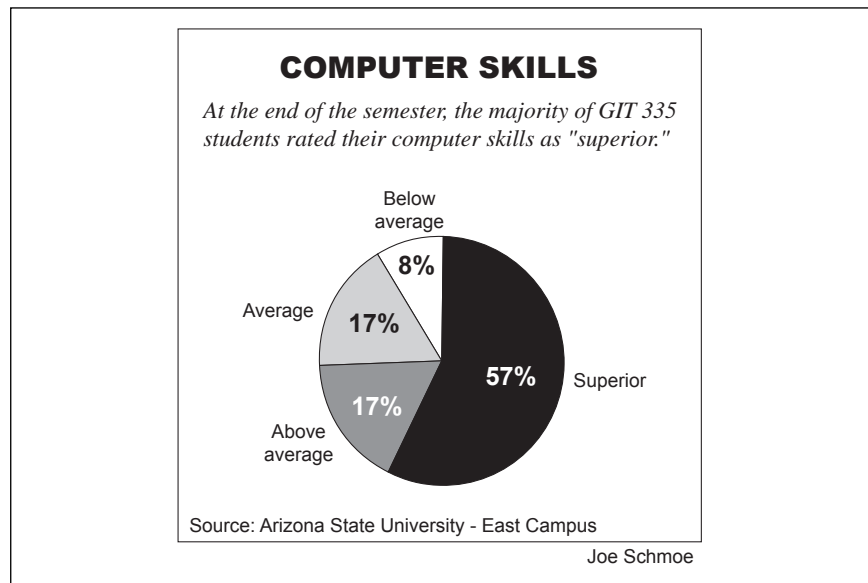


Figure 2. Good example of pie graph

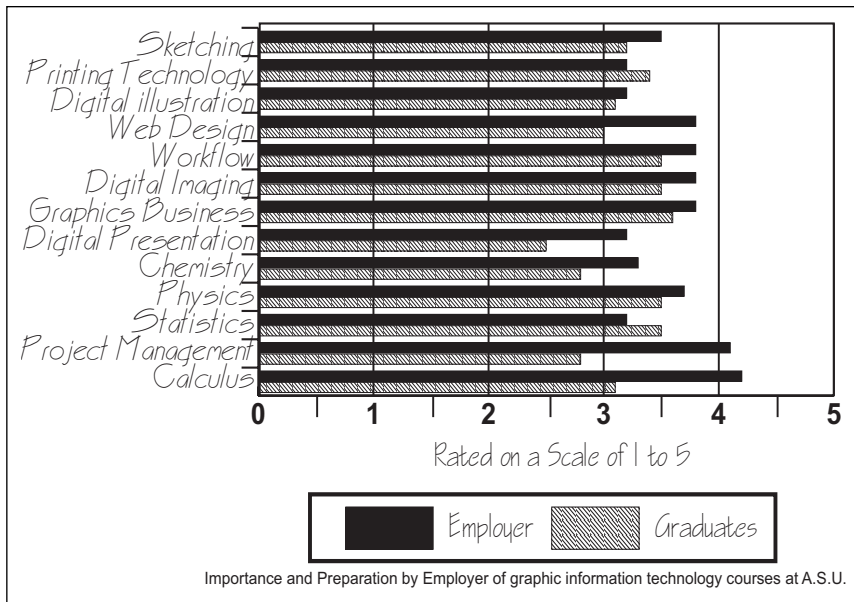


Figure 3. Bad example of bar graph

Bar graph guidelines

The bar graph can be horizontal or vertical. The vertical bar is sometimes called a column graph. A horizontal bar may compare people, products, and companies; with the largest bar traditionally being placed at the top.

In a vertical multiple-bar graph, each set of bars is clustered together for each time unit, which is labeled on the y-axis. When comparing two variables, a horizontal alternate to the verti-

cal multiple-bar graph is “bar pairs,” which has a zero in the middle and bars going from the center out. (Figures 3 & 4)

A bar graph in which each column is divided into sections, is an alternative to using several pie graphs next to each other, when comparing amounts over time. The one rule about using this type of bar graph is that the observations must be kept in the same order for each column.

Horizontal or vertical deviation bars, in which there are bars on either side of the reference axis, indicate the area of standard deviation from the anticipated value.

Make this visually explicit, so there is no perceptual confusion. Also do not obstruct readership by using keys; putting labels on data is much more reader-friendly.

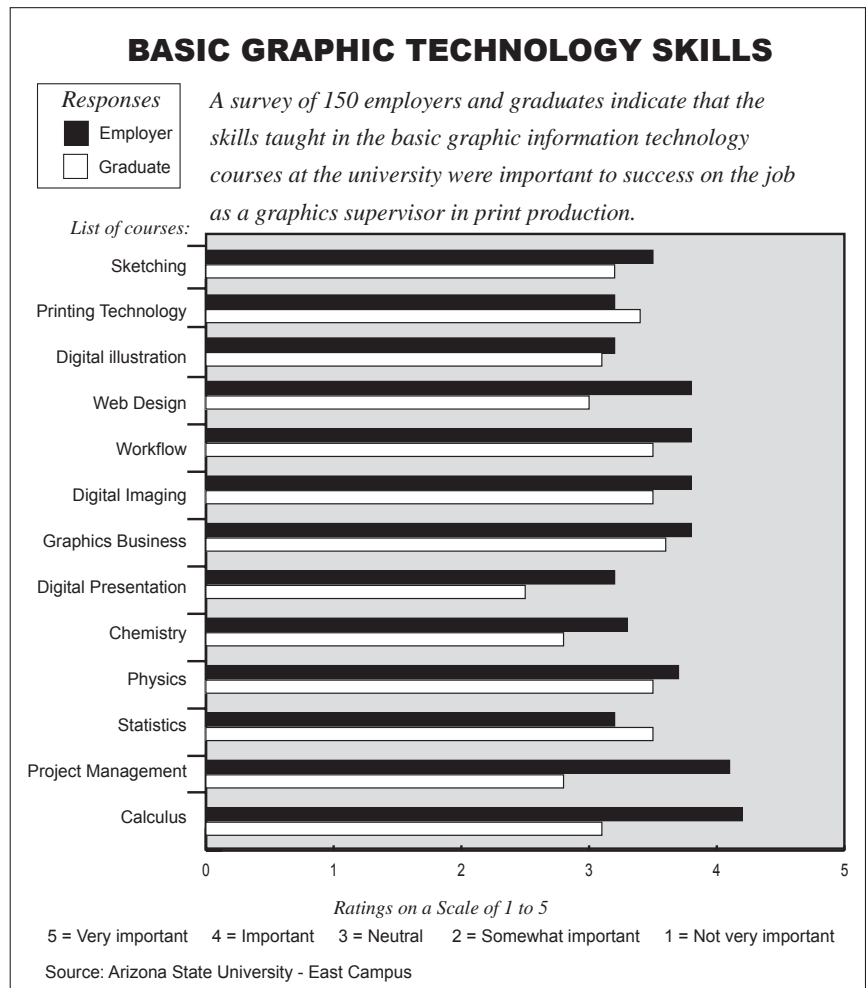
Line graph guidelines

A line graph is a visualization of quantities, plotted over a time period, by means of a rising and falling line. It is often referred to as a fever graph. Appropriate uses of line graphs include any set of figures illustrating a flow that needs to be shown over a period of time. A successful line graph allows the reader to understand the flow of the figures if it clearly shows the relationship of the point immediately before it and the one immediately following it (Miller, 1999). A line graph has certain guide-

lines to aid readability and comprehension of the content. It is conventional to begin the xy-axis at a zero value. If the value is otherwise, a break line is required for proper graph etiquette. It is often customary to emphasize the milestones of the fever/line graph with a black dot or square.

Scatter plot graph guidelines

Dots are also used for data values in scatter plot graphs and plotted in terms of two scales. A regression line can be used with a scatter plot for visual impact, but it is important that the slope and position of this line be calculated from the data to represent the trend of the data set. If precise numerical values for plotting the line don't exist, the line should be omitted. Avoid the use of a background grid; it visually clutters the graph. Stick to tick lines only. Size and color the point symbols so they're readily visible in the graph window. (Figures 7 & 8)



Joe Schmoie

Figure 4. Good example of bar graph

Statistical ethics guidelines

During the 1980s, visual communication and aesthetics were priorities of infographics with the “char-

toons” of USA Today’s Nigel Holmes, and the new-age designers Robert Lockwood and Mario R. Garcia, who based their graphics less on functionalism, and more on color and familiar imagery.

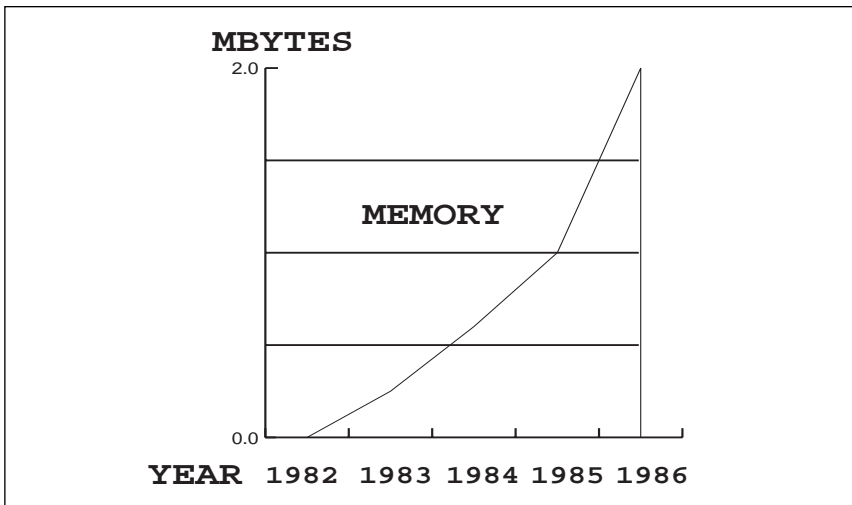


Figure 5. Bad example of line graph

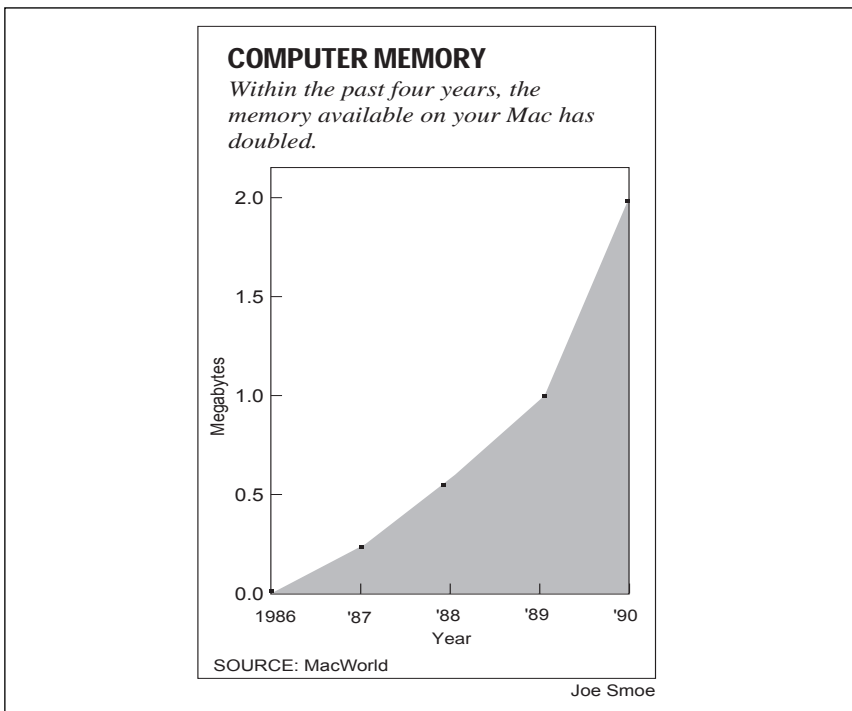


Figure 6. Good example of line graph

Edward Tufte (1983) published a milestone book *The Visual Display of Quantitative Information*, which showcased the weaknesses of the graphs of the 1970s and 1980s. Tufte made an ethical plea for the accuracy of the analytical information, so that perceptual misrepresentation would not occur. Educators, who approach graphing as a functional endeavor, must also realize the importance of a visually pleasing infographic in the readers' comprehension of the content. The skeptical statistical community has begun to accept and give credibility to the graphs that are not only well designed, but also accurate. With those facts in mind, infographic designers of today must approach the ethics of the graph in the same manner as they would approach the ethics of the published paper.

An ethics guideline for displaying statistical information is rule number one: "Avoid intentional visual

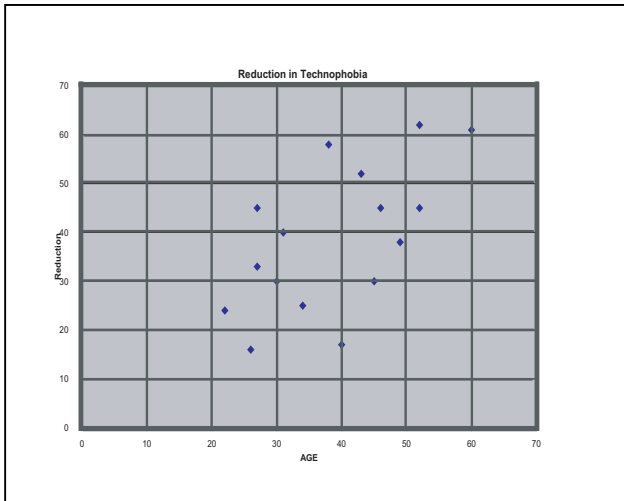


Figure 7. Bad example of scatter graph

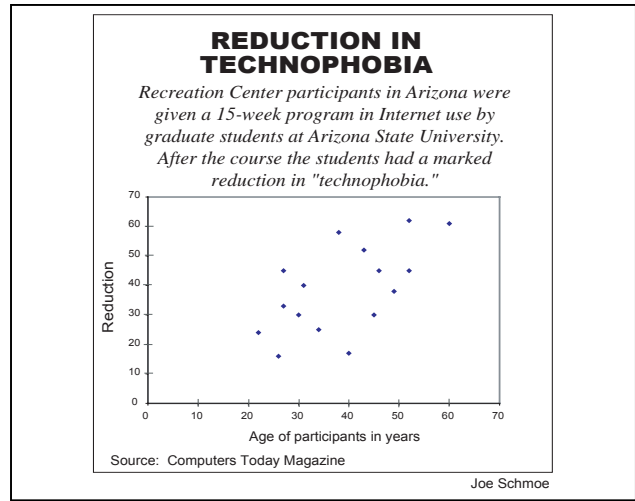


Figure 8. 'Good' Scatter Graph Example

lying to make your point!" Another statistical guideline is to collect data carefully and completely to avoid visual bias.

Divulge the source of the information, paying particular attention to using reliable sources. Remember that projections are only as reliable as the source. Point out estimates and projections to avoid misleading readers. Check to see if there is a margin for error, especially on polls.

Edit carefully all the numerals, spelling, and grammar. Check for the

accurate representation of story and that the details in graph match the details in story. Are the values of measure appropriate for the culture of the reader?

WHERE CAN DATA BE FOUND?

The most common location to find graphs is in print - technical publications, newspapers, and magazines. In recent years, graphs have made a home in cross-media, including the World Wide Web with Flash animations, and multimedia corporate presenta-

tions in Microsoft Powerpoint.

Designers who are specifically hired as graphic reporters or visual journalists spend more than 50 percent of their job on research in order to create infographics. So where do they find their data for graphs? They often collect handouts, maps, brochures, annual reports, and URLs from the Internet. One thing a graph designer does not want to do is duplicate exactly what has been done before. Put another twist on the data.

Here are some links that may be useful in collecting quantitative data for graphs and research:

<http://www.Altavista.digital.com>

<http://www.fedsworld.gov> (government agencies online)

<http://tiger.census.gov> (maps of the Census Bureau)

<http://www.bls.gov> (Bureau of Labor Statistics)

CONCLUSION

Although infographics have existed in one form or another for thousands of years, the types most often utilized by visual communicators of quantitative data are charts, graphs, diagrams, and maps.

Graphs used in technical papers perform the function of presenting numerical data in a visual mode. Graph etiquette involves the technical and visual guidelines for creating graphs. Content, typography, contrast, grammar, graphics presentation and ethical guidelines, if fol-

lowed, will help the graph design produce visually effective and non-biased graphs for use in publications.

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Dr. Sadowski has been an active member of the ASEE Engineering Design Graphics (EDG) Division and the Society for Technical Communication and has written and presented in the areas of creative thinking, design, layout, and publishing. She is currently the Technical Editor of the Engineering Design Graphics Journal.

Prior to coming to ASU, Dr. Sadowski was a Professor of Computer Graphics at Purdue University in West Lafayette, Indiana where she was presented the Charles B. Murphy Award for outstanding undergraduate teaching and placed on the Purdue University Book of Great Teachers. Her B.S. is from Bowling Green State University, M.A. from The Ohio State University, and Ph.D. from Purdue.

THE DEVELOPMENT AND EVALUATION OF WEB PAGE ELEMENTS FOR AN ACADEMIC PROGRAM

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INTRODUCTION

According to Murphy and Rowe (1988), identity systems have become much more than a mere distinguishing mark for products, they have become endorsements, indications of quality, value, reliability, and origin. They have become a form of shorthand that enables consumers to recognize products, services, and organizations.

The two basic components of an identity system are a name and a mark. An organization's name is its single most important identifier. It is familiarly linked with the organization's products and service, and as perceptions are built around it, it comes to embody many emotional aspects as well. An organization's mark may simply be a distinctive logo-

type, or it may combine a logotype with a symbol or other graphic device. If a mark is used, it must interpret the organization, its culture and its activities in an unusual way. The best marks defy logic and appeal to a wide audience.

It is also important that an organization's identity system be developed very carefully. It must avoid any negative overtones, meet the organization's strategic needs, reflect the organization's style and be unique. It should allow flexibility in application, be easy to use, and last ten to twenty-five years. Further, it should make the organization stand out in the various symbols and identities that flood the business and educational worlds today (Cropper & Haller, 1994).

The current identity system of the School of Technology was over ten years old and it was not a contemporary design. This alone was a valid reason for proposing a new identity system for use by the School for recognizability, marketing, and promotion. Coupled with this is the rapid development and use of the World Wide Web (WWW) by private business, government, and education. Each of these segments of society has used the WWW for marketing and promotion. Because many prospective students will use the WWW as a resource for gaining information about universities and individual schools or departments within them, the School of Technology at Purdue University should consider changing their identity system to a more contemporary look that could be used with traditional or digital materials.

STATEMENT OF THE PROBLEM

Will the development of a contemporary identity

system present a unifying and integrated look for the School of Technology at Purdue University?

SIGNIFICANCE OF THE PROBLEM

This project was essential because it developed a contemporary identity system with a unifying look for the School of Technology. It was important that the School of Technology capitalize on the opportunity to stand out among other universities and college's schools and departments as well as set the standard for Purdue University. Universities are now operating in a more fiercely demanding and competitive marketplace than ever before. The ability to communicate clearly to a diverse audience is essential to success. The development of an identity system allows the School of Technology to take a step forward in enabling students, parents, and professionals from industry to recognize and understand the School and its specific departments.

There was an awareness of an existing identity problem within the School of Technology. The goal was to translate the objectives of the School and each department into a series of distinctive, memorable marks. A series of marks were developed for the School of Technology and the eight departments within the school which included the following: Aviation Technology, Building Construction Management, Computer Technology, Electrical Engineering Technology, Industrial Technology, Mechanical Engineering Technology, Organizational Leadership and Supervision, and Technical Graphics. Although the development of the marks was an important they alone will not constitute an identity program. The marks created are not as important as their consistent application as a visual unifying factor. The extent of this identity system also included the development of home pages, section heads, and navigation bars

for the School of Technology and each department.

ASSUMPTIONS

The following assumptions were applied to this directed project:

1. The dean, department heads and anyone else thought to be appropriate were unbiased and gave an accurate, honest evaluation of the School and their respective departments.
2. The professional panel was unbiased and gave an accurate, honest evaluation of the identity system.
3. The professional panel was a representative sample of individuals from higher education and industry.

LIMITATIONS

The limitations for this directed project were as follows:

1. The number of professionals available for review purposes during the evaluation of the identity system.
2. The amount of cooperation and information the dean and department heads provided on the questionnaire.

3. The amount of cooperation and information the professional panel provided during the evaluation review.
5. The evaluation instrument accurately measured the professional panel's assessment toward the identity system.
6. The evaluation instrument accurately assessed the dean and department heads objectives for the School and each department.

DELIMITATIONS

The delimitations for the directed project were as follows:

1. The project was a proposed design of a Web based identity system for the School of Technology.
2. The applications within this identity system included symbols, home pages, navigation bars, and section heads for the School and each department.
3. The project did not include the implementation of the home pages on-line at the various WWW sites.

PROCEDURES

The development of an identity system for the School of Technology at Purdue University consisted of four phases: research and analysis, design development, design refinement, and design implementation. The research and analysis phase included gathering information to learn what the School of Technology is, what it does, and where it is going. This phase included a questionnaire and a visual audit of the School's existing graphic communications. The questionnaire allowed the dean, department heads, and anyone else thought to be appropriate to be involved in a meaningful way. Their attention was focused on meeting the School's or individual department's objectives and not on design considerations. During this phase, the scope of work, problems and criteria was determined.

The design development phase included the actual creative process of designing

the graphic image according to the previous research. The decision on the appropriate type of graphic image was explored in this phase. The following three types of symbols were considered for the graphic image for the School and each department: typographic symbol, the use of the School's and department's name or initials, distinctively rendered; abstract symbol, a nonfigurative design whose meaning is built up over time, through use and association with the School; descriptive symbol, the symbol has a visual association with the School and departments (Murphy and Rowe, 1988).

The design refinement and implementation phases refined and modified the identity system as agreed by appropriate committee members in the previous phase. The symbols, home pages, section heads, and navigation bars were reviewed by a panel of professionals. The panel of professionals consisted of individuals from higher

education and the business community who are familiar with identity design and/or development and implementation of WWW technology. The panel was selected from a group of peers that work within academia and industry. Additionally, each of these individuals were contacted and asked to recommend one additional participant based on a brief description of this project. From these sources a list was formed, and contact letters were sent to each individual participant explaining the project, required involvement, and time frame. An evaluation form was designed to assist the panel in evaluating the symbols, home pages, section heads, and navigation bars. To assist the panel in filling out the evaluation form they also received a brief description of the School of Technology and each department, a description of the concepts behind the development of each mark, and standard information concerning the home pages.

RESULTS

The results have been stated in relation to the four phases utilized in the procedures section. The research and analysis phase presented the findings and responses from the questionnaires completed by the dean and department heads. The design development phase consisted of the various developmental sketches for the series of marks. The design refinement phase presented the findings from the evaluations completed by the professional panel concerning the entire identity system. The design implementation phase incorporated any changes thought to be necessary from the findings of the evaluations from the professional panel. The final designs of the marks, home pages, navigation bars and section heads are documented in this phase.

Research and analysis phase

The research and analysis phase identified several rea-

sons for developing an identity for the School of Technology. The results from the visual audit of the School's existing graphic communications and the information received from the questionnaire clearly supported the need for a redesign. Although the existing print materials did have a unifying appearance, they still did not reflect the desired image that was established from the questionnaire. The School and departments each have an existing logo and home page. The Department of Technical Graphics and the Department of Organizational Leadership and Supervision are the only departments who did not have existing logos. The visual audit of the existing logos and home pages revealed an inconsistent and dated image for the School of Technology.

The dean and department heads all responded to the questionnaire. The questionnaire was divided into three sections: section one

asked questions concerning their existing logos, section two dealt with the image of the school and departments, and section three allowed for additional miscellaneous questions that were beneficial in developing a logo. The questionnaire consisted of both open and closed-ended questions. More than half (12 out of 20) of the questions were open-ended, and were selected because they are said to yield more specific and individualized responses and minimize the imposition of predetermined responses when gathering data (Gall, M., Borg, & Gall, J., 1996).

The questionnaire brought to light departmental strengths and misperceptions, distinctive characteristics, methods of communications, likes and dislikes of their current logos, and changes they foresee with the image of their department in the next five to ten years. It was evident by the responses from the dean and department heads that industry professionals and

prospective students were the two most important audiences for developing a strong image. There was an overwhelming response to see a new identity meet the strategic needs and reflect the school's and each department's style and unique strengths.

Design development phase

The design development phase consisted of developing a design concept that would be the most appropriate solution for the School and each department. It was important that the overall image of technology be able to promote itself as efficient, strong, dynamic, and innovative. The information obtained from the questionnaire helped narrow down the options of developing an image for the School. The findings from the questionnaire helped focus the attention on certain key design routes that were likely to be particularly appropriate and productive. Although several

developmental sketches were explored, design solutions were developed from clearly understood and agreed upon guidelines established from information obtained from the questionnaire.

In designing the series of marks for the School and each department, it was extremely important to develop an integrated appearance. The overall concept of each mark incorporated elements common in all areas of the School of Technology. The common elements utilized were a hand, an arrow, and a consistent background treatment. The hand implied the hands-on applications throughout all the departments in the School. The direction of the arrow captured a sense of motion and excitement that technology is constantly changing and moving. The consistent background treatment of simple, geometric shapes was used to balance the serious nature of the subject matter with a sense of something bold and full of

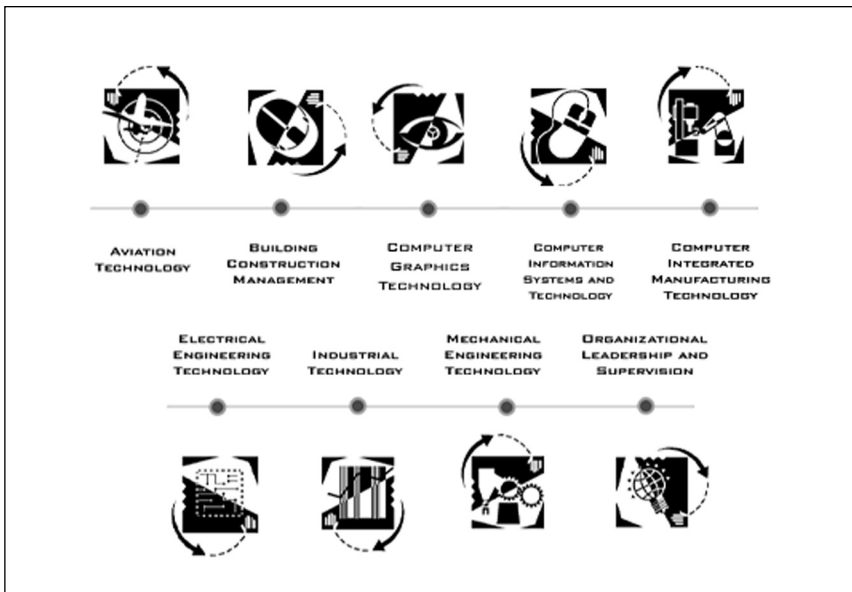


Figure 1. School of Technology Departmental Marks

energy. The mark for the School relied on the common elements along with a typographical treatment and other geometric shapes. The name of the School was incorporated into the mark because the abstract symbol alone will not have sufficient distinctiveness to stand on its own (Murphy and Rowe, 1988). In addition to the common elements, the series of departmental marks were developed along with a symbol that would clearly identify each individual department (See Figure 1).

School of Technology. The rapid transition from traditional to digital technologies is represented by the strong sense of motion, change, and morphing from the squares to the circles.

Aviation Technology. The overall image communicates an understanding of aviation as an integrated transportation system. The circular image and dashed line incorporated with the airplane simulate air-traffic control.

Building Construction Management. The recognizable image of a construction hard hat was used to represent and symbolize the many components that are involved in the planning and building process of construction management.

Computer Graphics. The eye symbolizes that all students need to be visually oriented in all areas of graphics and the cube represents the three-dimensional emphasis of the computer graphics program.

Computer Technology. The image of a computer mouse was selected as a common recognizable element to represent the department's focus in computer networking, applications of information technology, and information systems and telecommunications.

Electrical Engineering Technology. The elements of this mark depict a circuit board that represents the variety of electronic applications and the wide spread use of computers within the

field of electrical engineering technology.

Industrial Technology. The image of a bar code label is used to symbolize the widespread use of bar coding throughout the manufacturing process and the overlapping trend line signifies quality and productivity.

Mechanical Engineering Technology. The combination of gears and a robot is used to represent working with manufacturing and machinery. The emphasis of this mark is to imply a strong mechanically oriented background.

Organizational Leadership and Supervision. The image of the globe incorporated with the light bulb signifies that students apply their knowledge to comprehend the global influence of business and industry and develop ideas to make informed decisions.

Following the development of the marks for the School and each department, the home pages, navigation

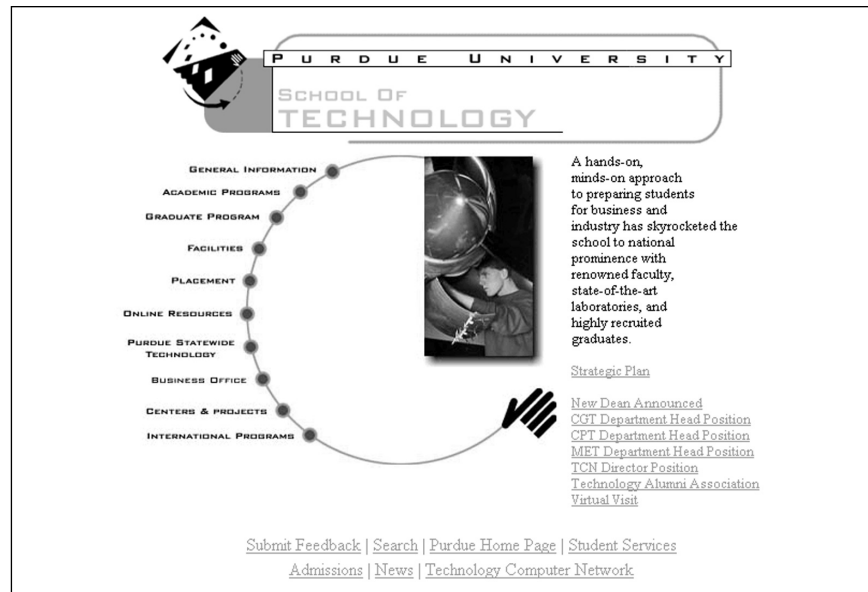


Figure 2. School of Technology Homepage

bars, and section heads were designed (See Figure 2). The marks were incorporated into the design along with information and standards provided by the School of Technology Network Policy Committee. The School of Technology home page and the home page for each department all follow a standardized format that will allow the user to easily travel through the web site. This will serve to provide a level of consistency between School of Technology departments.

Design refinement phase

The data gathered from the professional panel evaluation was positive. All 10 professionals from both academia and industry agreed to participate in this project. Nine of the 10 professionals responded to the evaluation (see Table 1). The evaluation was divided into three sections: section one evaluated the design of the marks, section two evaluated elements of the Web design, and section three allowed for overall comments or suggestions.

FIGURES AND TABLES USED IN THE PAPER					
Question	SA	A	U	D	SD
1. Suitability of the series of marks' content: Is the proposed series of marks compatible with the School of Technology's purpose and general nature?	67%	33%	0%	0%	0%
2. Suitability to the media to be used: Other than the obvious uses, such as print, does the series of marks lend itself to use in other media applications?	56%	44%	0%	0%	0%
3. Is the series of marks a creative one, clearly distinct from those used by other schools and departments in similar areas of technology?	67%	33%	0%	0%	0%
4. Does the series of marks show a sense of contemporaneity? Will it be likely that the marks will still appear attractive in five years' time?	56%	33%	11%	0%	0%
5. Does the series of marks impart a strong, lasting impression? Is one look enough for it to be recognized and remembered?	22%	56%	22%	0%	0%
6. Does the series of marks suggest that the School of Technology bears a sense of responsibility, experience, and confidence to society and will it create a favorable impression on the target audience?	45%	22%	33%	0%	0%
7. Is the selection of typography appropriate for the School of Technology and does it visually complement the series of marks?	44%	56%	0%	0%	0%
8. Does the series of marks show a sensitivity to the aesthetic elements of design?	89%	11%	0%	0%	0%
9. Suitability of the home pages, section headings, and navigation bars content: Is the proposed home pages, section headings, and navigation bars compatible with the School of Technology's purpose and general nature?	89%	11%	0%	0%	0%
10. Is the selection of typography appropriate for the School of Technology and does it visually complement the home pages, section headings, and navigation bars?	56%	44%	0%	0%	0%

Table 1. Professional Panel Evaluation of the Proposed Web Page Elements
(Continued on next page)

Design implementation phase

Final refinements to the marks, home pages, navigation bars, and section heads were made based upon the professional panel review. The series of marks for the departments were designed to be flexible enough to be used as a stand alone mark, a mark with the complete name of the department spelled out, and also a mark with the acronym that represents each department under the Purdue University identification system. After the marks were incorporated into the home pages, section heads, and navigation bars the following basic guidelines were developed for the School of Technology's web site

1. The colors to be used will be black, gold, and cool gray to remain consistent with Purdue University's home page colors.
2. The image area on the home pages will remain flexible to accommodate one featured image or several smaller images.

3. An area for a caption will highlight the images or allow the viewer to be notified of something new within the site.
4. Both the image and caption areas will be a flexible way to allow for change to keep the sites up-to-date about what is happening within the School of Technology and each department.
5. A common header will be used on all School of Technology and department pages.
6. The specific buttons on the home pages will be included in a navigation bar along with the copyright information at the end of all pages.
7. The School and department marks located on the section headers of all pages will be linked to the home pages in addition to the home page text link below each navigation bar.
8. Other standard elements include a common counter and guestbook of feedback area for School of Technology and departmental home pages.

11. Do the home pages, section headings, and navigation bars ensure text readability and visual clarity?	56%	22%	22%	0%	0%
12. Do the home pages, section headings, and navigation bars show a sensitivity to the aesthetic elements of design?	89%	11%	0%	0%	0%
13. Does the use of color and contrast create visually appealing home pages, section headings, and navigation bars?	44%	56%	0%	0%	0%
14. Do the page elements, such as font size, colors, and other visual cues, serve as a consistent identifying and navigational cues to potential viewers? Are there commonalities between the home pages, section headings, and navigation bars?	78%	22%	0%	0%	0%
15. Do the home pages, section headings, and navigation bars impart a strong, lasting impression as well as motivate viewers to respond, revisit, and explore the site?	44%	44%	12%	0%	0%
16. When incorporated with the home pages, section headings, and navigation bars will the series of marks allow for flexibility in application?	56%	44%	0%	0%	0%

Table 1. Professional Panel Evaluation of the Proposed Web Page Elements
(Continued from previous page)

CONCLUSIONS

The author's conclusions are based on the responses from the questionnaire and data from the professional panel evaluation. According to the questionnaire, the dean and department heads all responded favorably to developing an identity for the School. The data from the professional panel evalu-

ation did determine that someone who has no history with the applications of the new identity system and its development would be able to interpret and understand the solutions. Based on the results of this project, the following conclusions have been divided into two groups (a) identity factors and (b) web page elements.

Identity factors

1. The School of Technology does not currently have a unified identity. This was apparent in the School and departments existing logos and home pages.
2. Prospective students and industry professionals are the most important audiences for developing a strong image for the School of Technology.
3. Overall, the dean and department heads expressed more dislikes than likes about their current logos.
4. Currently there are several misperceptions about the school and departments by potential students and other individuals.
5. It was important to allow the departments the option of using the mark alone or the mark combined with a typographic treatment of the department name or initials. The solution of a typographical treatment of the department initials combined with the mark seemed to be of greatest concern to most department heads.
6. The proposed series of marks' content is compatible with the School of Technology's purpose and general nature.
7. The proposed series of marks have been designed to be used in all type of media applications.
8. The selection of typography is appropriate for the School of Technology and visually complements the proposed series of marks.
9. The proposed series of marks do show sensitivity to the aesthetic elements of design.

Web page elements

1. The selection of one visually appealing image may be stronger than several smaller images on the home page. The selection of a unique image for the School and each department's home page will allow for an individual emphasis for each area while keeping the other elements consistent. The image area will also allow for change so that visitors will feel that the site will hold something new

for them each time they visit, giving them a reason to return to the site again and again. The site's graphic identity will remain constant while the image area content changes (DiNucci, Giudice, & Stiles, 1997).

2. The interface of the home page needs to communicate a definite message for any specific user to generate a particular response. Most viewers want to go in, get the message, and move on. Web site designers run the risk of allowing high technology to get in the way of communication by overwhelming the viewer's senses with an intimidating amount of heavy content and complex operation procedures. Viewers should want to revisit the site because they feel emotionally drawn to return. Good interface design done well motivates viewers to respond, revisit, and get involved in the site; poor interface design deadens viewer interest permanently (Donnelly, 1996).
3. Although color coding helps orient users through-

out a site, it was not used as an element in the design of the School of Technology's home pages. When designing a color-coded system, it is important to keep the number of colors down to a manageable number (around six) which is based on colors that are easily distinguishable from one another. Using a color coding system would have required nine colors for the School of Technology's web site. This would have been an over-use of color in a Web site and would have ended up looking like a rainbow, in which case color loses all its meaning and becomes an eyesore (Waters, 1994).

4. The School of Technology should use black, gold, and cool gray as the predominant colors on their web site to remain consistent with Purdue University's web site colors.
5. The selection of typography is appropriate for the School of Technology and visually complements the home pages, section heads, and navigation bars.
6. The design and layout of the home pages, section heads, and navigation bars ensure text readability, visual clarity, and is appropriate to the School's overall message. The font sizes, color, and other visual cues serve as a consistent identifying and navigational cues to potential viewers.

RECOMMENDATIONS

The major purpose of this project was to develop and evaluate a proposed Web based identity system for the School of Technology at Purdue University. It is recommended that the marks and home pages be presented to the department heads for any necessary changes and approval. The changes should not alter the overall concept that unifies the consistent image for the School of Technology. The modifications to the marks should only apply to the individual symbols that were developed to clearly identify each department. The changes to the home pages will only include the selection of a visually stimulating image or images that would best portray each specific department. Following approvals and

changes, it is recommended that the School of Technology and each department implement the new marks, home pages, section heads, and navigation bars.

It should be recognized that this project is only the beginning of an identity system for the School. This author is concerned about how the marks that have been created will be used by others, because marks ultimately end up being used by someone other than the original designer. It is this author's recommendation that an identity manual be developed and maintained to ensure consistency and proper use of guidelines.

However, even if the rules are not spelled out, the original and subsequent applications of the marks form a precedent and imply a set of rules for using them. To this author, the value of consistently applied identity standards and guidelines seems self-evident. Consistency makes communications clear and reduces confusion.

Consistency ensures recognition. Consistency builds loyalty and brand equity (Dubberly, 1995). Based on the results of this project, the following additional recommendations are made:

1. It is recommended that the School of Technology Network Policy Committee limit the number of choices on the home pages to no more than 10. People get lost or will lose interest if they have to click too many times to get to a piece of information; too many choices at any given point can be confusing; viewers want to know where they are in the site at all times. The solution is a flat structure where any area of content can be accessed in three mouse clicks (Coyne, 1996).
2. The School and department marks located in the section heads of each page should be a direct link to the home pages.
3. The School and departments should follow the basic guidelines and standards for the home pages, navigation bars and section heads as explained in the results section of this article.
4. The arrow and the hand of the marks on the home pages and section heads could be animated to spin when clicked on or be set to continuously rotate.
5. Future studies would benefit from following up with an interview with the dean and department heads to increase the overall quality of the responses from the questionnaire.
6. Based on the review of the existing images in the School's print materials, it is recommended that the images for the Web be more visually appealing, innovative, and captivating.
7. It is recommended that the marks for the School and departments be used exclusively as icons on the web if the proposed identity system is not implemented.
8. Finally, if the new identity system is implemented, it must be devised for every piece of the School's communication. This can happen in one grand sweep, with all pieces being

replaced at once, or through attrition, as supplies of pieces bearing the old identity are depleted, new ones, bearing the new identity, can be brought in. The School cannot afford to discard vast amounts of costly printed materials, so it is recommended that high-profile materials such as stationery, signs and advertising be updated immediately and other pieced phased in as needed.

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- the faculty at Purdue, she worked as a professional graphic designer for eight years. While at Purdue she won several local and national awards including a bronze medal for Designer of the Year by the National Council for the Advancement and Support of Education (CASE). Her work has also been featured in Fresh Ideas in Brochure Design and Fresh Ideas in Letterhead Design published by North Light Books.*

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AN ALTERNATIVE WAY OF GAINING UNDERPINNING KNOWLEDGE FOR THE PRINT INDUSTRY

JOHN PROCTER
BUSINESS DEVELOPMENT PRINT
LEEDS COLLEGE OF TECHNOLOGY

WHY WAS PRINT MEDIA ONLINE DEVELOPED?

The Print Media Online training program was developed in direct response to the needs of the printing and packaging industry - with particular reference to the Yorkshire region in the United Kingdom. Leeds College of Technology's Print Media Skills Centre always endeavors to support competitiveness and profitability within the print and packaging sector, namely by improving access to quality training and expertise.

Skills gaps need to be addressed by providing employees and individuals alike with formal training and recognized qualifications. Many companies, however, find it a struggle to free up the time and money

needed to send employees out of work and on skills development and retraining courses - often for days at a time - when facing busy workloads and endless deadlines. To amplify this problem, the closure of many print colleges in the UK means that companies are now forced to send their employees even further afield to receive training. As a result, training is often neglected - at a great cost to the employees, business and industry at large.

The main obstacle appeared to be freeing up the time to send employees to college - and the inflexibility of the timetabling on existing in-college courses, the college saw a great advantage in putting training online. Allowing students to learn online negates the need for

employees to leave their company to study for the theoretical aspect of their course. Online training also affords a greater degree of flexibility and accessibility, as it brings the training to the learner.

LEEDS COLLEGE OF TECHNOLOGY'S RESPONSE

The college responded to the industry's problem by initiating the development of a totally flexible, innovative ILT based learning solution. The training program in question would deliver the knowledge and theory needed to pass the City & Guilds 5260 qualification via the web (a qualification only previously delivered in a classroom situation).

The program would target adult learners of all ages from within (or wishing to enter) the printing and packaging industry. It would be offered on a 'when you need it' basis, meaning that learning can begin at any point within the year and is not limited to one or two rigid

enrollment dates. This 'roll-on, roll-off' approach to delivery means that there aren't any strict deadlines that students have to meet, and employees never have to wait before they can commence learning.

The design of the learning program was split into three distinct (but by no means segregated) categories: the learning content, interaction with peers and tutor support/communication.

It was determined that the course would be delivered using the college's existing Virtual Learning Environment, WebCT.

Subject specialists from within the college's Print Media Skills Centre were responsible for writing learning material. They held regular meetings with the multimedia team to determine the illustrations, photographs and diagrams needed to enhance the text.

The content was designed and written to exist as many

small, individual 'sections', such as 'Colour Theory' or 'Machine Tools'. The sections work as stand-alone nuggets of learning, and can be combined with other sections to make up each unit of the course.

At the end of each section, the student completes an online quiz to test their understanding of the learning. The results of the quiz can be 'auto-marked' and the grade presented onscreen as soon as it is submitted; alternatively, the course can be marked by the tutor and the results fed back to the student by e-mail or telephone.

Each section has an associated glossary of terms to explain difficult jargon and unfamiliar terminology. Although most of the learning takes place on line, the students are given the option of printing out a brief summary of the topic they are working on, in the form of revision notes. They are encouraged to review these notes when away from (or unable to access) the PC.

The main concern at Leeds college of Technology was to avoid falling into the trap of developing a passive, isolated learning experience. The development team was aware that online learning (when not planned correctly) can be a solitary, isolating and somewhat 'stale' experience. For this reason, measures were taken to encourage group cohesion and to engender a sense of community between learners.

To stimulate active learning, innovative 'group bonding' devices were used, these being the use of synchronous and asynchronous communication tools as an integral part of the course.

The bulletin board and email are examples of asynchronous communication tools. The bulletin board enables students to post and review (permanent) messages to coursemates, start discussions, ask questions, or answer the questions of others, engage in existing discussions, and receive instructions and updates from the

tutor. In the course, the communication tools have been used socially (which is encouraged) and to discuss learning and problems that individuals are having with the course.

The support and encouragement of the tutor as the force that drives the learning is perhaps the most important feature of the course. E-learning puts a greater emphasis upon the learner. However, the tutor's role as facilitator, learning coach and counselor provides the essential 'human' element needed to turn learning material into a successful, fully supported e-learning venture. Wherever possible, the tutor provides an in-college induction session to welcome everybody to the course, familiarize students with WebCT and to draw a picture of what will be learned and what the students can expect from the course and the course tutor.

Videoconferencing support is also available, should the learner have such facilities within their place of work.

MEASURING THE OBJECTIVES—REAPING THE BENEFITS OF INNOVATION

Providing a quality program to support the city & guilds 5260

Our main objective was to develop a quality e-learning product to support the City & Guilds 5260 qualification. The learning materials developed fought off stiff competition from other colleges and institutions to win 'Best Post-16 Teaching Resource' award at the Becta ¹/Guardian Web Awards 2001. One judge commented, "This site demonstrates a real attempt to meet the needs of the students through the web medium, and is a good example of targeted writing for the Web". Another

judge commented that, "The level and detail of the coverage superbly meet the requirements of print and packaging students at the college. The simple navigation, clean pages and level of language geared to the audience all serve to enhance the site."

In addition, the success of the online training program has in part contributed to the college being awarded Centre of Vocational Excellence status for printing and packaging. Leeds College of Technology's Print Media Skills Centre has been awarded specialist status by the Government. It will act as the only 'Centre of Vocational Excellence' in the field of printing for the UK. Education and Skills Secretary Estelle Morris announced sixteen such colleges of Vocational Excellence in a drive to provide employers with the industry skills they need.

¹ British Educational and Communications Technology Agency

Increasing the number of trainees studying online

Initially developed to support the Yorkshire and Humber region, the course has been so successful that it has attracted clients and trainees from all across the UK, and has even generated interest internationally. Most companies who have reviewed the course to date have subsequently enrolled their employees for training. At present, the college has 209 students utilizing the Print Media Online e-learning facilities, and is helping companies such as R.R. Donnelly, TetraPak, Pindar, Newsquest York & County Press, Smurfit UK, Acorn Web, Alcan Lawson Mardon, Newsquest Sussex and The Mirror Group to fulfil their training requirements online.

Feedback has been extremely positive from both employers and employees alike. The majority of the companies that we have spoken with have commented that flexible, distance learn-

ing is a perfect solution to their training needs. Without doubt, Print Media Online has struck a chord and created quite a stir within the industry.

The college believes that flexibility is the key - both in delivery and development. We understand that different employers have different needs, and we are doing our utmost to work with employers to provide a solution that best fits their needs. Proven success and experience has led to collaboration between the college and employers, resulting in customized courses and learning materials specific to individual companies.

The way in which the learning material has been designed in the sections means that employers seeking unaccredited short courses can be catered to with minimum fuss. The sections can be regarded as building blocks, and employers are free to pick and choose the blocks of knowledge

required to create their perfect course.

Tutors have found that flexible delivery has led to students completing the course quicker than they would have had they been studying in college. Online learners aren't held back by time restraints and the speed at which training is delivered. They can therefore complete the course as quickly or as slowly as is needed/desired. Prior to the onset of study, a learner agreement is made between tutor and student to determine the length of time in which the student wishes to complete the program. By doing this, the tutor can monitor whether or not the student is on track to complete the course by the agreed completion date. Of course, all deadlines are flexible, to accommodate for any problems that may arise which delay completion on time. However, they should be thought of as target dates.

CONCLUSION

The college deems the Print Media Online project to have been a worthwhile venture. It has been more successful than ever anticipated. The rapidly growing number of participants has necessitated the addition of another online tutor.

Innovative delivery has opened doorways for those to whom they were previously closed. Thus access to education and training has been brought to the people who need it most in a manner befitting their needs and priorities.

John has worked within the Print Industry for over 40 years and in fact followed in his father's footsteps. He served a six year apprenticeship in Lithographic Printing while attending Leeds College of Technology

ABOUT THE AUTHOR

John Procter is the Business Development Executive for the Print Media Skills Centre at the Leeds College of Technology, which has been recognized as a Centre of Vocational Excellence for Print. This post involves visiting companies throughout the UK and developing online and conventional courses as needed. He was responsible for developing the award winning Print Media Online approach to industry-based training.

DETERMINING ACCURATE COSTS FOR PRINTING EQUIPMENT—AN APPLICATION FOR ACTIVITY BASED COSTING

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How much does it cost each year to own a car? This might seem like an odd question to ask at the beginning of a paper when addressing the true operating cost in a printing company, but it is easier for the non-accountant to relate to. Let's go through the process of determining the costs of the car the same way you would determine the hourly cost of running a press. For

the sake of this example, we will establish that the car was purchased new and is presently in the third year of payments on a 5-year bank loan. There are fixed costs; the costs that will be paid whether or not you even take the car out of the garage. There are variable costs; the costs that are dependent on how often and how many miles you drive. When dealing with

insurance there may be further issues depending on whether you drive your car to work (and just exactly how far your drive is to work), just for leisure, if it is the family vehicle; whether or not you have any accidents or tickets on your current record; whether you have teenage drivers in your family, etc. There are even administrative costs associated with paying the monthly bills, tax bill, and the yearly safety inspection. Below (Table 1) is a typical breakdown associated with a typical cost of owning a car for a year based on driving approximately 15,000

Fixed Costs:		Administrative Costs:	
Monthly Loan Payment (\$429.52 x 12 months)	\$5,154.24	Paying monthly bill, (5 min. x 12 months x \$12.50/hr.)	\$12.50
Yearly Insurance Premiums (\$380.00/six months)	\$760.00	Dropping car off for service (3 x 30 min. x \$12.50/hr.)	\$18.75
Property Tax (City, County and State Tax)	\$409.00	Waiting for instant oil change (5 x 30 min. x \$12.50/hr.)	\$31.25
		Taking car in for yearly state inspection (time and fee)	\$20.00
		Tags and registration	\$35.00
Variable Costs:			
Gasoline (15,000 miles/20mpg*\$1.60 a gallon of gas)	\$1,200.00		
Oil Change every 3,000 miles (5 at \$29.99)	\$149.95		
One tune-up per 15,000 miles	\$129.00		
Car Washes (25 at \$4.00)	\$100.00		
Parking/Speeding Tickets (1 speeding/2 parking)	\$175.00		
Yearly tire approx. (\$400/3—replaced every 3 years)	\$133.34		
Yearly brake approx. (\$200/3—replaced every 3 years)	\$66.67		
Tolls	\$70.00		
Parking permit (yearly permit for work and special events)	\$150.00		
Unplanned repair (water/fuel pump, etc.—2 events/year) ...	\$300.00		
		Total	\$8,914.70
		Daily cost of running the Car (divide by 365)	\$24.43/day
		**Labor (lost time that could have been used to earn income)	
		Based on an average of 1 minute of travel time for every mile	
		driven. (15,000/60 x \$12.50 hr.)	\$3125.00
		All Inclusive Total	\$12,039.70
		Daily cost of running the Car (divide by 365)	\$32.99/day

Table 1. Costs associated with owning a car

miles a year. Obviously this is an estimation based on average use, pollen count in the spring (a direct impact on how many times the car needs to be washed and the air filter needs to be changed), average gasoline prices, etc.

Depending upon your age (effects hourly wage and buying power for the car), geographical location (effects weather, taxes, gas prices, etc.), the numbers may be higher or lower. This is the type of analysis that the estimating/accounting department must go through to identify the costs associated with running a press. NAPL suggests that the cost analysis be reviewed at least once a year and more often if possible. When a printer looks at the costs of running a piece of equipment, there is a more defined list of variables than in our car sample. That list would include:

Fixed Costs:

- Depreciation
- Insurance
- Property Tax
- Utilities/Overhead

Variable Costs:

- Direct Labor
- Indirect Labor (supervision/misc.)
- Employee Benefits
- Payroll Taxes
- Workmen's Compensation
- Power Cost
- Direct Supplies
- Repairs to Equipment
- General Factory Expenses
- Administrative and Selling Overhead

In a large company, it is the responsibility of the accounting and estimating departments to spend hours gathering data and calculating the hourly cost of running the equipment. In a smaller printing company the estimator or planner may instead work off standards available through trade associations or commercial estimating companies. The textbook process of establishing prices for printing determines all of the costs associated with a printed piece and then applies a markup. The goal is then to hit the projected cost and time for each piece of equipment required in the production of the piece. If a certain prepress job takes twice as long as the estimator/planner projected, the company will not make a profit unless it is made up in the press or post-press portion of the job. If the projected time was missed in all three areas the company surely lost money on the job. Identifying all of the components of a budgeted hourly

rate and realistic production standards is beyond the scope of this article, but there is a practical cost factor that can be identified by the operator or department supervisor. What is the best deal on the tires? Translated to a press, the question might be what is the best deal on the rollers, blankets, presswash, etc.

Go back to the earlier analogy of identifying the cost of owning a car. In the list there was money set aside for tires each year knowing that somewhere between 40 and 50 thousand miles there will need to be new tires put on the car. The estimated price is \$400. Perhaps that was the last price paid for tires or just a projection of what one might find them on sale in the Sunday paper. When it is actually time to buy the tires it typically is not as simple as that. What tires are on sale? There may be 20 or 30 options from the 5 to 6 companies in your town. The price might range from

\$79.00 per tire to \$129.00 per tire; furthermore, there are tires rated for 40,000, 50,000, 60,000, and even 80,000 miles. Some perform better in rain; some are better suited for highway driving, and some for off road driving. You can get hazard warranties to insure the life of your tire and add free balancing as well to the overall cost. How do you decide which is the best choice? The numbers on the form outlined earlier do not give you a clear choice. You could go with the least expensive tire and be under budget, but those tires probably will not last three years, realistically you will end up over budget by having to buy an additional set of tires within the next three year period. It is also possible that if you go over budget with the current purchase you might actually stay under budget in the long run. For example, if you purchase a more expensive tire that is rated for greater mileage and will last 4 years or 5 years, you have actually

saved money. It is not as simple as looking at the budget line and finding the amount that fits, it is about making the most practical choice that in the long run or the big picture makes the most economic sense. Still other issues effect the final decision, such as how long you want to keep the car or safety issues associated with the driving environment. You might be asking again how does this relate to printing? Well, consider a press. Doesn't this same situation hold true for the way one would consider ordering blankets, rollers, press solvent, etc.? The accountants may have planned out the cost, but it is typically the operator that determines the best choice. The operator needs to determine the most practical costs overall. There is a very straight forward costing method that can be applied by the operator to help make sound decisions. It is called Activity Based Costing (ABC) and once again you do not have to be

an accountant to use it or understand it.

The complexity of determining all of the operating costs can be overwhelming, but when you take one small piece and compare two or more options and find a common denominator, you can easily make the right decision. Using rollers, blankets and press wash as examples you may find that the cheapest option is not always the most economical option. The first step in the ABC method is to determine what are all the cost factors of the specific activity that you are reviewing. Often times many of the costs associated with a given situation are separated out into maintenance and consumables. To properly understand the true expenses of a given activity, you need to bring together a complete listing of the costs associated with it, not just its replacement, but the costs associated with the daily use during the entire life of the activity. Additionally, there are also safety and environ-

mental concerns that may need to be addressed when considering specific alternatives. Starting with rollers- you need to generate a list of activities that have costs associated with them. There is a wide variation in the industry on how often rollers are stripped and when roller pressures are reset, removed and cleaned, replaced and reset, conditioned, etc. During the process of interviewing companies on their roller usage and yearly costs, few printers actually knew the unit cost of maintaining their rollers. One company interviewed did a study of different types of rollers on different presses and kept track of how long it took before the rollers needed to be replaced. This was a large printer with multiple facilities and a large number of presses to set up with different options. Ideally, this was a valid concept, but they neglected to keep track of the auxiliary costs that are typically dumped into routine maintenance or down time.

In an activity based study these costs are considered a roller activity, not a maintenance cost. Below is a listing of the different activities that need to be considered when looking at the total cost over the life of a roller.

Costs associated with replacing and maintaining rollers in an offset press:

- Cost of recovering a roller
- Downtime for removing and installing recovered rollers (based on hourly rate of each press)
- Monthly maintenance (cleaning, conditioning, and stripping/adjusting rollers)
- Bimonthly removal and hand cleaning of rollers (downtime and cleaning supplies)

When printers were surveyed as to their roller costs, they knew how much the last set of rollers cost to recover and had kept track of how often they needed to be replaced. They could not make an easy comparison from a 74 cm (approx. 29") press to a 102 cm (approx.

40") press. They also typically looked at the press as a whole rather than finding a common denominator. The replacement intervals for rollers were anywhere from 6 months to 18 months. The press operator's reason for replacement was typically poor print quality. In all cases surveyed, this was a subjective observation by the press operator. There was no standard test to check the hardness scale on the roller (durometer level) or strip setting concerns. One company made a practice of replacing the rollers every six months automatically. Other companies were unfamiliar with conditioning and cleaning a roller with a cleaner to remove gum, calcium and paper dust build-up in the rollers. There are several products on the market that can be placed on the rollers overnight or over the weekend to help breakup these contaminants that can not be washed away with solvent; additionally, only a few companies were actually wash-

ing the rollers with press wash and then water or a mixture of water-miscible presswash and water. This type of daily care of the rollers will greatly extend their life. In determining the actual cost of a roller there needs a common time frame and a common increment for comparison.

Table 2 is a table that can be used in any print shop to find the average monthly/yearly cost of a roller. One critical factor taken into account in the table on the next page is the fact that different roller compounds will hold up longer in the press. A more complex rubber compound will extend the life of a roller and can reduce the shrinkage rate (reducing the need for resetting roller pressures) reducing cost over the life of the roller. It is difficult to compare the roller costs of a 2/C 25" press and a 6/C 40" press. It is like comparing apples to oranges. They are both fruit, but they cannot be added up. The

spread sheet illustrated on the next page breaks down the known roller costs for a given press into the cost of 1" of roller for a month and a year and then that number is mathematically interpolated to project the cost if all the presses were 40" wide. These columns can now be compared on a fair and equal basis. The first diagram shows 8 companies (each line represents the total numbers of rollers used on all presses in their plant). You will notice that the cost per inch or comparable 40" conversion is all over the place, with a low of \$405.84 and a high of \$3,016.68. Why is there such a big difference? The quality of the original roller, weekly care and maintenance of the rollers, operator differences, the age of the press, clean-up solvents used, etc. You can buy the best roller, treat it poorly and it will not last. You can buy an inexpensive roller and treat it properly and it may last longer than projected. Every roller has a

Determining Company Wide Monthly/Yearly Roller Costs
(all press widths mathematically converted to 1" and 40" widths for comparison)

A	B	C	D	E	F	G	H	I	J	K	L	M
Comp.	Combined Presses for each Company	Options being compare	Total Roller Cost for each group of Presses	Months covered by purchase	# of Press Units total	Avg. # of inches per unit	Average Cost per unit per month	Conversion cost to 1" of Roller per month	Conversion cost to 1" of Roller per year	Interpolated cost per unit per month as a 40" press	Interpolated cost per unit per year as a 40" press	Validation Check (the fee pennies is due to rounding)
1	Web Presses	1	\$9,275.00	18	16	38	\$32.20	\$0.85	\$10.17	\$33.90	\$406.80	\$9,275.00
2	Web Presses	2	\$140,000.00	12	74	38.8	\$157.66	\$4.06	\$48.76	\$162.53	\$1,950.40	\$140,000.00
3	Web Presses	3	\$21,116.75	14	12	20	\$125.69	\$6.28	\$75.42	\$251.39	\$3,016.68	\$21,116.75
4	Sheetfed Presses	4	\$31,402.12	18	11	38	\$158.60	\$4.17	\$50.08	\$166.94	\$2,003.33	\$31,402.12
5	Sheetfed Presses	5	\$89,397.83	36	19	40.8	\$130.70	\$3.20	\$38.44	\$128.14	\$1,537.63	\$89,397.83
6	Sheetfed Presses	6	\$31,736.80	24	39	37	\$33.91	\$0.92	\$11.00	\$36.66	\$439.87	\$31,736.80
7	Sheetfed Presses	7	\$15,608.79	24	20	38.46	\$32.52	\$0.85	\$10.15	\$33.82	\$405.84	\$15,608.79
8	Sheetfed Presses	8	\$9,998.70	27	7	40	\$52.90	\$1.32	\$15.87	\$52.90	\$634.84	\$9,998.70
	All Presses Averaged	8	\$348,535.99	21.63	198	36.38	\$81.40	\$2.24	\$26.85	\$89.49	\$1,073.93	\$348,535.99

Column Identification and Calculation (items in italics must be entered by the company; the remaining columns are automatically calculated within the spread sheet)

A=The number assigned to the company (or specific a press as shown on the next page).

B=Identification of what type of presses (press on the next page) were used in the company.

C=This number is used to in the formulas in certain cells to determine the average for the number of press comparisons.

D=Total cost of the rollers for the time in months in column D, including journals, housing, shaft repairs, new cores, and bearings.

E=Total number of months associated with the purchase period for roller costs.

F=Total number of units on all press (on a single press on the table on the next page).

G=Average number of inches for all roller in the plant (on a single press the table on the next page). An example would be if a company had two 6/C-40" presses and one 5/C-29" press, the numbers would calculate as: [(12 units X 40") + (5 units X 29")] ÷ 17 units = 36.76" average roller length.

H=Average cost per unit, per month is calculated by dividing column D by column F. This is not a fair comparison because it does not take into account the length of the roller in each unit.

I=The average cost of 1" of roller per month = [(Column D ÷ Column E) ÷ Column F] ÷ Column G. This takes into consideration the length of the roller and is now a fair comparison.

J=Column I X 12 months. This gives you a yearly figure; the calculation has brought all the comparison to a common length of time and to a standard measurement unit of 1".

K=Column I X 40". This gives the interpolated cost of a single printing unit of a 40" press for one month as a comparison standard.

L=Column K X 12 months. This gives the interpolated cost of a single printing unit of a 40" press for one year as a comparison standard. By multiplying the least common denominator or the 1" roller cost by 40" it allows you to compare all presses at a common standard.

M=The validation check is: [Column L (Column E ÷ 12)] (Column G ÷ 40") Column F = Column D (with a slight deviation for round off error).

Table 2. Company-wide roller costs

life cycle. These charts are simply a way to identify where you stand as a company and how each press in your plant stacks up against the others. If one press has much lower roller costs, find out why. Is it the press, the operator, the rollers, the fountain solution, etc.? You may be able to take the knowledge from one press and transfer it to another.

Tables 3 and 4 are two different printouts of spread sheets created in Microsoft Excel. The first is a group of companies that volunteered their roller costs for their entire plant. They have all their presses compressed onto one line. The second table is a sample of one printing company that runs several different presses. The Excel file is available on the web at <http://graphics.clemson.edu/ABC>. You can download these two sample files, as well as an Excel blanket file where you only need to enter 6 pieces of information to conduct your own cost analysis. All you have to add is the name of the press, the cost of the set of rollers for the press, the number of months a set number of rollers has lasted on that press and the number of units in the press with the actual width of the rollers.

These tables have a tremendous amount of information on them, but they are only relevant as examples for your company. One roller manufacturer states that the per year/per month cost when interpolated to a 40" press should be at or below \$800.00 per unit per

Determining Individual Press Monthly/Yearly Roller Costs (all press widths mathematically converted to 1" and 40" widths for comparison)												
A	B	C	D	E	F	G	H	I	J	K	L	M
Press	Combined Presses for each Company	Options Being Compared	Total Roller Cost for each group of Presses	Months covered by purchase	# of Press Units total	Ave. # of inches per unit	Average Cost per unit per month	Conversion cost to 1" of Roller per month	Conversion cost to 1" of Roller per year	Interpolated cost per unit per month as a 40" press	Interpolated cost per unit per year as a 40" press	Validation Check
1	2/C 29 Heidelberg	1	\$3,456.83	12	2	29	\$144.03	\$4.97	\$59.60	\$198.67	\$2,384.02	\$3,456.83
2	6/C 40 Heidelberg	2	\$8,988.60	18	6	40	\$83.23	\$2.08	\$24.97	\$83.23	\$998.73	\$8,988.60
3	5/C 40 Heidelberg	3	\$7,585.68	24	5	40	\$63.21	\$1.58	\$18.96	\$63.21	\$758.57	\$7,585.68
4	5/C 25 Heidelberg	4	\$6,188.90	20	5	25	\$61.89	\$2.48	\$29.71	\$99.02	\$1,188.27	\$6,188.90
Total	All Presses & Rollers	4	\$26,220.01	18.50	4.50	33.50	\$78.74	\$2.35	\$28.20	\$94.02	\$1,128.20	\$26,220.01

A	B	C	D	E	F	G	H	I	J	K	L	M
Press #	Individual Press Name and Size	Sample #	Total roller cost	Months covered by purchase	Number of Press units	Actual width of roller (in inches)	Cost per unit per month	Conversion cost to 1" of roller per month	1" of roller width per year	Interpolated cost per unit per month for a 40" press	Interpolated cost per unit per year for a 40" press	Validation Formula
1												
2												
3												
4												
5												
6												
7												
8												
9												
10												
11												
12	Total Lines	All Presses and rollers	\$0.00	#00/01	#00/01	#00/01	#00/01	#00/01	#00/01	#00/01	#00/01	#00/01

Available as a FREE downloadable Microsoft Excel File from <http://graphics.clemson.edu/ABC>

Table 3. Individual press roller costs

year/\$66.66 per unit per month. They have seen printer achieve an average \$600.00 per year, which would be a practical goal to shoot for in any plant. Looking at the least common denominator of 1" of roller cost per year/per month, the recommendation would be \$20.00 per year or \$1.67 per month for each inch of roller length. These are reference points. The most valuable activity you could get involved in is to find out why your presses are different. Is it the roller, press, operator, cleaning solvents, maintenance schedule, etc.? Why do some rollers last longer on the press, thereby making a major shift in cost? Once again is it the roller, press, etc. If you choose to download the Microsoft spreadsheet from <http://graphics.clemson.edu/ABC> (at no cost) you can find an easy format to start making better comparisons for yourself.

WHAT ABOUT BLANKETS AND BLANKET WASHES?

Returning to the analogy about owning and caring for a car, the blankets are like the oil that goes into the engine. It needs to be changed a lot more regularly than the tires (that was the roller analogy), but that does not change the importance. Just like rollers, you can purchase a range of blankets that print better when printing solids, dots, UV inks, waterless inks, or if you are using different types of fountain solutions. Cost is also a major factor. What was presented in the roller section of this article shows that the most economically priced blanket may not be the best priced blanket. Two of the most significant issues for determining the quality of a blanket is how well it stands up to the printing process and for how long. In a blanket study that was done at GATF for the 2002 TechAlert Conference, all of the blankets tested had a reasonably similar amount of dot gain

and solid ink density transfer, but the test did not examine the life of a blanket. On a web press running 70,000 impressions an hour, 24 hours a day, the blanket will last roughly a week. Since most publication web presses print blanket to blanket and if it is a four color press, 8 blankets need to be replaced. If a blanket manufacturer created a blanket that lasted 8 days instead of 7 days, that would be 7 less blanket changes in a year. This would save on blanket costs and down time on the press. If a good shift can change all 8 blankets in 1 hour not only does the company save the cost of replacing the 7 sets of blankets, they will have 7 more hours of production to sell at as much as \$750/hr. That's over \$5,000 in savings for press time and as much as \$12,000 in blankets, simply by choosing the best overall blanket. It may cost more, but if it performs more consistently, longevity can make up for

the difference and increase in price.

When press supervisors were asked what blanket they were using on the press and what type of test they used to qualify a blanket, most had very little data available. When care and maintenance issues relating to blankets were discussed, most never kept track of the time or scheduled maintenance on the blankets. It was thought of as consumable by most press supervisors. Several printers had actually run tests to identify which blankets gave the least dot gain, similar to the GATF study mentioned for TechAlert. Others were just using the blanket that had been decided on 3 years ago or the blanket from a local company that will deliver a new blanket the same day (reducing the need for inventory).

Three critical factors that relate to the life and cost of a blanket are the consistent life of a blanket, how durable the blanket is and what types of

jobs are run on the blanket. Today's desktop systems can compensate for dot gain on the press (both optical and mechanical) without any thought or trouble. If the blanket does not perform consistently from week to week and month to month, being able to compensate for dot gain does little good. The second point is how well can the blanket handle a smash? How compressible is it? Not all blankets are the same. In blanket studies run at Clemson University, the blankets were intentionally smashed with varying thickness of metal taped to the blanket, ranging from .002" up to .025" and then the job was printed again to see at what thickness of smash the blanket survived. A second step of that test was to replace the packing material and run the image again. It was identified that the paper packing took the first impact of the blanket smash. Not all blankets rebounded from this intentional and controlled smashing and the

same could be assumed in the pressroom. There is a very real correlation to the smashing characteristic and the third concern, what types of jobs are being run on the blanket. If a company specializes in using a lot of textured stock this will have an adverse effect on the life of the blanket. You are constantly over impressing the blanket to push the ink into the bottom of the texture. Also, if you are constantly running different sizes of stock, it can indent the blankets in areas that might be affected on larger image areas. Sometimes these blankets can simply be taken off and rested or soaked in water to allow the fibers to return to their normal state.

Obviously, there is more to a piece of blanket than a piece of rubber attached to a fabric backing. Blanket materials are changing today to adjust for changes in ink and fountain solution, and are striving for more productivity. Blanket sales representatives want to talk

about the new changes in blankets, but in so many cases the door is closed when the price is heard. As illustrated with the record keeping of the rollers, a little knowledge and a little testing can aid in better decision making as to which is the right blanket for your company. It would also be appropriate to point out that not all presses will run the same with the same blanket. Find the blanket that gets the most out of your press. Some blankets are better designed for printing solids and some are better for dots. Some are better for coated stock and some are better for uncoated or textured stock. Many, if not most, printers try to select a middle of the road blanket that does a good job across the board and does not require changing the blanket for a job with more or less solids, dots or texture paper. You need to decide what is best for your situation.

Consider keeping track of your blanket usage for all

of your presses on the Microsoft Excel spreadsheet template included on the same downloadable file as the roller study. It can be downloaded free from <http://graphics.clemson.edu/ABC> (Table 4). You may find that certain presses use blankets faster than others, and this can be caused by the operator, press, substrate, maintenance (or lack of it), poor packing, fountain solutions, etc. Printers take better care when it comes to their rollers because they are more expensive and last longer, but a well maintained blanket can extend the life and double their value. Clemson's findings showed that printers considered no specific life expectancy out of a blanket. Some companies change them every month; some change them every six months. What makes the difference? The first step is to track your company's activities. The Blanket Excel spreadsheet only requires you to put in the name of

the press, how often you change the blankets in months, the cost of blankets for the given press over the changeover period of time, the number of units and the size of the maximum press sheet. The other costs are automatically worked out for you. You can compare every press with a common denominator of 1 square inch of blanket material or you can compare the mathematical interpolation of what it would be if all of your presses were 40" wide presses.

One blanket option was placed in the sample to allow you to see how it calculates the usage. This is a tool to better understand what your true costs are on something as specific as a blanket.

PRESS WASH/BLANKET WASH

In today's environmentally conscious community using the right press wash is not only important to production and the life of your rollers or

Available as a FREE downloadable Microsoft Excel File from <http://graphics.clemson.edu/ABC>

One blanket option was placed in the sample to allow you to see how it calculates the usage. This is a tool to better understand what your true costs are on something as specific as a blanket.

Table 4. Spreadsheet for blankets.

blankets, it is critical to the air quality within the plant and outside the plant. Environmental press washes may not clean the rollers thoroughly enough when you change colors on the press, or they could require twice the allocated time to wash up the press. The same is true with blanket washes. This cost analysis is different than the one outlined for rollers and blankets. The decision cannot be based on consumable cost alone. If too much solvent is entering the air it will be unhealthy for the employee and may put you over the acceptable level of VOCs (volatile organic compounds) permitted in the air. This could open the door

to a stiff fine if the state health agency or the EPA visits you. A balance is required between production time lost or gained, wear and tear on the rollers and blankets, and the air quality level in the plant. It is important to note that if there is adequate ventilation the hazard may not be in the plant, but the emissions from your plant may put you above the EPA limits. Use the spreadsheet shown in Table 5 also available for free by download the Excel file from <http://graphics.clemson.edu/ABC>, to study the variables associated with working with different solvents. One advantage of working with a consumable like this is that

you can change chemicals over a shorter period of time and compare the results between different alternatives more quickly than with rollers or blankets. If you take it seriously, you will need to hire an outside firm to come in and take air samples at several points throughout your study. As solvent companies present to you the environmental alternatives for both press wash and blanket wash, they preach the positive points and many times leave out the negative points. There needs to be a balance between production and the environment. More appropriately, if a particular solvent is already low enough

in VOCs not to cause a problem, why do you need another solvent that may take longer to clean the blanket or the rollers and does not improve the air quality? Additionally, proper cleaning procedures will not only extend the life of the rollers and blankets, but use less solvents and give the solvent less of a chance to evaporate into the air.

When cleaning blankets, a practical process is to wet a portion of the blanket with solvent and then go back over the same area with a clean dry rag. This will help prevent the pores of the rubber from getting clogged with a mixture of dried ink/fountain solution/paper dust/set-off

powder and gum. If this is left unchecked the blanket will glaze over and not accept ink properly. With the rollers, certain manufacturers suggest certain cleaners for their rollers. If the solvent is too strong it will leech out the plasticizers in the rubber and cause the roller to shrink. Additionally, there is fountain solution, paper dust, and set-off powder that get mixed in the ink and will not come off with the typical solvent. Some roller manufacturers suggest a water miscible solvent with a mixture of 25% water. This solution helps to remove both types of residue on the rollers. The basic underlining theme in the past few sentences is to ask what

is recommended by the roller and blanket manufacturer. The larger solvent companies will have run tests on their rubber to know what a solvent does to it over an extended period of time. Another concern that you can look at by filling out the Microsoft Excel study is that you may use a less expensive solvent and find that you are going to have to use twice as much to clean the rollers or the blanket. Once again, the most economical solution is not necessarily the cheapest. You need to find out. You could save your company hundreds, even thousands of dollars each year simply by examining the practical alternatives.

Available as a FREE downloadable Microsoft Excel File from <http://graphics.clemson.edu/ABC>

	A	B	C	D	E	F	G	H	I	J	K	L	M
	Solvent Sample	Individual Inks Name and Size	Sample #	DME of Press	Length of Cleanup time on the press (in hours)	Amount of solvent used to clean the press, all units combined (in gal.)	Cost per gallon of solvent used for cleaning the press	Average number of press clean-ups in a day (all shifts combined)	Cost per cc. of press wash	Cost of solvent to clean press	Cost of Press time to clean press	Total Cost to Clean press for 1 day	Total Cost of Clean. press for 1 year (180 hours)
2	1								\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
3	2								\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
4	3								\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
5	4								\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
6	5								\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
7	6								\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
8	7								\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
9	8								\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
10	9								\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
11	10								\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
12	Total Lines	All Presses and rollers	0	#DN/01	#DN/01	#DN/01	#DN/01	#DN/01	#DN/01	#DN/01	#DN/01	#DN/01	#DN/01

Table 5. Spreadsheet for solvent variables.

NOW THE BIG PICTURE

If you do a search for information on Activity Based Costing you will find there is no shortage of information on the subject. Consultants and academic scholars are writing articles for trade journals, academic journals and web pages. In addition there are many books available on the subject. The most referenced is *Cost and Effect: Using Integrated Cost System to Drive Profitability and Performance*, by Kaplan and Cooper. Kaplan and Cooper were among the first consultants to begin preaching the process of Activity Based Costing in the mid 1980's (Dodd, 2002). This was the beginning of a concept that has moved from one industry to another. It was recognized as finding the soft costs and/or hidden costs associated with a manufacturing process (Cross, 2002; Lere, 2002). Some consultants suggest that it is beneficial look at the administrative costs and tie them to the spe-

cific process that requires their attention. To illustrate this point, one could look at a specialty printer's web page (such as NEBS <http://www.nebs.com>) where the customer calls up their companies business card template, fills in the data fields on a spread sheet and after pressing enter, they receive a PDF proof of their business card. It becomes their responsibility to proof it and accept the image. Once proofed, it goes into the system and waits for enough cards with the same stock to input, and then it is automatically moved into the print stage. There is virtually no interaction from anyone in the administration side (customer service, sales, planning, etc.) of the printing company. Therefore, it is the position of some of the consultants/academics that are writing on ABC that production processes should not have to pay for a portion of the administrative cost associated with running a business as typically found with

Cost-Based Estimating. The key phrase here is "some of the consultants/academician". Select three articles on ABC and you will not find three authors that agree on much about ABC.

In one white paper, *Driving Improved Profitability with Activity-Based Costing*, by G. David Dodd, William K. Lavelle and Stuart W. Margolis, aimed specifically at the printing industry, they claim that the traditional method of Cost-Based Estimating used in the printing industry does not work any more and ABC may be the saving grace for the industry. This white paper is available free on the web at <http://pointbalance.com>. If you wish to download the paper you will be asked to log in with contact information. These authors have put the paper in the public domain to generate interest in the concepts and create leads for their consulting business. You will receive a thank you email from the author the next day with

contact information if they can help you further with the process of ABC. It is a compelling article as are most of the ones you can research on the subject of ABC. They explain the difference between profit leaders and laggards and suggest that the key to the leaders success is in the way they account for assigning and controlling administrative cost. These comments are backed up by statistics from the PIA Ratio studies (Dodd, 2002). Since the study was not designed specifically for their topic, the statistics are open for some interpretation. Although they are promoting Activity Based Management more than Activity Based Costing, their conclusion would agree that the most important success element, which is supported by many different hypotheses from various references, is what makes a company a profit leader is that they do more with less and therefore make a greater profit. What causes the success is as var-

ied as the products each printing company produces. Do not jump on the bandwagon assuming that the solution to all of our problems is in determining a new method to find the correct price for a printed piece. Observations from visiting dozens of printing companies support the concept that success can work with any costing method as long as the process is followed properly and all of the true costs are considered. This might mean in some situations one method is better than another, but diligence in whatever system a company selects produces success. This is, of course, only true if a company works to find out ALL of the costs associated with the process. The ratio method of doubling, tripling, or quadrupling the paper costs based on the difficulty of the job (a process still practiced in some smaller printshops) will seldom match the true costs of the printed piece. Quality work and quality

management lead to success in the printing industry. The costing method is only a tool and needs to be used, as any good mechanic would select the right one for the job at hand.

UNDERSTANDING THE LARGER PICTURE OF ABC

Some experts will argue that you cannot have Activity Based Costing without Activity Based Management (Forrest, 2002). Others will discuss the reality of not knowing all the facts at the initial point of determining the price of a printed piece so it is really best to use Fuzzy Activity Based Costing (Forrest, 2002). For the statistical novice, fuzzy math is a process of working with facts and figures that have variance and through some complicated statistical analysis a projection can be made. This does sound like the typical estimating situation, but once again it is not the only way to perform the task of determining the cost.

In *Printing Estimating* by Ruggles (1996), he divides the estimating process into two categories, cost estimating and price estimating. He further breaks each down into various methods that a printer can select; each with varying degrees of difficulty to implement cost and projected accuracy. Ruggles strongly suggests that for a printing company to be successful in their estimating practices they need to base their estimates on their actual cost. This is regardless of whether you are performing cost-based or price-based estimating. He also recognizes that today's market it is becoming so fast paced that the printed job needs to be produced faster than some companies can produce an estimate. In today's On-Demand Digital market, turnaround time is the key to success. Typically On-Demand Digital Printing cannot be priced with the conventional cost-based process that most printers have used for years. In price

estimating, which sometimes is called to as value-based estimating (what price will the customer expect for the desired benefit), is not so focused on keeping all of the equipment running the maximum number of hours per week. The printer may be able to charge more than the hourly rate due to the service offered the customer, specifically fast turnaround time. But this does not remove the need knowing the true costs. Value-based pricing is converting the pricing process to more of an acquired talent where over a period of time, say a week or month, the estimator knows the company is hitting the cost determined for each production area.

An article by John Lere, a professor of accounting from St. Cloud University, expands the views on ABC with the white paper mentioned earlier to include not just administrative services, but all material, maintenance, shipping, etc. related to a printed piece (Lere, 2002;

Vokurka, 2001). It is a process to find the true cost of an activity. The value of ABC is knowing when it is appropriate and when it is just an exercise. Greater accuracy delivers diminishing returns as you continue to fine tune the process. At a point, the cost of researching better options costs more than the improvement in production costs. It is then time to look at another area for improvement. ABC is no quick fix (Forrest, 2002), yet many consultant/academician suggest it is time to switch to this new process of determining costs. Cost-Based estimating is still the dominate method of estimating in the industry (Ruggles, 1996; Dodd, 2002). It is not a process that has remained stagnant over the years, it has changed and become computerized (Ruggles, 1996). For some printers it has become the foundation for creating a price list for fast turnaround quotes or for partnering agreements that are spelled out in long term

contracts. The prices still come from knowing what are the valid operating costs throughout the building. Any way you look at it, the task of determining the costs of every process in a printing company is a daunting task, but accuracy and diligence will reap success. Look for the right tool to solve the problem at hand, whether it is Activity Based Costing or Cost-Based Estimating.

In conclusion, returning to the pressroom situation covered earlier, everyone needs to recognize that inks, substrates, fountain solutions, etc. are constantly being reinvented to run faster, cleaner and allow for quicker drying times. Presses today run almost twice as fast as presses purchased 20 years ago. You cannot expect all of these variables to change. As these variables change you need to examine the changes that need to take place in the rollers, blankets or chemicals used in the pressroom. Activity Based Costing is a tool that may

help a printer make better choices for a more profitable pressroom. Can these concepts be related to other areas around the company? Certainly, but care should be taken that you do not try to push a square peg through a round hole.

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John Leininger is a Professor in the Department of Graphic Communications at Clemson University. He has been teaching at Clemson since 1986, where he received his Doctorate in Vocational Technical Education in 1991. He has taught courses in flexography, lithography, digital printing, inks and substrates as well as the department's management class dealing with estimating, planning, equipment purchasing, cost analysis, and plant layout. He has also taught training development courses in the Department of Human Resource Development at Clemson. John is also proud of the fact that he has served as the International Printing Week chair for the IAPHC for the past 5 years. In the past 18 months he has attended 30 conferences/industry shows

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AN INVESTIGATION TO DETERMINE THE COST DIFFERENCES BETWEEN TRADITIONAL AND WATERLESS LITHO

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INTRODUCTION

Waterless lithography (litho) or dry offset printing (dryography) has been in existence for several years, but not many research studies have been conducted in the field of waterless lithography. As a result, many graphic communications professionals jump into installing a waterless litho press without knowing much about the waterless litho process. Eventually, most of them became dissatisfied with waterless litho or face unanticipated problems with waterless litho.

William C. Lamparter, President of PrintCom Consulting, performed an interview survey for the *American Printer* magazine in mid 1994. Lamparter (1994) found that in spite of eco-friendliness, higher

image quality, cost savings on makeready time, less makeready and substrate running waste, and reduced waste disposals; waterless lithographers perceived controversial issues associated with waterless litho. These issues were plate characteristics, ink characteristics, cost considerations, high initial capital investment costs, proofing limitations, recycled paper use, waterless desking, and better quality. Two experimental studies were conducted at R. R. Donnelley & Sons Company by Ben Wong, David Strong, Rick Stone, and Zhenhua Xie to measure the print characteristics of waterless litho. Wong concluded "we have had good results but there are extra plate and ink costs" (Vruno, 1997).

The cost is an important factor for implementing any technology, because prices and profits are based on the cost. An empirical study was conducted to determine the cost incurred in traditional or wet lithography (litho) and waterless litho. This paper investigates the cost differences between traditional litho and waterless litho.

Purpose

The purpose of the research was to determine the costs associated with traditional litho and waterless litho. The costs of the following equipment and materials were included in this study: (1) press, (2) retrofitting units, (3) plate processor, (4) training, (5) plate, (6) ink, (7) plate processor developer, (8) waste disposal, (9) dampening solution, and (10) makeready.

Problem

The problem of the research was to compare costs between traditional litho and waterless litho. A review of

literature showed controversial arguments on costs associated with waterless litho.

Research Question

The following research questions were prepared for this study:

1. Do waterless lithographers save money using waterless litho in comparison with using traditional litho?
2. Do waterless lithographers perceive that waterless litho is more economical than traditional litho?

REVIEW OF LITERATURE

This research study was based on relevant information gathered through both primary and secondary sources. The findings related to costs associated with waterless litho are discussed in the following paragraph.

The cost of a waterless litho plate was \$3.00 per square foot. That was approximately 150% to 200% higher than the cost of a traditional litho plate (J. Zenner, Product Manager, Toray

Marketing & Sales, Personal Communication, October, 1996). In addition, the run length of a waterless litho plate was lower than that of a traditional litho plate no matter what brand of a plate or type of paper was used ("What it is," 1997). The prices of waterless litho inks were approximately 20% to 25% more than traditional litho inks (M. David, Manager, Pricing Department at Superior Inks, Personal Communication, October 31, 1996). However, a survey conducted by the researchers at the Waterless Printing Association, reported that if a press was dedicated to printing waterless jobs, all the time, labor and material savings offset the increased costs associated with the process. The data collected by Tri Service, Inc. in 1991 and 1992 indicated that L&E Packaging saved \$102,600 per year. Lamparter (1994) stated that a company dedicated to printing only waterless, realizes an average paper waste savings of 9.6%

by using waterless litho over traditional litho.

A review of literature showed mixed reactions for using waterless litho. Research studies examined that waterless litho saves money on certain aspects, for example, dampening solution, makeready time, paper wastage, and waste disposal. On the contrary, it is more expensive than traditional litho on other aspects, for example, capital investment costs and raw material costs.

METHODOLOGY

A survey instrument, questionnaire, was prepared for collecting data. Gay (1996) stated that usually descriptive data are gathered through a questionnaire survey, an interview, or an observation. The questionnaire contained questions regarding demographic information of participants, costs for traditional litho and waterless litho, and perceived opinions for waterless litho as compared to traditional litho on various

Cost	N		Mean	Median	Standard Deviation
	Valid	Missing			
Cost Satisfaction Index (Likert scale)	23	0	3.4565	3.50	1.1248
W-Plate	21	2	20.24*	19.00	13.67
T-Plate	14	9	9.07*	9.50	2.34
W-Ink per lb.	18	5	7.94	6.00	3.84
T-Ink per lb.	11	12	5.45	6.00	0.82
W-Plate Processor	12	11	23458.33	17750.00	12160.78
T-Plate Processor	3	20	15000.00	15000.00	3000.00
W-Plate Processor Developer per month	10	13	184.10	130.00	153.81
T-Plate Processor Developer per month	9	14	123.89	89.00	98.38
W-Waste Disposal per month	7	16	208.57*	70.00	308.89
T-Waste Disposal per month	6	17	246.67*	75.00	333.09

Table 1. Statistics for Cost Comparison

Note: 'W' refers to waterless litho and 'T' refers to traditional litho

costs. The questionnaire was pre-tested for its validity and reliability. A pilot test was conducted to check the validity of the questionnaire, eliminate any ambiguity, and make appropriate changes according to respondents' suggestions. A targeted sampling technique was applied to select the final subjects. Printing com-

panies of the United States who had experienced with both waterless litho and traditional litho were selected. Questionnaires were mailed to middle-level to top-level management personnel of those companies. Bailey (1967), Balian (1982), Balsley and Clover (1988) stated that mail questionnaires have advantages of standardized

wording, no interview bias, respondent privacy, convenience, cost and time saving, but usually the response rate is low. Figures related to traditional litho costs and waterless litho costs were collected for analysis. Participants were asked to provide costs for the same waterless litho press as if it were used as a traditional

Satisfaction Index	Frequency	Percent	Valid Percent	Cumulative Percent
1.75	1	4.3	4.3	4.3
2.00	3	13.0	13.0	17.4
2.25	2	8.7	8.7	26.1
2.75	3	13.0	13.0	39.1
3.25	2	8.7	8.7	47.8
3.50	1	4.3	4.3	52.2
3.75	2	8.7	8.7	60.9
4.00	3	13.0	13.0	73.9
4.75	3	13.0	13.0	87.0
5.00	2	8.7	8.7	95.7
5.25	1	4.3	4.3	100.0
Total	23	100.0	100.0	
Missing	0	0.0		
Total	23	100.0		

Table 2. Frequency of Cost Satisfaction Index

litho press. In addition, waterless lithographers' perceived opinions about costs involved in waterless litho were measured in comparison with those of traditional litho. A seven-point Likert scale was used to measure participants' opinions. The seven-point Likert scale was designed as: (1) Very

Satisfied, (2) Satisfied, (3) Somewhat satisfied, (4) No difference, (5) Somewhat dissatisfied, (6) Dissatisfied, and (7) Very dissatisfied. The participants' opinions about cost satisfaction relating to investment costs, raw material costs, waste disposal costs, and training costs were grouped to form a

cost-satisfaction index. The frequency of responses for each question was calculated. Means, two-tailed "t" test, and paired samples correlation were executed for quantitative data.

FINDINGS

A total of 27 questionnaires (32.53%) were received out of

Description	Waterless Litho Amount in US \$ (Mean Value)	Traditional Litho Amount in US \$ (Mean Value)
Press	1,565,021.74	1,565,021.74
Hollow Core Vibrator Rollers	20,733.33	(optional)
Temperature Control System	95,291.67	(optional)
Plate Processor	23,458.33	15,000.00
Training (training time x wage/hr.)	28,043.25 (1121.73 x 25)	71,840.00 (2873.60 x 25)
Total Fixed Costs	1,732,548.32	1,650,861.74

Table 3. Comparison of Fixed Costs

Description	Waterless Litho Amount in US \$ (Mean Value)	Traditional Litho Amount in US \$ (Mean Value)
Plate Amount per Month (plate price x plate consumption)	6,072.00 (20.24 x 300)	2,721.00 (9.07 x 300)
Ink Amount per Month (ink price x ink consumption)	3,970.00 (7.94 x 500)	2,725.00 (5.45 x 500)
Plate Processor Developer per Month	184.10	123.89
Waste Disposal per Month	208.57	246.67
Dampening Solution per Month	None	298.80
Makeready per Month (makeready time x no. of jobs x wage/hr.)	5,800.00 (1.16 x 200 x 25)	5,850.00 (1.17 x 200 x 25)
Total Variable Costs Per Month	1,732,548.32	1,650,861.74

Table 4. Comparison of Variable Costs

83 subjects from 28 states of the United States. Twenty three valid questionnaires were used for the data analysis. It was found from the paired samples correlation analysis that the cost of a waterless litho plate was significantly higher ($r = 0.845$, $p=0.000$) than the cost of a traditional litho plate at $=0.01$. On the other hand, the cost of waste-disposal for traditional litho was significantly higher ($r = 0.970$, $p=0.006$) than the cost of waste-disposal for waterless litho at $= 0.01$. It was determined that the cost of ink, the cost of a plate processor, and the cost of plate processor developer used in waterless litho were higher than those of traditional litho, but they were not significant. The mean for the cost satisfaction index was 3.46 on the seven-point Likert scale. See Table 1 for more information on data.

Though the mean of the cost satisfaction index was 3.46, the frequency of the cost satisfaction index showed the distribution of

data across the scale (Table 2). It was determined that waterless lithographers' cost satisfaction level varied from "very dissatisfied" to "somewhat satisfied."

It was found that the total fixed costs for waterless litho were \$81,686.58 higher than traditional litho (Table 3). Similarly, the total variable costs per month for waterless litho were \$4,269.31 higher than traditional litho (Table 4).

CONCLUSIONS

Producing printed products using waterless lithography is more expensive than producing the same products using traditional lithography. Lithographers have to invest more money in order to perform the waterless litho process. In addition, they have to pay more on variable costs of materials, such as, plates, inks, and plate processor developer. It was found that the cost of a waterless litho plate was significantly higher than the cost of a traditional litho plate. These results match

with the waterless lithographers perception about the costs that are associated with waterless litho in comparison with those of traditional litho. It was determined that the mean of the waterless lithographers' cost satisfaction index was 3.46. This is close to "somewhat dissatisfied."

Operating waterless lithography saves money on waste disposal, dampening solution, and makeready. It was found that the cost of waste-disposal for waterless litho was significantly lower than the cost of waste-disposal for traditional litho. Waterless lithography also eliminates the use of dampening solution.

The cost is not the only factor for deciding whether one should implement waterless litho or not. There are other factors, such as, quality of the printed products and environmental friendliness for implementing the desired process. The results provide important data for one who wants to

know about the costs associated with both waterless litho and traditional litho.

RECOMMENDATIONS FOR FUTURE RESEARCH STUDIES

Recommendations are made based on research methodology and findings. The following recommendations are made for future research studies.

1. An experimental study should be conducted to print jobs using both waterless litho and traditional litho under the same settings.
2. A correlation study should be conducted to determine the relationship between operating the waterless litho press all the time and costs against operating the waterless litho press occasionally.
3. A research study should be performed with a larger sample size of printing companies that operate both waterless litho and traditional litho to verify the results, and generalize findings for the larger population.

4. Research should be performed to compare the quality of the printed images that are produced using waterless litho against the quality of the traditional litho products.
5. Research should be performed to compare the environmental friendliness of waterless litho against the environmental friendliness of traditional litho.
6. Research should be performed to compare the overall satisfaction of lithographers with waterless litho against traditional litho.

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ADULT LEARNING BARRIERS

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INTRODUCTION

This paper summarizes a study which was undertaken to identify and categorize adult learning barriers, excluding learning disabilities. The purpose is not to determine how these barriers can be dealt with, since this would be a project in itself.

When a group of adult learners walks into the classroom for the first time, we need to be very careful not to make the assumption that these people come to us as a blank slate. This is probably the most detrimental attitude that a postsecondary teacher can have. The adult learner comes to us as a very complex human being.

According to William A. Draves, the author of *How To Teach Adults* (1984), adults share four characteristics that

affect their classroom performance, which are emotional, physical, mental (or psychological), and social. For the purpose of this study we have added "technological." Mr. Draves wrote his book in 1984. At that time the greatest advancement in writing was the word processing typewriter and Mr. Draves did not recognize the impact of technology on today's adult learners.

A survey on learning barriers was conducted at Western Wisconsin Technical College. This was not a college-wide survey; only a cross sampling of the student population. The departments that participated were Graphics, Automotive, Emergency Medical Technician, Economics, and the students in the Holmen Learning Community. The

Holmen Learning Community was included in the survey to determine if there was a substantial difference between technical college students and students that are full time teachers. A total of 130 surveys were analyzed.

The survey results were broken down into five areas: emotional, physical, psychological (mental), social, and the newest one, technological. Each area is summarized in this article. Each area has a brief explanation of the barrier we were attempting to identify, and a general summary of the comments made on the survey forms for each barrier stated.

EMOTIONAL BARRIERS

When our survey asked adult learners for the emotional barriers they encountered when learning, we took into consideration that, according to Dr. Neil Pritchard who retired from the University of Wisconsin-Stout as a Professor of Vocational, Technical, and Adult Education, an adult's

emotional state is more complex than that of a middle or high school student. An adult must be emotionally comfortable in order to feel at ease with the learning process.

J. Roby Kidd, in *How Adults Learn* (1979), stated, "Feelings are not just aids or inhibitors to learning; the goals of learning and of emotional development are parallel and sometimes identical and can probably be most conveniently stated as self-realization and self-mastery" (p. 95). In addition Draves (1984) stated, "Throughout the ages, one's emotional state has always been manipulated to try to induce learning, but somehow the attempt to produce positive feelings became distorted in the mistaken belief that greater learning would occur if one produced negative feelings of pain, fear, or anxiety" (p. 8). It is unfortunate that the misuse of the emotional characteristic of individuals has been exploited.

The following emotional factors were identified as potential learning barriers for adults.

Children and Family.

Handling the emotional roller coaster of family life.

Dealing with Death and its Responsibilities. Not only are adults faced with the grieving process, but also taking on the additional responsibilities of taking care of arrangements and the handling of estates.

Depression. This clinically diagnosed illness affects a large segment of the population.

Financial Concerns. Adults must deal with the responsibilities of money management

General Stress. This includes the wide range of situations that increase stress levels that interfere with the student's ability to learn.

Health Concerns. Some of these health issues now become long term. The adult learner must accept and deal with long term and short term health

problems.

Impatience. Some adults are anxious about getting things completed ahead of time.

Learning Disabilities. Adult learners with learning disabilities, which were not properly diagnosed earlier in life, tend to have low self-esteem and blame their inability to learn on other emotional factors rather than understanding how their learning disability affects them.

Maturity Level. The ability or inability to handle adult situations.

Personal Emotional Reactions. Frustration, anger, procrastination, etc.

Relationships. The difference between adolescent relationships and adult relationships is that adult relationships tend to have longer and more devastating consequences on both the cognitive and psychomotor areas of the learning process. Relationships can include anything from a spouse, a boyfriend/girlfriend, or friends and family members.

Self-Esteem (Self Worth).

Learning becomes harder with low self-esteem. Adult learners require the same praise and reassurance as younger learners.

Teacher Relations. Having to deal with teachers that are more their equal and having to accept a wide variety of different personalities and teaching styles can create a variety of reactions in the adult learner.

Test Anxiety. "Test anxiety" is the same for everyone.

Work Time versus School Time. This is the ability to juggle time cycles and allow for appropriate times for both school and work.

PHYSICAL ENVIRONMENT BARRIERS

We often hear phrases similar to this: "When I went to school we had to walk two miles, sit in a cold classroom on hard wooden chairs, and walk home in a snow storm, and we learned just fine." This is a great story and could be a great plot for a play, but our survey showed that today we have become

creatures of comfort. Yes, some people come from physically hard times, but times have changed.

Draves says that, "All adults in your class, even the younger ones, are declining physically. Everyone is aging; even those who refuse to admit it. Our physical state affects our capacity to learn. Physique and intelligence are related because our bodies influence how and whether we can learn" (p. 9).

We found that there are a number of physically uncomfortable conditions that come up as learning barriers.

Cleanliness and Clutter. Most adult learners want a clean environment in which to work and work areas absent of clutter.

Commuting and Parking Distance. Most adult learners prefer to have better parking facilities and classes scheduled to eliminate excessive walking and excessive time spent between classes.

Distractions and Quiet. The adult learner tends to seek out an environment that is free from distractions and noise which tends to erode the retention process.

Environmental Control. Most adult learners would like the ability to control their environment to satisfy their individual needs. For example, the mean temperature of 72 degrees with 45 to 50 percent humidity is quite different than the actual daily fluctuations in climate control. Adult learners notice temperature and humidity inconsistencies. Adult learners who come back to school with physical impairments discover that uncomfortable seating reduces the ability to concentrate.

Ergonomically Correct Seats. The standard seat that is found in most classrooms does not take into consideration the wide variety of size and impairments of adult learners. This can reduce the ability to concentrate.

Exercise. Because of a lack of physical activity, the adult learner expressed a need

for some type of exercise that would help to stimulate the academic process.

Freedom to Move About. The adult learner does not like to be confined for long periods of time in the traditional classroom setting. They almost prefer a “kindergarten” type classroom, where they do a multitude of activities in relatively short periods of time and move around from activity to activity.

Medication. There are a multitude of prescribed medications that have different effects and have the potential to affect an individual’s ability to comprehend. Some medications affect physical as well as mental capabilities.

Music and Background

Sounds. The opinion on the use of music in the classroom was evenly split. Half prefer it quiet, and the other half prefer some type of soft, nonverbal, background music. Such a split will continue to make it a very difficult decision as to what type of music can be used to promote learning, if any at all.

Recess. The adult learner needs time to rejuvenate by having a cup of coffee, smoking a cigarette, or just being able to communicate with other individuals without any concern for the academic process.

Security and Structure. As with school children, adult learners have a concern for a safe and structured environment in which to learn.

Space and Lighting. Adult learners tend to require more space than do younger learners. Adult learners need to be able to spread their work out in front of them. Most prefer a well lit work area.

Vision and Hearing. Showing overheads, PowerPoint presentations, and videos on inadequately sized screens makes it very difficult for any learner to properly see and understand the information being presented. Sound is another problem. As we grow older we do not hear the same as when we were children. Appropriate audio speakers, strategically positioned through-

out the classroom are extremely important.

PSYCHOLOGICAL (MENTAL)

Adult learners come with an eagerness to learn or they would not be there.

However, there are mental situations that, if not caught early in the learning process, could deter the adult learner from achieving his/her full potential. In addition, adult learners come with life experiences and have already established a number of their learning patterns.

Concentrated Curriculum.

Some adult learners prefer instruction that removes a lot of the “fluff”. They prefer going directly to the main subject matter and presenting it in a continuous, sequential pattern so there are no gaps between the learning of one unit and the beginning of the next unit.

Attitude and Motivation. The adult learner tends to have an overall positive attitude regarding the learning process.

Concentration (Lack of). The ability for adults to concentrate varies. We find adults who need a very quiet environment, others that prefer some type of musical stimulus, and those that can maintain their concentration when placed in environments of total confusion. This makes this a very unique concept in creating a positive learning environment within the classroom structure.

Depression and Anxiety. Depression and anxiety not only affects adults physically, but also emotionally and psychologically which affects how an individual retains and processes knowledge.

Maturity. Adult learners now realize the value of an education, so they don't have to be bullied or threatened into learning situations.

Mental Block. As adults and as children we all have times when we reach a mental impasse. Understanding that this is a common phenomenon, we need to examine this and try to determine what teaching strategies can be

used to work around these situations.

Memory Loss (Due to Age). This appears to be more of a problem for those of age 40 and above. Also, we need to be aware of students that have suffered memory loss due to medication, disease, or personal injury.

Procrastination and Time Crunch. Just as with younger learners, adult learners who have had years of poor time management tend to spend more time procrastinating over assignments than actually working on the assignments. Procrastination perpetuates the stress cycle surrounding projects.

Study Habits. We found that study habits are an area which still needs to be of primary concern. Those adult learners who were taught good study habits as a child still retain good study habits and those who had poor study habits still have poor study habits and struggle with this. The only difference is, some of those with poor study

habits because of maturity, now know that they have to correct this behavior in order to succeed.

Subject Aversion and Appreciation. If we hated math as a child, we hate math as an adult. As an adult learner we also tend to excel in the areas that we like, and avoid at all costs areas that we do not like. It becomes a challenge to convince adult learners that the "whole concept" is still part of a well-rounded education.

Understanding the Importance of Education. The majority of adult learners have come to appreciate the value and importance of education. Proving the relevance of specific subject matter is much easier when the student already values the education process as a whole.

Worry and Self Doubt. This barrier does not change from childhood to adult learning. Adult learners worry about how they are doing and if they are achieving. Because of this they need continuing reinforcement as to how they

are doing. Without positive reinforcement, the criticism of friends, family, and teachers is multiplied causing self-doubt.

SOCIAL CHARACTERISTICS

Draves states, "The most important social characteristic of the adult learner is an abundance and variety of experiences. This aspect alone makes teaching adults different from teaching children or youth" (p. 11).

Yes, the adult learner brings to the classroom this wealth of social knowledge, but because the adult has this expanded world of sociability it also creates a series of new barriers. Our survey shows that some of these barriers are difficult for the adult learner to overcome.

Family Changes (Responsibilities).

This category applies to approximately 40 percent of the population surveyed. Unlike young students the adult learner often has family responsibility, and without family

support the sense of responsibility can become a barrier that adds extreme stress, which interrupts the learning process.

Financial Responsibility.

Adults have a responsibility to maintain the basics such as shelter, food, clothing, and transportation. This can definitely interfere with the ability to complete outside classroom assignments. Stress increases when an employer requires that an individual work long hours and is not flexible with the adult learner's school schedule. Also, with the decrease in grants, scholarships, and financial aid, the adult learner has to become more creative to survive.

Friendships More Varied. In middle and high school, friendships were confined to very close, closed groups of individuals. You did not venture outside your particular group or you found yourself ostracized from the group. As an adult, you are placed into classes with a wide range of age, nationality, gender, and belief differences. This makes for a

whole new learning process in accepting these differences. If not accepted, this makes for a lack of camaraderie and comfort in the learning environment.

Equality. One thing that the adult learner expects from the teacher is to be treated as an adult. Some teachers still consider the adult learner to be a middle or high school age person simply because they are a student. When adults are treated in this manner it may impact the learning process.

Independence. The adult learner now faces a new challenge: the ability to make decisions on their own that previously had been made for them by an adult. This can either be positive or negative depending on whether or not there has been a sound structure developed for making important decisions.

Scheduling. Because of family, work, social commitments, and time constraints, if lab and study schedules are not offered in a variety of time slots, the adult stu-

dent is faced with being out of sequence or having to extend the learning time, which adds financial and mental stress to the individual.

World Awareness. As opposed to children, adults are much more aware of their world. They are concerned with community problems, state problems, and world problems which affect them emotionally, mentally, and financially.

TECHNOLOGICAL BARRIERS

Our survey reveals that some of the technological advances that were supposed to make the learning process easier have done just the opposite.

Confusing "New" Technology. With rapid technological change, even those students who graduated in the early 90's are now faced with learning a whole new way to do the simplest tasks, such as writing a simple letter.

Catching up. Computer technology and software programs are changing at rates ranging from six months to every year. This has added

an entirely new stress factor into the learning process. This not only affects the student both mentally and physically, but it adds the same stress factor to the educator.

Workplace Application. For adults, interconnection between work and learning has to be very clear. The adult learner needs and looks for the assurance that what they are learning in the classroom can be applied to their career with a minimum of transitional effort.

Repair and Maintenance. Now we require students to do homework on computers. However, a computer is not free of equipment malfunction. How do we deal with equipment malfunction and students losing data?

Scheduling Lab Time. With class, family, and work schedules, and no computer at home, how do students schedule lab time?

Technology Costs More. With the cost of computer software and hardware, including updates what is the balance between providing the learner with adequate train-

ing and not overburdening them with additional cost over the cost of tuition and textbooks?

IMPLICATIONS FOR FURTHER RESEARCH

As stated in the beginning, the purpose of this study was to identify the barriers that adult learners are facing in education in the 21st century, excluding learning disabilities. The study of learning disability barriers is an entire study within itself. The barriers that we chose were general barriers that affect the entire adult population.

In this research we have not tried to analyze or recommend a course of action to deal with these barriers but to present information to show that there are additional barriers above and beyond common learning disabilities and that these barriers do influence how the adult learner processes the educational material that is being presented in the classroom. If we are going to

assist the adult learner in being successful we need to take a more in-depth look at these barriers and what we as educators need to do to help students overcome these barriers.

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THE NEW 2+4+CAREER MODEL FOR EDUCATION

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INTRODUCTION

Federal vocational education legislation has consistently emphasized secondary and postsecondary linkages since 1972 (Bragg, 1999). This enhanced secondary-to postsecondary smooth transition can create valuable educational opportunities for all students (Progress Report of the New Model and Support Services for Transfer Students in Arizona). To provide students a smooth transition to college, support services to students, and an institutionalized school-to-work transition system, a 2+4+Career model was developed by Dr. Benjamin L. Lee, Coordinator of Graphic Communications (GC) program at California State University, Los Angeles (CSULA) and Mr. John

Santos, Director of the Inner City Graphic Communications (IGCA) Academy.

The basic structure of the 2+4+Career model was the integration of the 2+4 articulation, university early entry program, and career service. The 2+4+Career model provides high school students a smooth transition to four-year program plus a pathway to career. Students receive college credits while they are in high school and start their full-time employment before they graduate from the university.

This project was implemented in the Winter 2000 quarter. Twenty-two students were selected from the Inner City GC Academy's senior class to attend one class at CSULA. Presently, there is sufficient

funding to support 100% of the students' expenses. Eight major printing/publishing companies such as Bowne & Co. and Color Graphics are serving as industry partners for this program and provide students with internships and career opportunities. This program not only provides GC Academy students the college experience but also has motivated more than ten students to continue their university education at CSULA.

THE 2+4+CAREER MODEL

The 2+4+Career model is the integration of the two-year GC Academy program, the ACE/PACE program, the four-year university GC program, and an internship/ placement service. This model is unique because the three major components overlap (Figure 1). GC Academy students begin university level GC courses during their senior year through the ACE/PACE

program. After the students are admitted to the four-year program, they will participate in the internship program with industry partners. During their senior year, they will start their full-time employment at the company they have chosen. The 2+4+Career model is a high efficiency education plus career model and has many advantages:

1. The two-year program, four-year program, and the industry are tied in with each other, the curriculum design following the future-industry standards.
2. Academy students receive college credits through the ACE/PACE program; students could accumulate nine credits before they start their four-year program.
3. There is sufficient funding from grants from Printing Industry Association, Los Angeles Unified School District, and Inner City GC Academy to cover 100% of the students' expenses.

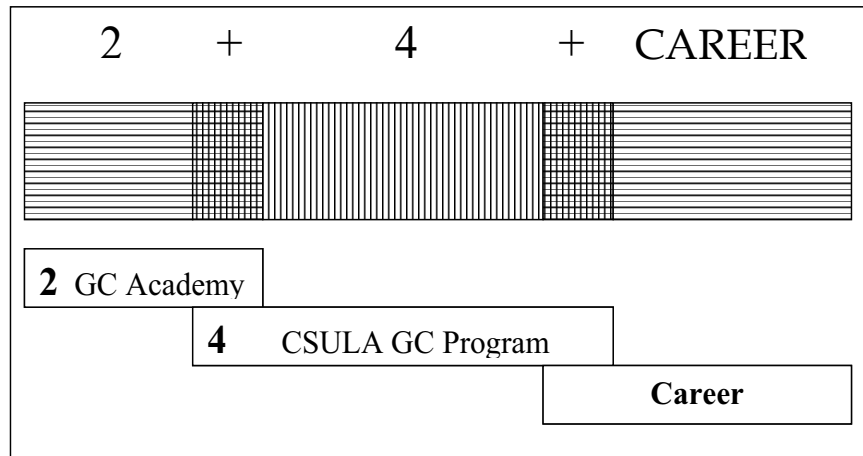


Figure 1. The 2+4+Career Model

4. This model not only provides high school students the college experience but also motivates them to continue their university education.
5. The university outreach office provides support services to assist students through the university admission, financial aid, and scholarship application procedures.
6. Students enrolled in the four-year program will start their internship during their second year and start their full-time employment before graduate from university.
7. This model provides graduating students a pathway to a career.
8. This model will provide the industry with appropriately trained new employees.

CURRICULUM DESIGN

The inner-city graphic communications academy's curriculum 10th grade courses:

- English 10AB* or Honors English 10AB*
- Algebra 1AB or Geometry AB* or Algebra 2AB
- Biology AB*
- World History
- Physical Education
- Art AB*

11th Grade Courses:

American Literature/Contemporary Composition*
Geometry AB* or Algebra 2AB* or Trig/Math Analysis
Chemistry AB or Advanced Physical Science AB*
American History AB*
Graphic Communications 1AB*
Foreign Language
Intersession Courses:
 Intersession (Fall)
 Applied Mathematics/Graphic Arts*
 P.S.A.T. Prep*
 Intersession (Spring)
 Advanced Press*

12th Grade Courses:

Expository Composition* , World Literature* and/or
Journalism
Algebra 2AB* or Trig/Math Analysis or Calculus AB*
U.S. Government/Economics*
Advanced Graphic Communications+
Foreign Language
Elective
Intersession Courses:
 Intersession (Fall)
 S.A.T. Prep*
 Intersession (Spring)
 Internship*

* Courses taught by Academy Teachers

Academy students are advised to take a 4th year of
Mathematics.

***The B. S. in graphic
communications
curriculum at CSULA***

Graphic communications services will increasingly be on-demand, delivered over the Internet or high bandwidth networks. The future business environment for on-demand cross-media services is shown in Figure 2. The new GC curriculum at CSULA was designed based on the on-demand cross-media concept.

The BSGC degree program will provide unique training to those who wish to enter the rapidly converging digital and print media fields. Graduates of the program will have the educational qualifications and necessary skills to be hired:

- by the digital media and print industry in management-related occupations,
- by government offices in printing and publishing-related occupations,
- by community colleges in graphic communications/printing teaching-related occupations.

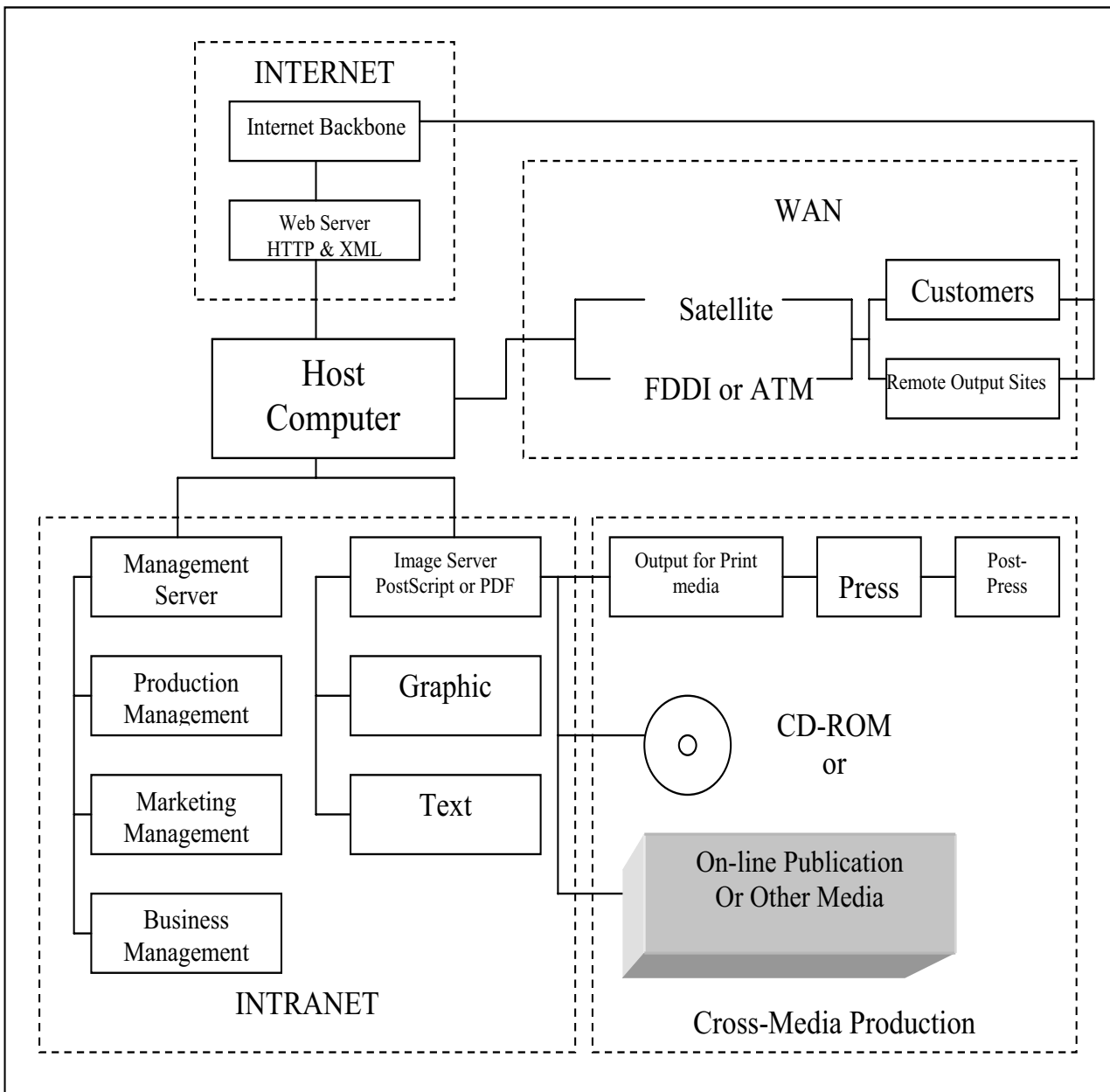


Figure 2. An On-Demand Cross-Media Graphic Communications System

A total of 104 quarter units will be required for the major. There are 60 quarter units in required courses (Table 1), 36 quarter units in technical elective courses (Table 2), and 8 quarter units in special emphasis courses (Table 3).

Course No.	Course Title	Units
TECH 101	Industrial Safety for Technology	(3)
TECH 130	Intro. to Graphic Communications	(3)
TECH 150	Intro. to Higher Education in Technology	(2)
TECH 231	Imposition and Electronic Image Assembly	(3)
TECH 232	Electronic Prepress Systems	(3)
TECH 233	Presswork Procedures	(3)
TECH 234	Photo Offset Lithography	(3)
ACCT 200A	Principles of Accounting	(4)
ACCT 200B	Principles of Accounting	(4)
ECON 201	Principles of Economics	(4)
ECON 202	Principles of Economics	(4)
FIN 205	Foundations of Business Law	(4)
CIS 283	Introduction to Application Programming	(4)
CIS 294	Business Computer Systems	(4)
CIS 301	Management Information Systems	(4)
ACCT 300	Managerial Accounting	(4)
TECH 400	Technical Communication	(4)

Table 1. List of Required Courses

The student will select 36 quarter units (12 courses) from the following:

Course No.	Course Title	Units
TECH 330	Graphic Communications Processes and Materials	(3)

Table 2. List of Technical Elective Courses (Continued on next page)

TECH 332	Typography	(3)
TECH 432	Typographical Layout and Design	(3)
TECH 433A	Printing Estimating	(3)
TECH 433B	Computer Aided Printing Estimating and Job Costing	(3)
TECH 434A	Graphic Communications Production Management	(3)
TECH 434B	Graphic Communications Production Management	(3)
TECH 435	Color Theory, Reproduction, and Management	(3)
TECH 436	Electronic Publishing Technology and Management	(3)
TECH 437	Alternative Media Production	(3)
TECH 438	Image Capture, Processing, and Management	(3)
TECH 439	Digital Workflow Management	(3)
TECH 454L	Special Topics in Technology	(3)
TECH 490G	Adv. Problems in Technology	(3)

Table 2. List of Technical Elective Courses (Continued from previous page)

The student must select two courses from one of the following categories:

Management Elective:

The student will select 8 quarter units (2 courses) from the following list of courses with the consent of his/her advisor:

Course No.	Course Title	Units
ECON 303	Money, Banking, and the Economy	(4)
FIN 303	Business Finance	(4)
FIN 305	Commercial Law	(4)
MGMT 460	Case Studies in Business Management	(4)
MGMT 468	Small Business Management	(4)
MGMT 483	Managing E-Commerce	(4)

Table 3. Options, Concentrations, or Special Emphasis (Continued on next page)

Marketing and Sales Elective:

The student will select 8 quarter units (2 courses) from the following list of courses with the consent of his/her advisor:

Course No.	Course Title	Units
MKT 304	Principles of Marketing	(4)
MKT 341	Salesmanship	(4)
MKT 346	Marketing of Services	(4)
MKT 442	Marketing Management	(4)
MKT 448	Mail Order/Direct Response Marketing	(4)

Digital Imaging and Document Management Elective:

The student will select 8 quarter units (2 courses) from the following list of courses with the consent of his/her advisor:

Course No.	Course Title	Units
CIS 310	Software and Hardware Concepts	(4)
CIS 413	Planning and Controlling the Automated Office	(4)
CIS 442	Data Base Design	(4)
CIS 484	Communications Systems	(4)

Table 3. Options, Concentrations or Special Emphasis (Continued from previous page)

The BSGC degree at CSULA is designed to meet the educational needs of students who wish to obtain management positions in the digital media or print industry. The BSGC program is focused on digital imaging graphic communications. It was designed based on identification of future trends in the graphic

communications industry. The goal of this program is to produce leaders for the thriving graphic communications industry. The BSGC program curriculum is well matched to the present and projected GC job market. The curriculum will continue to update as needed in order to keep this program current.

ACE/PACE courses

Three courses – Introduction to Graphic Communications, Imposition and Electronic Image Assembly, and Electronic Prepress Systems – can bridge the CSULA’s GC curriculum and Inner City GC Academy’s curriculum. These three active learning hands-on courses contain hands-on

projects and support by the state-of-the-arts Graphic Communications/Digital Document Management/Media Lab, which includes digital imaging, printing, electronic publishing, e-commerce, PDF workflow, and cross-media production. The course descriptions follow:

Introduction to Graphic Communications – 3 Units. General technology course emphasizing the importance of graphic communications in our culture, history, theory, and laboratory application of varied graphic communications processes. Lecture 1 1/2 hours, Laboratory 4 1/2 hours.

Imposition and Electronic Image Assembly – 3 Units. Prerequisite: TECH 130 or consent of instructor based upon previous experience. Applications of principles of imposition with emphasis on electronic image assembly techniques. Lecture 1 1/2 hours, Laboratory 4 1/2 hours.

Electronic Prepress Systems – 3 Units. Prerequisite: TECH 130 or consent of instructor based upon previous experience. Theory and application of electronic prepress systems to solve problems of digital image generation of image carriers for production printing. Lecture 1 1/2 hours, Laboratory 4 1/2 hours.

Students take Introduction To Graphic Communications in the fall quarter, Imposition and Electronic Image Assembly in the winter quarter, and Electronic Prepress Systems in the spring quarter. These three courses will generate nine credits before students start their four-year college program.

ADMISSION AND PLACEMENT

Regular admission to CSULA

The intermediate goal of the 2+4+Career model is to encourage GC Academy stu-

dents to continue their college education. CSULA's outreach officers participate in this project and assist students in applying for admission. The support services include:

1. Application for admission and application fee waiver.
2. Financial aid application.
3. Equal Opportunity Program application.

With assistance from the faculty and outreach staff, 67% of the first group and 70% of the second group applied for admission to CSULA. 100% of the applicants were admitted and received different levels of financial aid.

Internship, placement service, and industrial partners

At the present time, there are eight major printing/publishing companies such as Bowne & Co. and Color Graphics participating in this project. The arrangement includes

internship and placement. All students participate in the internship program during their second and third years at different companies based on the students' preference. All students start their full-time employment at the beginning of their senior year. The class schedules also adjust to fit the students' full-time working schedules.

POSITIVE EFFECTS

The 2+4+Career model paves a school-to-university-to-work pathway for high school students. It has positive effects on many areas:

Positive effect on the academy

The 2+4+Career model gives non-college-bound, at-risk students a chance to experience university life and to give them the opportunity to make a choice regarding higher education based on their experiences. By identifying

these at-risk students early on in high school, the academy can motivate them to work harder at their academic and technical courses. One of the biggest motivating factors is that the GC academy students know they have a choice after graduating from high school and that there is a prestige that goes along with starting one's university education while still in high school.

The GC academy students understand that there is limited space in the program, therefore, they understand they must compete for placement. The 2000-2001 school year will see 47 students competing for 30 available placements. This increased level of competition influences their other academic courses as well. Once these high school seniors are in the program, they know, that in order to continue at the

university in the 2+4+Career program, it is necessary that they maintain a high grade point average. This healthy level of competition has proven to be most effective when comparing the data of the first academy graduating class. Upon entering the academy at the start of the 10th grade, the average accumulative grade point average was 1.52. Upon graduation the average accumulative grade point average of these students was 2.98. Students are given increased tutoring and technical support, provided by the Los Angeles Unified School District Regional Occupational Program (LAUSD/ROP), allowing a smoother transition from high school to university culture. The LAUSD/ROP provides an instructor as well as transportation to and from the university.

Inner-City Graphic Communications Class of 2000 Statistics

	Academy	School
Accumulative Grade Point Average	2.98*	2.47
Same students in 9th grade		1.52
2.36		
Stan 9 Reading total**	24	17
Stan 9 Math total**	29	22
SAT Average score	757	720
	Started	Completed
Academy Class of 2000	56	38
Males	29	19
Females	27	21
Cal State LA 2+4+C***	22	15
Males	9	7
Females	12	8

Continuing Education in Graphic Communications School Major

Cal State University Los Angeles	Graphic Comm. Print Management6
	Graphic Design1
Cal State University Long Beach	Graphic Design1
Cal State University Northridge	Graphic Design1
Brooks College	GraphicDesign1
U.S. Army	Lithographer22
Post-Secondary Plan	Started	Still In Progress
University	15	14
Community College	9	6
Military	2	0

* Academy Students started in 9th grade with a GPA of 1.52

** Based on last Stanford test taken in 11th grade

*** Funded in part by the Printing Industries Association R.A.I.S.E Foundation and The California State Partnerships Academy.

Positive effect on the workforce

The 2+4+Career model could motivate more non-college-bound students to continue their college education. This will up-grade the work force in the long run. Students enrolled in the four-year college program will start their internship during their second year and start their full-time employment before graduating from the university. This school-to-work pathway will also provide the industry with appropriately trained new employees. All these facts not only generate a positive effect on the workforce but also provide more resources for industry.

A HEALTHY CYCLE FOR EDUCATION AND INDUSTRY

The positive effects of the 2+4+Career model on both the education and workforce build a healthy cycle for education and industry (Figure 3). The 2+4+Career model has motivated about 70% of the non-college-bound students to continue

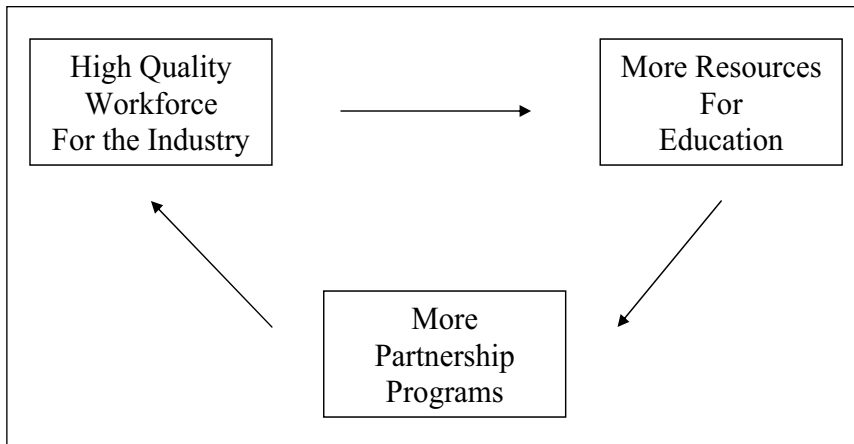


Figure 3. A healthy cycle

their college education. This will up-grade the workforce and provide the industry with higher quality new employees. Appropriately trained new employees will reduce the costs for pre-job or on-the-job training. In other words, it will generate more resources for the industry. Consequently, the industry will contribute more resources to education and support more 2+4+Career partnership programs.

CONCLUSION

The 2+4+Career initiative not only provides high school students a college

experience but also motivates about 70% of non-college-bound students to continue their university education and, furthermore, start their career before they graduate from the university. This model has many positive effects on students, curriculum development, and the workforce. The seamless school-to-work pathway provides students a smooth transition to career. All these positive effects build a healthy cycle which will further improve the secondary, postsecondary, and industry linkage.

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the Graphic Communications Division of NAIT; a member of the Los Angeles County Regional Occupational Program Graphic/Printing Advisory Committee; a member of many schools' advisory committees; a judge of many educational competitions; and a reviewer for many grant programs and publishers.

John Santos is Lead Teacher of the Imaging Sciences and Technology Academy at Manual Arts High School in South Central Los Angeles. John Santos' students have maintained over a 90% retention rate at the university level. John's belief that his responsibilities towards his students surpass graduating from high school, will see the results of his efforts next year (2004) when nine of his first 10 academy students will graduate from college.

John has been instrumental in developing several innovative educational programs, including the Foundation for Education's Center for Entrepreneurship, and the Cal State L.A. 2+4+C Program. The Center for Entrepreneurship was devel-

oped to teach students business and marketing skills as well as assist them with their self-esteem. The 2+4+C program is a unique program which allows at-risk students the opportunity to experience university life while still in high school. It has had more than a 90% success rate over the last three years.

ESTABLISHING INTERNSHIPS WITH THE INDUSTRY—A WORKING GUIDE FOR UNIVERSITY DEPARTMENTS

CYNTHIA CARLTON GILLISPIE-JOHNSON
NANCY GLENZ
GRAPHIC COMMUNICATION SYSTEMS
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INTERNSHIPS

One would be surprised at the many companies that do not understand the term "Internship." When trying to start a partnership with companies and establish internships, the companies would often ask for a guide of what is expected of them. The Department of Graphic Communication Systems and Technological Studies at North Carolina A&T State University developed a working guide for the department. The department offers two courses in Internships. Internships offer the students the opportunity to work closely to their major field of study. The department, school, and university urge students to gain work experience before graduating. The internships are student oriented, and the

student must be committed to a mutually agreed upon work schedule.

Qualifications of the students

Minimum qualifications assigned by the department provide a broad base from which employers can identify more competitive students. The department may or may not provide pre-screening of applicants; however, the department assists in providing a pool of candidates who most closely match to the qualifications requested by the employer.

How the company benefits as an internship employer

Participation as an employer of internships is an effective and inexpensive

method of recruiting capable employees. The program provides an opportunity to observe the job performance of prospective employees over a period of time as well as provide the participating company an opportunity to project a good company image to a large student population. Industry is given the opportunity to participate in the educational and cultural growth of young citizens. Overall, participation in internships helps to establish good relations and better communication with the university. Through this, the department is kept abreast of changing requirements in industry and can provide better-trained students by adapting to these changes.

GUIDE SUGGESTIONS

Why choose my university

In this section of the guide, the department gives facts about their university. An example: North Carolina

A&T is one of two land grant institutions established in the state in 1891. It is the largest Historically Black University within the 16 constituent campus system of the University of North Carolina and enrolls over 9,000 undergraduate and graduate students annually.

The University offers a cadre of academic programs and boasts about its distinguished faculty.

The academic programs are fully accredited by the Commission on Colleges of the Southern Association of Colleges and Schools.

Responsibilities of the employer

In this section of the guide, information is given about the duties and responsibilities of the employer:

- Letter from the supervisor confirming employment and describing employer responsibilities.
- Internship should consist of at least 300 hours a semester.
- Employer is expected to assume responsibility for the student's supervision during the work term(s)
- Compensation should be accordance with prorated salaries for entry level employees.
- Compensation formulas may vary from employer to employer; however, if there will be no compensation, this must be clearly stated to the student.
- It is recommended that supervisors discuss job expectations with the student within the first week of employment. This gives the student the opportunity to ask questions regarding their expectations and identify what they expect to gain from the experience. The discussion should lead to mutually beneficial communication.
- Employers should provide in-service training to supervisors and department personnel where interns are placed so that they understand why interns are there.

Responsibilities of the student

In this section of the guide, the student is given a clear explanation of what is expected. Responsibilities of the student consist of but are not limited to the following:

- Compile portfolio that consists of a daily journal/diary including reflections regarding tasks and interactions, sample of work completed and justification of why it was placed in the portfolio. Samples may include photographs or video of selected activities.
- Successful completion of the work period(s).
- Demonstrate willingness to learn new skills and apply them.
- Comply with the same rules and regulations imposed on all other company employees.

Evaluations

Evaluation of the student is a letter from the supervisor at the completion of the internship stating his/her evaluation of the student intern's

performance. The supervisor is asked to discuss the evaluation with the intern before submitting the letter of evaluation. The evaluation is used to assist student with his/her professional development. The student also evaluates his/her experience with the employer.

Some employers may like a standardized form for evaluation. If this is the case, a form is provided.

Industry – setting up a program

In this section of the guide, a clear explanation is stated about setting up a program for first timers. The first step for the industry in setting up a program is to identify available internship positions within their agency/ corporation/ industry

Afterward:

- Communicate with the contact person within the department.
- Provide a description of job responsibilities.
- Identify minimum qualifications suitable for the

position(s).

- Indicate the number of available positions and the periods(s) you wish to employ the students.
- Indicate preference for on-campus interviews or resume referrals.
- Provide department with information about your company.

Recruitment for interns should be scheduled at least one semester prior to the start date established by the agency/company/industry. If the company has a problem with a written contract with the student, a letter confirming employment and describing employment responsibilities should serve as a formal agreement between the employee and student and is kept on file within the department.

Work study schedule

This section of the guide provides an explanation of the university operations, whether the University operates on the quarter or semester system. The stu-

dent's schedule should be explained. An example is: Students can work during the fall semester, the spring semester of an academic year, and/or summer. Be concise and clear, such clarity should be stated as, the department is flexible in designing work schedules and takes into account the needs of both the employer and the student prior to approving work schedules. Employers are also made aware of situations where students must reschedule their work dates because of conflicts in class offerings. There are some academic areas that only offer classes once per year, etc.

CONCLUSION

By definition, the internship is an educational work program designed to expose the student to a career closely related to his or her major field of study. For a new intern, an orientation to the company/agency/industry is essential and necessary.

This is also true as it relates to job expectation.

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UNDERSTANDING DIGITAL HALFTONES

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ABSTRACT

For more than a hundred years, halftone images have been reproduced by rendering tonal values via crossline screen into different sized printing dots. The traditional photography halftone gives printers fairly predictable and consistent quality throughout the press run. In recent years, computers have been widely used in the electronic prepress area, especially the PostScript Raster Image Processor (RIP) technology in highly accurate imagesetters. Digital halftones have become the standard for halftone film output.

However, there are many myths in the digital halftone process that are not fully understood by most people. This study focuses on the basic principles of the digital halftone process, and what we should know about it in order

to reproduce halftone images with quality.

INTRODUCTION

It was not possible to reproduce a photographic quality image on print until the invention of the halftone. In 1881, Georg Meisenbach laid the basis for screening by inventing the autotypical halftone process that is still used today. (Kipphan, 2001)

The term "halftone" is used because halftone images do not have any tone. Halftones were created by using a camera containing a ruled screen with a grid pattern to break up the image into tiny dots of different sizes. Halftones utilize the deficiency of the human eye. The eye has limited resolving power and the halftone images are perceived as a

continuous tone when viewed at a distance.

The basic principles of the photography halftone process have been unchanged since Meisenbach invented the process. The photography halftone process gives printers a fairly predictable and consistent quality for reproducing images. However, in the early 1990s the application of the personal computer changed the prepress sector. Digital image processing in electronic prepress systems made photography halftones obsolete.

DIGITAL HALFTONE PROCESS

The development of electronic screening began in the early 1970's. It incorporates electronic dot generation via the high-end electronic color scanner as an alternative to the traditional photomechanical screening techniques. In the desktop or PostScript environment, four generations of screening technology have developed. (Fenton, 1994)

Digital halftones are generated by dividing the image plane into repetitive, uniform grids of large cells containing a fixed number of pixels.

The cells tile seamlessly and cover the whole image plane without gaps or overlapping. Various tone levels are simulated by varying the number of pixels that are within the cell. In the desktop or PostScript environment, clustered-dot and dispersed-dot halftones are two major screening patterns that are used in digital halftone processes (Kang, 1999).

Clustered-dot screening tries to mimic the conventional photographic halftones that were invented in the late part of 19th century by using a technique called threshold array. Threshold array is used to rasterize digital images into clustered laser dot exposures. It arranges different sized dots in fixed, angled grids for multicolor printing. Because of the requirements of different screen angles and screen rulings for multi-

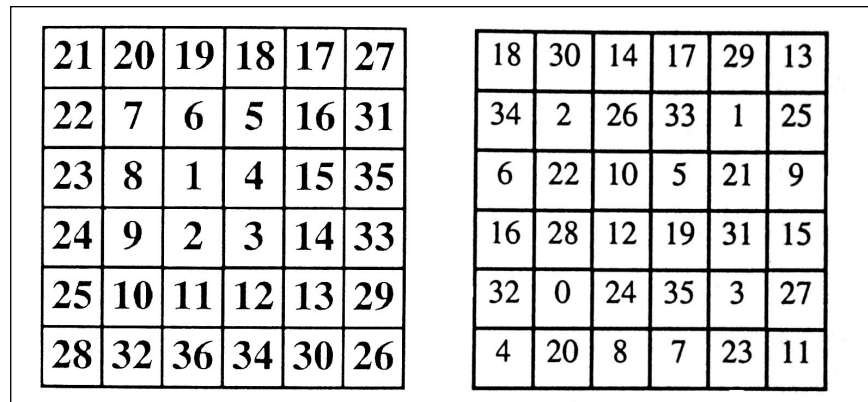


Figure 1. Clustered-dot and Dispersed-dot Threshold Array (Kang, 1999)

color printing, digital screening functions have become very complicated. Therefore, different generations of screening algorithms were developed to overcome the problem of massive calculations, thus achieving better quality and higher efficiency.

On the other hand, dispersed-dot halftoning abandons the familiar halftone dot and fixed line screen for a random scatter of microdots in order to form the image. Dispersed-dot is produced by either ordered-dither or error-diffusion algorithms.

Dispersed-dot ordered dither is similar to the clus-

tered-dot method. It uses threshold array to provide a fixed pattern of numbers to indicate the order in which pixels are turned on or off within a halftone cell. Instead of using a compact pattern like the clustered-dot method, the dispersed-dot-ordered dither turns pixels on individually without grouping them into clusters at a particular tone level. (See Figure 1)

Dispersed-dot-ordered dither gives a high-frequency appearance to the image content. However, it suffers from rigid, regular structures because of the fixed threshold array. In 1978, Allenbach introduced random nucleated screens to break up the regu-

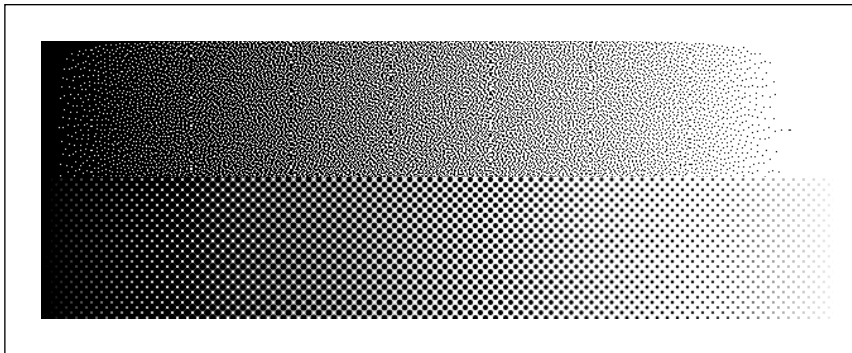


Figure 2. Grayscale tone rendition of conventional and frequency modulated screens. From top to bottom: UGRA Velvet Screen (FM, 21µm spot size), and conventional screen (150-lpi)

larity of dot patterns by ordered-dither method. (Allebach, 1999) Ulichney later introduced the error diffusion algorithms to further reduce the structure patterns. (Ulichney, 1987) These methods that give high-quality, artifact-free images are sometimes referred to as stochastic screening.

Dispersed-dot halftone processes, also called frequency modulated screen (FM screen) or stochastic screen, uses a microdot placement similar to the way photographic images are recorded on photographic film emulsion. This is due to the fact that the microdot is very small and randomly arranged

and the human eye fails to resolve it. Visually, FM screening is closer to a continuous tone effect than conventional screening. (See Figure 2)

DIGITAL HALFTONE PROCESS MYTHS

Halftone cell and tonal value

A major difference between photography and digital halftones is that photography halftones are produced by exposing film through a contact screen. In theory, halftones can have any dot size, screen angle, and shape. Digital halftoning does not have this freedom. It is confined in a digital grid that is defined by the output

device's addressability. The size and position of each pixel is fixed.

In a conventional digital halftone process (clustered-dot screening), a halftone dot is generated from a cluster of laser spots. A halftone cell is then divided into a matrix of single recording dots (laser spots). The number of laser spots within a halftone cell depends on the screen ruling and the resolution of the imagesetter or film recorder.

Figure 3 illustrates the relationship between the screen ruling and output device resolution. In this example, the figure indicates an output device has eight pixels per inch addressability. If the halftone dot is set for two dots per inch (2-lpi), each halftone cell will contain 16 pixels (4 x4). If the output is increased to four dots per inch (4-lpi), then the halftone cell will only have 4 pixels (2x2).

As we can see, the number of pixels in a halftone cell is limited by the addressabil-

ity of the output device. In the example given, the 16 pixel halftone cell means there are 17 possible tonal values (0 to 16) for this particular halftone dot. Therefore, the number of pixels in a halftone cell represents the tonal value of the halftone image.

The number of printable levels of gray (n) can be estimated with the following formula:

$$n = (\text{resolution/frequency})^2 + 1$$

If the gray level is too low, the image will become posterized. As a result, a high-resolution output device is needed for high frequency screen ruling halftones. For a lithography printing process, 1200 dpi is the minimum resolution for halftone film output.

For example, the AGFA SelectSet 5000 imagesetter has a resolution of 2,400-dpi. A screen cell of the 150-lpi, conventional halftone screen, output from the SelectSet 5000, contains total $16 \times 16 = 256$ ($2400\text{-dpi}/150\text{lpi} = 16$) laser

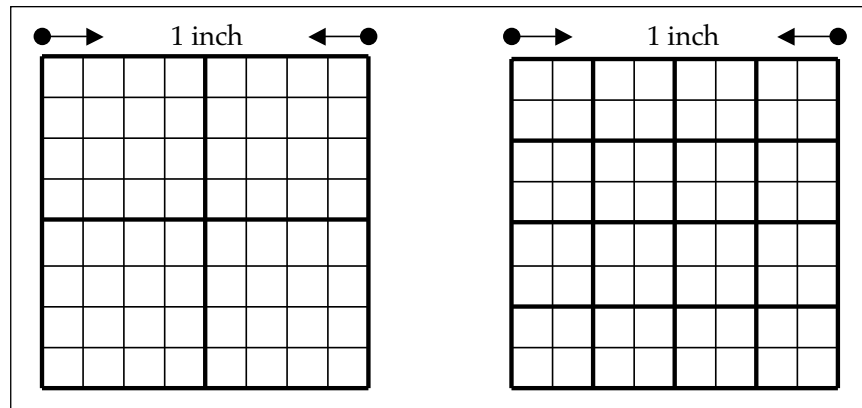


Figure 3. Halftone Cell

spots. The size of each laser spot is $10.5\mu\text{m}$ (microns, 10^{-6}m).

Screen angles

The other problem one encounters in the conventional digital halftone process is screen angle. For multi-color printing, the same frequency of line screens for different colors will cause interference between screens. This often causes a moiré problem. The solution to the problem is to vary the angle between the colors. The moiré pattern is less visible when screens are rotated by 30 degrees from each other. In four-color process printing, the screen

angles for black, magenta, cyan and yellow are 45, 75, 15, and 90 degree. (SWOP Inc., 1993)

It is easy to change the angle by rotating the contact screen during the photography process. But the angle for the digital halftone is also limited by the resolution of output device and output lpi combination. The precise angle is sometimes not possible during the output. Irrational tangent, rational tangent, and super cell are the three major algorithm developments that have helped achieve more accurate screen angles. (Kang, 1999)

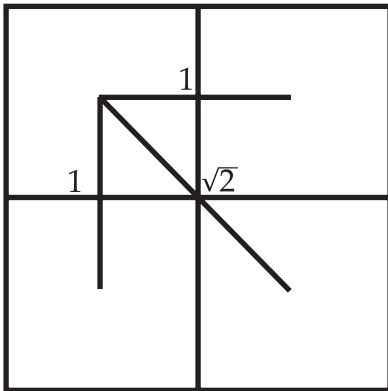


Figure 4. Distance of neighboring pixels

PPI, DPI and LPI

The terms pixel-per-inch (PPI), dot-per-inch (DPI), and line-per-inch (LPI) are often confused. PPI and DPI are often interchangeable in the digital image process. DPI is a measure of resolution. In the scanning stage, DPI is the sampling resolution - how many dots per inch it is recording. In the output stage, DPI is the number of dots created on each inch of output, whether on a printer or on a computer screen.

LPI is a measure of a conventional halftone screen. In digital halftoning, each halftone dot is a collec-

tion of pixels for the output device. The number of dots, as mentioned previously, depends on the screen ruling and the resolution of the output device.

When a scanned image will be printed using conventional screening, most experts recommend a sampling resolution between 1.5 to 2 times the screen rulings of the printed image. For example, a 300-dpi scanning resolution is always desirable for the 150-lpi halftone output.

Why is the magic number 1.5? The actual ratio is $2^{1/2}$. Digital images transform from pixels to halftones during the screening process. Because the digital halftone dot has a limited tonal value, the tonal jump could easily appear when each halftone dot is calculated from a pixel. To avoid this you average the tonal values of adjacent pixels. The ratio of $2^{1/2}$ comes from the maximum distance of neighboring pixels. (See Figure 4)

Frequency modulated vs. amplitude modulated screening

In digital halftoning, the term amplitude modulated (AM) screening and frequency modulated (FM) screening have been borrowed from the field of signal processing. Similar to the AM and FM radio waves, in AM screening dot frequency (screen ruling) is constant and dot amplitude (dot area) varies; for FM screening the dot frequency varies and dot size is constant. (See Figure 5) AM screen uses the variation of dot size and FM screen uses the variations of dot frequency to represent the image tone.

A distinction should be made between AM and FM screening. The AM screening uses the conventional compact way (clustered dots), and FM screening uses microdots that are resolved and dispersed in the screen cell (dispersed dots). (See Figure 6)

An AM screen is specified by its screen ruling, lines

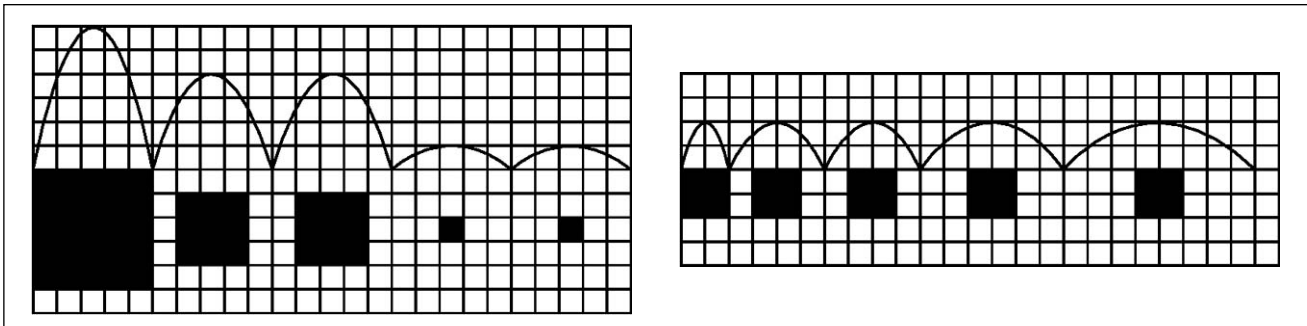


Figure 5. Amplitude Modulated (AM) and Frequency Modulated (FM) screening

per inch (lpi), and FM screen is specified by the size of microdots, usually given in microns (μm , 10^{-6} m). The output microdot size of a FM screen depends on the resolution of the output device. Because each FM dot is composed of a single laser spot or a matrix of laser spots, an FM microdot is always proportional to the imagesetter's laser spot size (1x1, 2x2... etc., a matrix of laser spots).

For example, AGFA's FM screening system, known as CristalRaster, uses a 2x2 matrix of laser spots to generate FM microdots. The laser spot size of a 2,400 dpi resolution imagesetter is $10.5\mu\text{m}$ and the CristalRaster FM micro dot is created by $2 \times 2 = 4$ laser spots, so the size

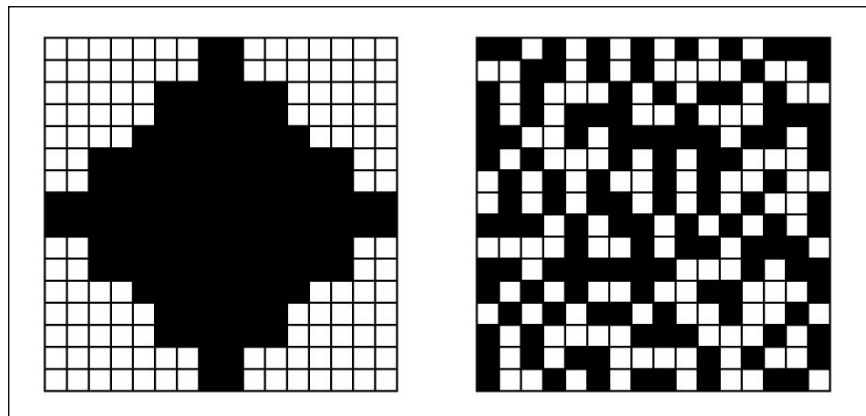


Figure 6. A 50% tone. Both AM & FM screen have 128 laser spots per 16x16 halftone cells ($128/(16 \times 16) \times 100\% = 50\%$)

of the FM micro dot output from a 2,400 dpi imagesetter is $21\mu\text{m}$. This is equivalent to a 1% dot of a 150-line screen. A 3,600 dpi resolution imagesetter produces a $14\mu\text{m}$ FM microdot, which is about equivalent to a 1% dot of a 200-line screen.

FM screen has been praised for several advan-

tages over conventional halftone screens, such as no visible dot pattern, no moiré, no tradeoff between tone level and frequency, no tone jump, smooth tone rendering, less need for edge sharpening, and less problem for shadow plugging. (Prince & Adams, 1993) The few arguments

against FM screen are their graininess and dot gain.

Over the past ten years there has been much discussion about FM screening. The idea of the frequency modulated screen has come to the market with various commercial trademarks like Adobe Brilliant Screen, Agfa Cristal-Raster, Linotype Diamond Screen, Hyphen Spectra Cell, Scitex Fulltone, UGRA Velvet Screen, and Varityper ESCOR, etc. It is discussed extensively in trade articles. Today, at least 20 FM screening products are available on the market. FM screens can bring about the quality improvement needed for printing. FM screening has been the most actively researched area in digital halftones during this decade.

SUMMARY

The digital halftone process was first introduced with the digital scanner in the 1980s. In today's electronic prepress workflow, the PostScript halftone process

has become the primary method for halftone film output. People in the printing industry must think of images in a digital way. The relationships between image resolutions, output device addressability, halftone line per inch (LPI), and screen angles are key issues in achieving quality halftone image output.

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CONDUCTING ONLINE SURVEYS VIA PORTABLE DOCUMENT FORMAT (PDF)

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INTRODUCTION

Surveys are increasingly being done via the Internet because of the cost and ease of use (Dillman, 2000). PDF is one such Internet system and will be explained in this article.

PDF stands for Portable Document Format. In 1991, Adobe unveiled this innovation at a Seybold conference in San Jose. The original idea was to design a file format that could be exchanged with different computer platforms and display information consistently on different output devices, such as computer monitors, desktop printers, and even presses. The goal was to achieve *WYSIWYG*, *What You See Is What You Get*.

ADVANTAGES OF PDF

PDF has several unique features as shown below (Adobe

Systems Incorporated, 2000; Padova, 1999) .

- PDF is a cross computer platform standard. When someone creates a PDF on any computer platform, others can open it and view it as originally created.
- PDF is device independent. PDF documents are color and font independent because they embed color management profiles and fonts used in the documents. This is how it can have output consistency.
- PDF can contain multimedia. It can include movie clips, animations, or sounds. Also, it can have hyperlinks that can link to Web pages or e-mail.
- PDF is editable. Even though PDF documents are static, with Adobe Acrobat, you still can modify them.

- PDF supports security. PDF viewing, printing, and modifying can be partially or full confined with passwords.

ELEMENTS NEEDED FOR A PDF SURVEY

Using PDF does not require a high level of computer literacy. The following are the elements needed (Guthrie, 1998; Padova, 1999).

- A Windows NT, 2000, or XP Server.
- Http server applications. Some of them, such as Apache or Sambar, are free and can be downloaded from company websites.
- Common Gateway Interface (CGI) or Perl script for communication between clients and the http server.
- Adobe Acrobat 4.0 or later version to manipulate your PDF survey questionnaire.

In addition to the above elements, it helps to have some understanding of JavaScript in order to create an interactive PDF online survey. The specifications of Acrobat JavaScript can

be downloaded from Adobe's Website at <http://www.adobe.com>.

CREATING PDF DOCUMENTS FOR ONLINE SURVEYS

To create PDF documents from most applications, like Microsoft Word, you simply print your document to a PDFWriter. If the document is designed for high-end output devices, you will have to create a PostScript file by using 'Print to File', and then use Acrobat Distiller to convert this PostScript file into a PDF.

After a static PDF is generated, you can create some form fields by using Adobe Acrobat's form tools. These form fields can be filled out in Acrobat or Reader. Acrobat form fields can be text fields, check boxes, combo boxes, radio buttons, and signature fields. For most of them, you can set up validation and calculation

After generating the survey, you can upload this document and set up the

http server application and an appropriate Common Gateway Interface (CGI) script by using Perl or any language that you are familiar with. Then, your Internet survey using PDF is ready to launch.

TIPS FOR DESIGNING PDF ONLINE SURVEYS

Return rate increases if participants are comfortable with the questionnaire you create. Following are some guidelines for Internet surveys (Dillman, 2000; Schonlau, Fricker, & Elliott, 2002; Guthrie, 1998).

- Show only one or a few questions per page. Respondents can be more focused on the question or questions without scrolling up and down. Also, you can set up links or buttons for previous and next pages underneath your questions.
- Zoom in to page width. Acrobat or Reader allows you to setup the initial viewing size. For survey purposes, zooming in to

page width is recommended.

- Eliminate unnecessary elements and use a white background. For conducting surveys, you don't want to confuse or distract the respondents.
- Use graphics with care. Make sure you really need any graphic used. If it is necessary to have graphics, select an image resolution to minimize file size. If graphics are not necessary, this will reduce download time.
- With PDF form fields, you may setup validations (limitations on what can be input) to reduce response errors. Form fields like radio buttons or combo boxes can be validated. JavaScript codes can be validated as well.
- Provide quick help or assistance. Sometimes, your respondents may need help for interpreting questionnaires. Quick help (called hot help in PDF) annotation, dialog

boxes, or a movie or sound clip can be provided for this purpose.

- Provide passwords to protect your online survey. Because an Internet survey is open to the public, a password is needed to restrict access and uniquely identify respondents. You can setup passwords when creating your PDF questionnaire or a digital signature can be applied as well.
- Take advantage of the multimedia capability of PDF. A PDF questionnaire can include print and multimedia. With PDF survey, you have more options in designing the questionnaire.

SUMMARY

Conducting a PDF survey has many advantages. The survey will look the same in different computer platforms and print the same. Think about PDF the next time you want to conduct an Internet survey.

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MANUSCRIPT GUIDELINES

ELIGIBILITY FOR PUBLICATION

Members in the International Graphic Arts Education Association or students of IGAEA members, may publish in the *Visual Communications Journal*.

AUDIENCE

Write articles for educators, students, graduates, industry representatives, and others interested in graphic arts, graphic communications, graphic design, commercial art, communications technology, visual communications, printing, photography, journalism, desktop publishing, drafting, telecommunications, or multi-media.

Present implications for the audience in the article.

TYPES OF ARTICLES

The *Visual Communications Journal* accepts four levels of articles for publication:

1. Edited articles are accepted or rejected by the editor. The editor makes changes to the article as

necessary to improve readability and/or grammar. These articles are not submitted to a panel of jurors. The decision of the editor is final.

2. Juried articles are submitted to the editor and are distributed to jurors for acceptance/rejection. Juried articles are typically reviews of the literature, state-of-the-art technical articles, and other non-empirical papers. Jurors make comments to the author, and the author makes required changes. The decision of the jurors is final.

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4. Student articles are submitted by IGAEA members. These articles are accepted/rejected by the

editor. These articles are not submitted to a panel of jurors. The editor's decision is final.

MANUSCRIPT FORM AND STYLE

Prepare manuscripts according to the APA style, including the reference list.

Submit a maximum of ten word-processed, 8.5" X 11" pages in 12 point type and double spaced (excluding figures, tables, illustrations, and photos). Also, provide a short biography for yourself that can be used if the article is accepted for publication.

All articles must be submitted in electronic form and as a hard copy. Articles can be submitted on a 3 1/2" disk, Zip disk, CD-ROM, or as an e-mail attachment.

The text should be submitted in Microsoft Word format. Do not submit documents created in page-layout programs.

Call out the approximate location of all tables and figures in the text.

These call-outs will be removed by the editor.

List your name and address on the first page only! Article text should begin on the second page.

ARTWORK

Be sure that submitted tables and other artwork is absolutely necessary for the article, and that each one has a caption.

Electronic artwork is preferred and should be in EPS or TIFF format. Send all artwork files and hard copies of these files with your submission.

Scan photographs at 300 ppi resolution. Scan line drawings at 800 ppi resolution. Screen captures should be as large as possible.

SUBMITTAL OF MANUSCRIPT

All manuscripts must be received by the editor no later than December 15th to be considered for the next year's journal.

The manuscript packet must include digital and

hard copies of all text and figures. Prepare text and artwork according to the instructions given in these guidelines.

Be sure to include your name, mailing address, e-mail address (if applicable), and daytime phone number with your materials.

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