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Women in Graphic Communication: A Comparison of Two Studies

by Twyla J. Cummings, Ph.D. • Rochester Institute of Technology

Today's graphic communication industry is multi-faceted and encompasses many disciplines including printing, publishing, design and information technology. It is an industry that has undergone significant structural change embracing new technology and service diversification. Another significant shift in the industry relates to the changing gender demographic. Once predominately male, many women have entered the industry and have moved up the ranks into leadership positions. These women have become positive role models for young women just starting their careers in graphic communication.

Purpose of the Study

In 2000 a research study was conducted to gain an understanding of the demographic and employment status of women in the graphic communication industry (Cummings et al, 2001; Cummings 2004). The resultant highlights of this study were:

- Women had a visible presence in the industry; particularly working in sales and for supplier/manufacturing companies.
- Women had minimal presence at management levels.
- Mentoring played a major role in these women's career development and advancement.
- Gender pay inequality was a major issue.

In 2011 the research questions from the 2000 study were revisited in an effort to determine if any significant trend changes over this eleven year span could be identified. An overarching goal of this research was to conduct a comparative study targeting a larger sample population and to once again determine the demographic and employment status of women in the industry.

Methodology

Both studies utilized a descriptive research methodology. A survey was administered for each study and the same question set was utilized. The survey questionnaire was focused in three areas: 1) demographics, 2) graphic communication industry status and issues for women, and 3) voluntary comments.

2000 Research Study

In 2000, the research sample consisted of women attendees and exhibitors at the 2000 Graph Expo Exhibition Trade Show in Chicago, IL and the female members of

the Graphic Arts Technical Foundation (now Printing Industries of America). Data were collected from 190 women through a paper survey.

2011 Research Study

The research sample consisted of women attendees of the 2011 Graph Expo Exhibition, members of RIT's Printing Industry Center, and members of the Print Production Professionals LinkedIn group. Data were collected from 349 women through an electronic survey.

Study Limitations

The time span between the two research studies and the advancements in technology resulted in two different methods for the administration of the survey. However, the same questions were asked and the demographic make-up of the target populations is similar. In 2012 the number of employees in the graphic communication industry was 468,185 (Davis, 2013). While employment numbers may have been higher in 2000, the samples sizes from both studies represent a small portion of the industry's employee population. Thus, the conclusions drawn from the research data cannot be generalized to all women working in the graphic communication industry.

Results

More than 45% of the 2000 study respondents worked for companies that employed 100 employees or less (Table 1). Only 18.9% of respondents from this group worked for firms with more than 500 employees. Approximately 57% of the respondents from the 2011 study work for companies that employ 100 employees or less and 23.2% worked for firms with more than 500 employees.

Respondents were asked about their current job titles/ areas (Table 2). The majority (32.8%) of the respondents

Table 1: Number of Employees Working at Respondents' Companies

Number of Employees	2000 (n=190)	2011 (n=336)
Less than 50	28.9	41.1
51–100	16.8	16.10
101–200	21.1	10.1
201–500	13.7	9.5
>500	18.9	23.2
No Answer	0.5	0.0

from the 2000 study indicated that they worked in the area of sales and/or marketing versus approximately 23% from the 2011 study. The majority (43.1%) of the respondents from the 2011 study reported being in a management role or a business owner as compared to only 11.4% of the respondents from the 2000 study.

Table 2: Respondents' Job Titles/Areas

Job Title/Area	2000 (n=190)	2011 (n=359)
Sales/Marketing	32.8	23.0
Customer Service	6.6	5.9
Sr. Mgmt/Owner	9.8	18.10
Middle Manager	1.6	25.0
Education	6.0	2.9
Computer Technology	14.2	1.4
Accounting	3.3	0.3
Other	20.2	26.1
No Answer	5.5	0.6

Length of Time Working in Industry

Respondents were asked questions related to the amount of time they had been employed in the graphic communication industry (Table 3). A total of 32.6% of the 2000 study respondents had worked in the industry between 1–5 years; 12.6% had worked in the industry 20+ years. The largest portion (46.8%) of the 2011 study respondents worked in the industry 20+ years.

Table 3: Time Employed in Graphic Communication Industry

Years in Industry	2000 (n=190)	2011 (n=349)
1–5	32.6	14.1
6–10	24.2	14.7
11–15	18.4	12.9
16–20	12.1	11.5
20+	12.60	46.8

Approximately 60% of the 2000 study participants and 49.4% of the 2011 study participants reported that they had been employed in other industries prior to working in graphic communication. Some of the other industries listed from both studies included accounting, law, networking products and retail sales.

Female Employees at Respondents' Firm

Table 4 shows that for both studies the majority of the respondents indicated that there were between 21% and 50% females employed at their company.

Table 4: Female Employees at Respondents' Companies

% of Female Employees	2000 (n=190)	2011 (n=333)
< 10	13.7	10.4
10 – 20	22.6	17.6
21 – 50	47.6	48.2
> 50	13.7	23.8
No Answer	2.6	0.0

Women in Management at Respondents' Firm

When asked what percentage of females at their firm held management positions (Table 5), 62% of the 2000 study respondents indicated less than 10%. Almost 49% of the 2011 study respondents reported that less than 10% of the women in their firms were in management. A small (2001–6.3%; 2011–10.7%) percentage from both groups reported that females in management represented 50% or more of the employees in their firms.

Table 5: Female Managers at Respondents' Companies

% Females in Management	2000 (n=190)	2011 (n=336)
<10	62.1	48.8
10 – 20	18.4	19.0
21 – 50	9.5	21.4
>50	6.3	10.7
No Answer	3.7	0.0

Women in Key Positions

The respondents were asked how the status of women in key industry positions has changed during their tenure in the industry. More than half (55.3%) of the 2000 study respondents indicated that the number of women in key positions had increased during their time in the industry and approximately 26% responded that there had been no change. More than 43% of the respondents from the 2011 study indicated that the number of women in key positions had increased and 34.5% indicated that it had stayed the same (Table 6).

Mentoring

Seventy percent of the women in the 2000 study and 67% of the women in the 2011 study reported having a mentor during their career. Of the seventy percent of the 2000

Table 6: Increase/Decrease of Women in Key Positions

Status of Women in Key Positions	2000 (n=190)	2011 (n=333)
Increased	55.3	43.5
Decreased	3.7	5.4
Same	25.8	34.5
Don't Know	13.7	16.5
No Answer	2.1	0.0

respondents reporting having mentors, 39% had a male mentor. Forty-two percent of these respondents had both a male and a female mentor at some point in their careers. Women from the 2011 study reported that more than 52% of their mentors were male and only 24.7% had both male and female mentors.

Problems Encountered

The respondents were asked about problems encountered during their career (Table 7). This question allowed for multiple answers. From the respondents of the 2000 study the biggest problem reported was pay inequality (54.7%). The next largest problem encountered was resentment from male peers (33.7%) followed by being passed over for promotion (24.2%). Respondents from the 2011 study also cited pay inequality (55%), resentment from male peers (31.1%) and being passed over for promotion (29.0%) as the three biggest problems faced in their career. Other problems indicated were: (a) not being taken seriously and (b) lack of support or encouragement.

Table 7: Problems Encountered During Career

Problem	2000 (n=336)	2011 (n=609)
Resentment from male counterparts	33.7	31.1
Passed over for promotion	24.2	29.0
Pay inequality	54.7	55.0
Sexual harassment	21.6	24.2
Other	16.3	20.2
Not applicable	24.2	24.5
No answer	4.2	0.0

Voluntary Comments

Respondents from both studies provided insightful comments relating to women in the graphic communication industry. The comments from both studies were largely focused on women's growth, career opportunities, the importance of hard work, gaining knowledge and male/female comparisons.

Research Findings

In a comparison of the findings (Table 8) from these two research studies the significant trend changes were: 1) more women working in management and senior management positions, 2) a significant increase in the number of women business owners, and 3) a significant increase in the length of time women have been employed in the industry.

Table 8: Comparison of Research Study Findings

Industry/ Demographic Status	2000	2011
Women's presence in industry	Majority of respondents had been in the industry 1-10 yrs.	The majority of the respondents had been in the industry 20+ yrs
Number of women employed at respondents' companies	Majority of respondents work for firms employing between 21% - 50% women	Majority of respondents work for firms employing between 21% - 50% women
Primary job titles/ areas	Sales/Marketing; 11.4% of respondents in management positions	Sales/Marketing, Business owner, Middle Managers; 43.1% of the respondents in management positions
Women in management	62.1% of respondents worked in companies where less than 10% of women were in management positions	48.8% of respondents work in companies where less than 10% of the women were in management positions
Women in key positions	Respondents perceived that there has been a significant increase during their career	Respondents perceived that there has been a significant increase during their career
Impact of mentoring	Majority of women have had at least one mentor during their career. Majority of mentors are male	Majority of women have had at least one mentor during their career. Majority of mentors are male
Problems encountered	Resentment from male peers, being passed over for promotion and pay inequality	Resentment from male peers, being passed over for promotion and pay inequality

Discussion

The primary purpose of this research was to examine the demographic and professional status of women employed in the graphic communication industry in 2011. The second objective was to compare the data from this research to the results generated from a study completed in 2000. The same research questions were administered in both studies. As compared to the 2000 study the data

from the 2011 research shows: 1) significantly more women in management positions, 2) an upward trend in women business owners and, 3) an increase in the length of time women have been employed in the industry.

There are many possible reasons for these upward trends, however the author of this research study suggests that some key ones include: 1) more advances in and shifts to digital technology, 2) changing workplace demographics and, 3) a breakdown of some of the barriers to entry into management positions that women previously faced. Additionally, given the time span between the two studies it is reasonable to expect that the tenure of women, who are becoming more established in their graphic communication careers, would have increased.

While the data from this research reveals the positive upward trends previously mentioned, it is disturbing to learn from the respondents of the 2011 study that they still routinely encounter problems with resentment from male peers, being passed over for promotions and pay inequality.

Implications

This research addresses the following question: *How has the graphic communication industry changed relative to the status of women between the years 2000 and 2011?* While the rise in women's status suggested by the data is exciting, women are still faced with major issues. For example even though the presence of women in management and senior level positions has increased, they are still not paid equally as compared to their male counterparts. Sadly, this is not just an issue for women in graphic communication, as women earn approximately 23.5% less than men in most all male dominated occupations (Institute for Women's Policy Research, April 2013 & September 2013).

So what does all this mean for women who might want to pursue a career in the graphic communication industry? With more women in managerial positions and the increased longevity of women in the industry, there will likely be more women available to serve as role models and mentors. Additionally, it seems that there are opportunities for talented women to successfully run their own businesses and be service providers to graphic communication companies. The presence of more women in the industry will allow new female entrants to see more people that look like them, which will ultimately help them to survive and thrive. Regarding the challenges women face, it is important to be aware that they exist and to not be deterred from pursuing their career goals.

This research has implications for both the academic and business sectors of the graphic communication industry. As the search for key personnel becomes more competi-

tive, it is anticipated that there will be more opportunities for women to pursue careers in all areas of graphic communication (Cummings, Sorce, Walker 2011). The findings from this study can be a useful resource in helping companies successfully recruit, develop and retain female professionals. It has implications for the academic sector because many young women enter the graphic communication industry as new college graduates. Educational institutions have an obligation to adequately prepare students for success in their careers. Thus, it is important that topics such as salary negotiation, management skills, and organizational strategy be incorporated into the curriculum of graphic communication programs. A comment from one study respondent supports this: "It is gratifying to see the number of young women in graphic communication academics. These women should be educated and trained to demand equal pay and suitable positions within companies."

This study will add to the limited research conducted on this very important subject. The outcome suggests that women make up an integral part of the graphic communication industry and will continue to do so. Therefore, it is hoped that the results highlight the important role that women play in the future success of this industry. Further it is hoped that it will serve to educate and inform key stakeholders about the challenges women still face and send the message that there is more work to be done to support diversity and inclusion in the workplace.

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The Usage of Virtual Technologies for Contract Proofs In Commercial Printing Organizations

by Bruce Leigh Myers, Ph.D. • Rochester Institute of Technology

Introduction

In the Fall 2013 edition of the *Visual Communications Journal*, results from a study regarding the adoption of technologies for contract color proofing in commercial printing were reported. The research highlighted selected results of a quantitative survey, and compared proofing technology adoption to a comprehensive 2005 study by the Print Industries Market Information and Research Organization (PRIMIR) entitled *Dynamics and Trends in Color Proofing 2005–2010*. Reported was proofing technology usage as compared to the 2005 report using Everett Rogers' Diffusion of Innovations as a framework. Findings indicated that among commercial printing organizations less sophisticated technologies were being increasingly utilized: these include non-color managed virtual proofs and jobs that required no proof at all. Further, it was reported that hardcopy continued to be dominated by inkjet technologies together with toner-based technologies, including digital presses, commonly utilized for contract proofing work. Another key finding was that among commercial printing organizations, the reported use of halftone-based hardcopy proofing technologies was virtually unchanged since the 2005 study.

For the present report, additional data obtained from the same study was examined. Specifically, commercial printing respondents were asked which factors underlie their decision to utilize virtual proofing versus hard-copy proofing technologies. In addition, these same respondents were asked about projecting the utilization of virtual proofing, hard copy proofing, and jobs that require no proof at all in the next three years, and through the rest of the current decade.

For the purposes of the present study, important definitions are as defined below:

Contract color proofs are defined as a proof that represents what the job will look like when printed on a lithographic press. For a proof to be considered a contract color proof, the customer agrees to accept output that matches the contract proof, and the printer agrees to produce output that matches this proof. Although there could be contract proofs for black-and-white printing, for the purposes of the present study the term contract proofs is used to refer to those contract proofs intended to represent color work.

Commercial lithographic printing organizations are defined as firms that provide lithographic printing, typically performed on a job basis, and is frequently advertising-driven. Included in this definition are printed products such as catalogs, directories, brochures, and posters. Printing excluded from this definition are publications such as newspapers and magazines as well as books, business forms, labels, tags, financial, and packaging printing.

Virtual proofs are defined here as proofs displayed on a monitor display. These proofs are sometimes also known as soft proofs. It is relevant to note that some reserve the term *virtual proof* for monitor-based proofs that are carefully calibrated in such a manner that they can accurately simulate process color printing, whereas soft proofs include uncalibrated monitor-based displays. As the present study is concerned with contract color proofing, and some commercial printers utilize uncalibrated displays as contract proofs, the term virtual proof is used here for any monitor display utilized as a contract proof regardless of calibration.

Need for the Study

One decade ago, virtual proofing was promoted as a technology promising to eclipse hard copy proofing technologies. In 2003, both ICS Remote Director and Kodak Virtual Matchprint, two prominent virtual proofing technologies, earned GATF InterTech™ Technology Awards. In that same year, some predicted that within three years virtual proofing technologies would be the "...de facto standard...".¹ Indeed, the fanfare surrounding virtual proofing at the time suggested a growth trajectory that was reflected in the projections reported in the 2005 PRIMIR study, which anticipated double-digit increases resulting in an increase in virtual proofing adoption to almost 25% of all contract proofs by 2009 in the commercial printing market. In contrast, the present research suggests that this adoption rate is largely unrealized: as reported in the Fall 2013 *Visual Communications Journal*, virtual proofs accounted for 16% of all contract proofs utilized by commercial printers with 20–49 employees, up from 7% reported in the PRIMIR study. For larger commercial printing operations the usage of virtual proofing technologies for contract proofs either declined or remained largely the same: organizations with

50–99 employees, reported that 10% of all contract proofs coming from virtual technologies, down from 14% reported in 2005 by PRIMIR. For the largest commercial printers with 100+ employees, reported virtual proofing usage for contract proofs were largely unchanged from the PRIMIR study, at 9%.

Recognizing the disparity between the projected and presently reported adoption rates of virtual proofing, an examination of the factors which underlie commercial printing pre-media managers' impression of the respective technologies could yield insight into factors which underlie the current state of proofing technology adoption. Further, the projections of these same managers for the respective technologies may possibly serve as a benchmark for future studies of this type.

Purpose

Using a cross-sectional questionnaire instrument, the present study collected quantitative data intended to assess the acceptability of virtual proofs as contract proofs, and to examine the relative importance of technical and job-related factors that comprise the impression of the proofing technologies of pre-media managers at commercial printing organizations. Finally, these same managers were asked to report their projections of the relevant proofing technologies in the next three years, as well as for the remainder of the decade.

A greater understanding of these issues could be relevant to various stakeholders in the graphic communications industry, including those in the creative and print purchasing community, printing production management and personnel, vendors, standards committees, specifications organizations, and educators.

Literature Review

The 2005 PRIMIR study offers a comprehensive analysis of multiple types of proofing across several industry segments. Although segment differences were reported by PRIMIR, an overall trend was noted: printers were reported as increasingly moving away from hardcopy halftone-based proofing to digital technologies that are not halftone-based: these technologies include inkjet, toner-based, and virtual proofing. Further, PRIMIR discussed anticipated proofing trends, which include the continued emergence and increased use of monitor-based soft proofing.

As the present study is concerned with technical and job-related factors affecting the adopting of proofing

technologies, technical literature relevant to proofing is germane. Michael H. Bruno's *Principles of Color Proofing* (1986), although over 25 years old, provides definitions and proofing criteria that is still relevant today: some may consider this edition to the seminal work on the technical analysis of color proofing. More recently, Gary G. Field's *Color Printing Excellence* (2013) provides a current analysis of relevant technical factors which are germane to proofing, as does IDEAlliance's *Guide to Print Production* version 12.0 (2012).

Research Design and Methodology

Using a self-reported questionnaire instrument distributed through the U.S. Mail, pre-media managers working at graphic communications organizations were selected to receive the survey in the Spring of 2013. For the sampling frame, the 2012 *Printing Impressions Top 400* list was utilized, from which 100 potential respondent organizations were selected. In a manner consistent with Dillman's *Mail and Telephone Surveys, The Total Design Method* (1978), potential respondents were initially contacted with an introductory letter, followed in several days by the survey instrument package. The survey package included the survey instrument booklet, a letter of instruction, and postage-paid return envelope. Two weeks after the initial package mailing, a reminder was sent to non-respondents, and approximately ten days after the reminder postcard a second survey package was sent to those who had not yet responded by that time. To potentially increase response rates, steps were taken to assure the respondent's anonymity.

As the research is limited to general commercial lithographic printing, an initial qualifying question which defined general commercial color lithographic printing asked those that did not do this type of work to disqualify themselves and to return the survey packet with the remainder of the questions unanswered. Of 100 mailed surveys, 4 were returned as self-disqualified: in these cases the respondent indicated that no commercial printing was conducted at that specific location. Forty-nine respondents identified their organizations as performing commercial printing, and responded to the majority of the subsequent questions.

Data Analysis and Results

The study solicited information regarding the acceptability of virtual proofing technology as contract proofs. These data were compared to that which was obtained in

the 2005 PRIMIR research report, as illustrated in Figure 1. When color managed virtual proofs are considered, those indicating that such technologies are either somewhat or totally acceptable increased from 52% to 81%, and when non-color managed virtual proofs are considered those responding somewhat or totally acceptable increased to 58% from 52%. Likewise, those with no opinion regarding the acceptability of virtual proofs as contract proofs decreased for both color managed and non-color managed technologies. Subsequently, there was a decrease in those that reported that the virtual technologies were unacceptable when the present results are compared to the 2005 PRIMIR study.

In addition, respondents were asked to evaluate the importance of various technical criteria when comparing virtual proofing technology with hard-copy proofing technology. The criteria here, which were selected from a review of the relevant technical literature, are: Repeatability, Ability to Simulate a Correct Dot Gain Curve, Ability to Simulate Actual Dot Gain, Ability to Simulate the Color of the Substrate, Ability to Simulate a Varnish or a Non-varnish Finish, Ability to Hold Highlight and Shadow Dots, Ability to Proof Custom Colors, and the Ability to Maintain a Minimal Environmental Impact. The results are summarized in

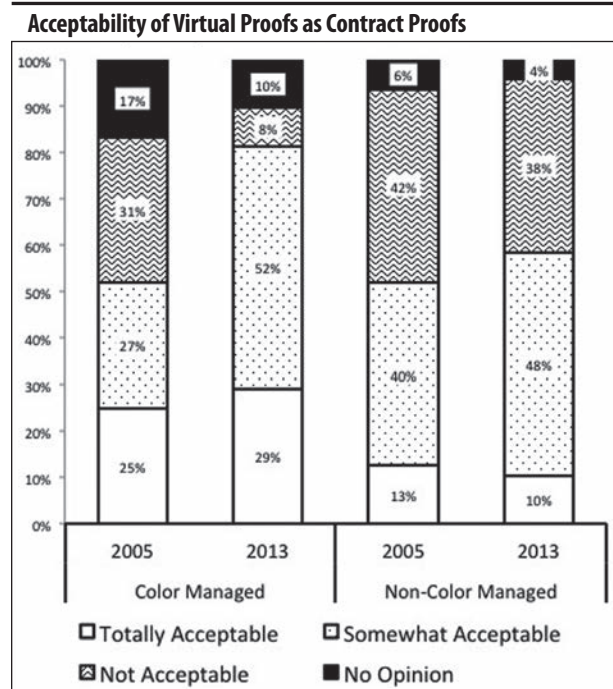


Figure 1

Proofing Technical Factors

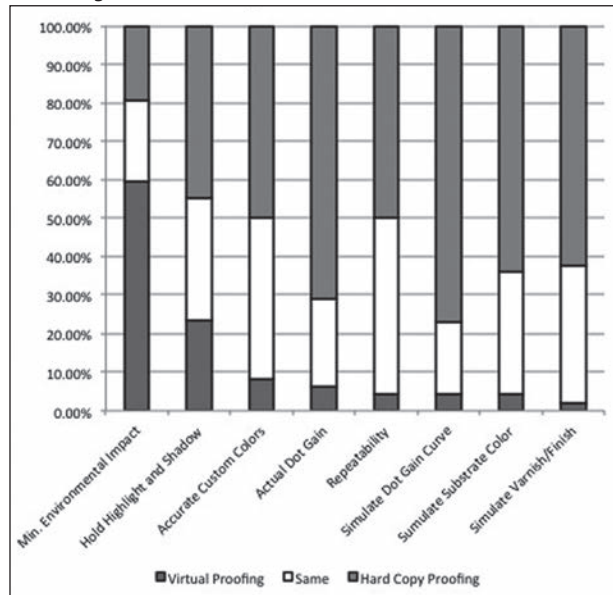


Figure 2

Figure 2. Here, the respondents indicated that the only factor where virtual proofing was reported as having a clear advantage over hard copy proofing was in reducing environmental impact.

Further, hard copy proofing technologies were reported better than virtual proofing technologies in criteria related to dot gain, specifically the ability to simulate the correct dot gain curve and the ability to simulate actual dot gain. Clearly, the respondents generally believed that these printing press-specific factors are better simulated by hard copy proofing technologies than by the virtual proofing counterparts.

Turning to an analysis of job-related factors, the literature suggest that the following criteria are relevant in the selection of a technology for contract color proofs: Turnaround Time, Quality of the Job, Type of Job, Complexity of the Job, Price Customer is willing to Pay, Format of the Document, Dependability of the Required Equipment, Type of Substrate Utilized for the Job and Only Proofing Technology Available. The reported results indicated that 90% of the commercial printing respondents based their decision to utilize virtual proofing technology as a contact proof were influenced by turnaround time, and more than 80% of the responses paid more attention to the “quality level of the job” and the “type of print job” in their selection of proofing technologies.

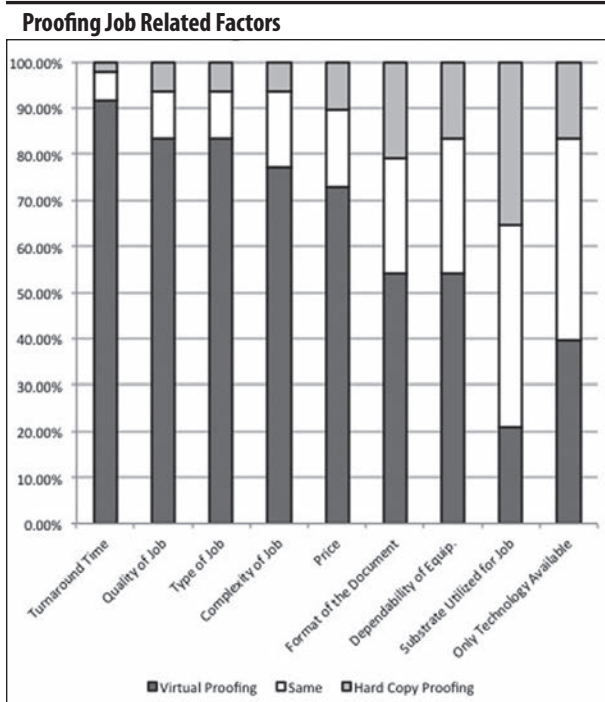


Figure 3

Results for all of the criteria analyzed are reported in Figure 3.

It is relevant to note that when comparing the rank order of job related factors from the 2005 PRIMIR study to the present research, turnaround time replaced the quality of the job as the most important job related determinant of proofing technology, as illustrated in Table 1.

2005	2013
Quality of the Job	Turnaround Time
Type of the Job	Quality of the Job
Complexity of the Job	Type of the Job
Price Customer is Willing to Pay	Complexity of the Job
Turnaround Time	Price Customer is Willing to Pay

When respondents were asked to predict future trends in technologies utilized for contract proofs, as illustrated in Figure 4, over 60% indicated a large or moderate increase in virtual proofing technologies, versus a 35% large or moderate increase of digital hardcopy proofs in the next three years. Over 40% indicated a large or moderate increase in jobs requiring non-contract proof at all.

Similar projections were made for the 2017–2020 time period, although it is perhaps relevant to note that nearly a quarter of the respondents predicted either a large or moderate decrease in virtual and digital hardcopy proofing in the rest of the decade.

Findings

When compared to the 2005 PRIMIR study, the present study indicates that current commercial printing organizations are generally more accepting of virtual proofing: pre-media managers at commercial printers are generally more open to the utilization of virtual proofs as contract color proofs.

Further, when examining technical factors related to contract color proofing, it is recognized that virtual proofing surpasses hard copy proofing in the minds of pre-media professionals working at commercial printing organizations in terms of minimizing environmental impact. Hardcopy proofing was reported as being perceived as especially superior when dot gain related factors were considered, namely, the ability to simulate a correct dot gain curve and the ability to simulate actual dot gain.

One curious finding in the analysis of the technical factors is that less than 9% of the respondents indicated that

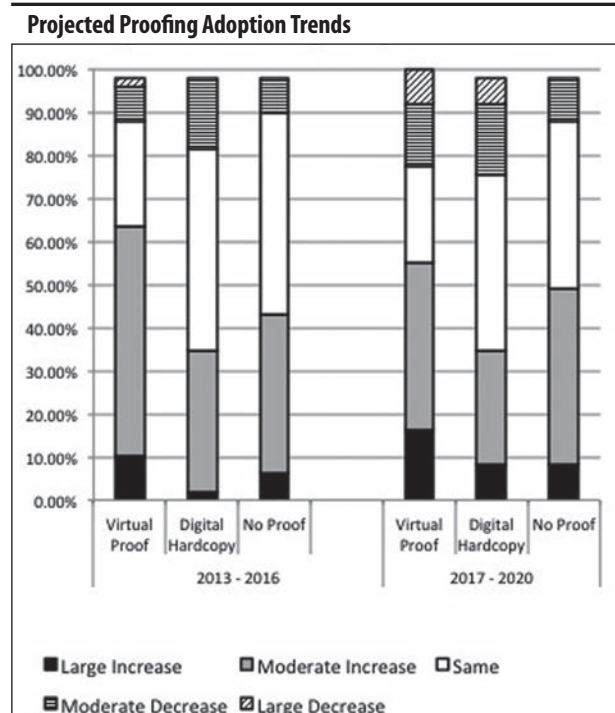


Figure 4

the technical criteria “ability to proof custom colors” was important in the decision to select virtual proofing technologies. It is recognized that this particular criterion has historically been widely touted as one of the primary reasons for selecting virtual proofing technologies over hard copy proofs. It is likely that today’s expanded gamut inkjet technologies are capable of sufficiently reproducing many custom colors, and could have therefore largely negated the formerly purported advantage of certain virtual proofing solutions.

In regard to job-related factors, perhaps the most striking difference between the present study and the 2005 PRIMIR research is the importance of turnaround time versus other job-related factors involved in contract color proofing selection. Ranked as the fifth-most important criteria in 2005, today it is regarded as the most important factor. This finding may be emblematic of an increased demand for fast turnaround in commercial printing jobs, where there could be insufficient time to produce a hard copy proof and to meet the required deadline.

Finally, when asked their opinions about future trends over the next three years and for the remainder of the decade, a large or moderate increase in virtual proofing technologies was indicated by the majority of the respondents, as was a large or moderate increase in jobs requiring no proof at all. This supports the recognition of a trend toward less sophisticated, faster turnaround technologies for contract color proofs. It is also relevant to note that a quarter of the respondents predicted a large or moderate decrease in virtual proofs and digital hardcopy proofs when the 2017–2020 time period is considered.

Conclusions

It is frequently interesting and relevant to compare the adoption and usage of innovations several years after their onset to ascertain if the often hyperbolic claims surrounding their introduction are realized. The present study indicates that, although today’s pre-media professionals in the commercial printing segment are more open to the use of virtual proofing, these technologies are not in the position of prominence predicted by some a decade ago. Further analysis of the factors surrounding this realization suggests that hard copy proofs are perceived as superior to their virtual counterparts in many technical aspects, and that virtual technologies are turned to when fast turnaround of jobs is paramount.

Future Research


The present study was limited to larger commercial lithographic printing organizations; future researchers may choose to examine additional market segments, including packaging, publication, advertising agencies and in-plant printing operations, as well as smaller commercial organizations. In addition, a qualitative approach to similar topics could uncover a richer understanding of salient factors here, versus the cross-sectional approach utilized in the current research. Further, this present research is limited to technologies serving as contract proofs only: an examination of the technologies utilized to produce intermediate proofs could yield a more comprehensive view of the proofing market as a whole.

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End Notes

¹Dan Caldwell, vice-president, operations for Integrated Color Solutions Inc., as quoted in Bury, S. (2003).

²It is recognized that many standards committees and specification organizations currently recommend the use of the term “tone value increase” rather than the historic term “dot gain.” For the purpose of the present research, however, “dot gain” is utilized as it is the normal vernacular utilized by many printing organizations. It is presumed likely that users of the term “tone value increase” understand that this is a substitute for the historic “dot gain” terminology, however the opposite case is less likely.

Visual Display Calibration: An Analysis of Efficacy in Color Management

by Kevin D. Smith, II M.S. • Daniel Wilson, D.I.T. • Illinois State University

Color management can be defined as a process of calibrating devices, characterizing those devices through a profiling process, and converting color images from one device's color space to another using software and workflows (Giorgianni & Madden, 1998; Sharma, 2004). Many organizations within the graphic communications industry must manage color quality throughout a production process, from image capture to printed product, particularly when color quality is critical to production success and client demands.

A complete review of color management technology is beyond the scope of this report, however it is important to note here that color accuracy of an image shown on a display requires a characterization of the colors within an image file. This characterization is contained numerically within an ICC (International Color Consortium) profile. The ICC profile is then used by the computer system to convert the CMYK or RGB color pixels in the image file into an intermediate, device-independent Profile Connecting Space (PCS) (such as CIE Lab D50). From here, a color conversion can take place, where the PCS values are converted into the unique device-dependent RGB values of the display. However, to assure an accurate display of the color image, an accurate ICC profile of the display is required (International Color Consortium, 2007). This is accomplished through calibration.

**An X-rite i1 Pro spectrophotometer calibrating a display
ambo Ultima-23 camera with a Fuji S3 DSLR attached with a
proprietary adaptor.**



Figure 1

Apple's Display Calibrator Assistant

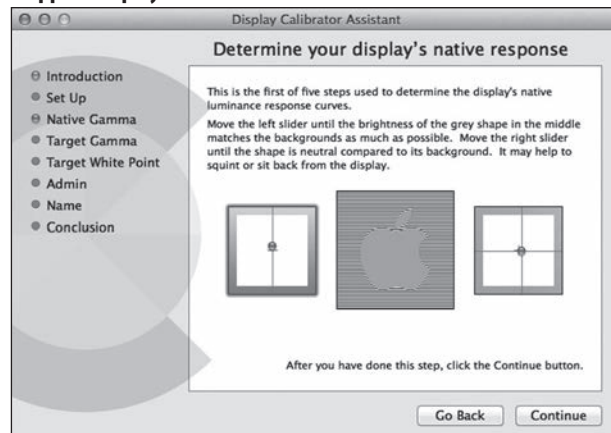


Figure 2

Display calibration software essentially adjusts the Look-up Tables (LUTs) of the computer graphics card and makes adjustments to assure that a consistent and predetermined neutral gray, white point, and gamma (contrast curve) are achieved. There are two general calibration methods that can be utilized. With the first method, *spectrophotometric display calibration*, a spectrophotometer is used to measure and interpret the quality of the light emitted by the computer display (Figure 1). Colorimetric values are interpreted and used by the display calibration software to create an ICC profile. Another method, *visual display calibration*, involves using a software utility to manually adjust an existing ICC profile. This is done by visually adjusting the tonal contrast and gray balance images on the display (Figure 2). Visual calibration is dependent on an individual's ability to accurately judge tonal contrast and gray balance and then make subtle adjustments manually, without assistance from a spectrophotometer. Regardless of which method is used for calibration, the resulting ICC profile is then assigned by the operating system to the display that was measured, and also may be embedded in a color image to communicate accurate color rendering of the image on other calibrated displays (Marin, 2011, X-Rite, 2009).

The focus of this study is on the efficacy of the *visual calibration method* within color-managed workflows. Both Apple Macintosh and Microsoft Windows provide free visual calibration utilities. Since the visual calibration

option is available to computer users, the graphic communications industry may benefit from a better understanding of the limitations of visual display calibration. Although it is widely assumed within the graphic communications industry that spectrophotometric display calibration is more accurate (Blinq Photography, 2010), data on the accuracy and variability of the visual method is lacking. Also, there are no studies that investigate any predictors of visual calibration success, such as human color acuity (the ability to distinguish between subtle color differences). The findings of this study may establish some relationship between visual display calibration accuracy and color vision acuity, as well as confirm the validity of using more expensive automated display calibration methods.

Literature Review

A study conducted by Fleming and Sharma (2002) identified the achieved gamma and Delta E value in a visually calibrated display. The experiment was conducted on a single Mitsubishi Diamond Plus CRT display with a Power Mac G4. The results showed that the gamma achieved was 2.03 (when a 1.8 gamma was targeted) and that there was a DE of 12.76 (very significant error). Fleming and Sharma suggested that the Delta E of the monitor should be considered as critical in color-managed workflow and that the visual calibration method was deeply flawed. Fleming and Sharma conducted the experiment on a single unit and did not present descriptive statistics. Composition of the sample was not reported in the research.

Though not specific to displays, research conducted by Dry Creek Photo (2011) identified the measurement accuracy and variability of commonly used calibration spectrophotometers. They tested ten X-Rite i1 Pro spectrophotometers for repeatability. Their results showed a mean Delta E 2000 of 2.0 and a max Delta E 2000 of 3.5. Their results also showed a standard gamut error of 4.4 Delta E in white and 9.6 Delta E in black, as well as a wide gamut error of 2.3 Delta E in white and 10.7 Delta E in black. They suggested that the spectrophotometric calibration method is capable of measuring with great accuracy everything except perhaps the darkest colors, where visible color shifts may occur even after calibration.

Research Methodology

Two primary research questions guided the development of this research design:

1. What is the variability of visual display calibration?

2. Is there a relationship between human color acuity and the ability to visually calibrate a display accurately?

Population and Sample

The target population was college students enrolled in College of Applied Science and Technology-related courses. The sample for this study was 104 students who were enrolled in Family and Consumer Science courses and Graphic Communication courses for the 2012–2013 academic calendar year at Illinois State University. These students were recruited to participate in this study because of the importance of color consistency and color managed workflow systems within their respective fields of study. Out of the 104 individuals, 66 (63%) were enrolled in Graphic Communications courses and 38 (37%) were enrolled in Family and Consumer Science courses. Out of the 104 participants that volunteered, 43 (41%) were male and 61 (59%) were female.

Instrumentation

The Apple Display Calibrator Assistant software utility on an Apple iMac computer was used for visual display calibration. PatchTool Display Check software and an X-rite i1 Pro spectrophotometer was used to measure an RGB nine-step grayscale displayed on the visually calibrated display. The PatchTool software numerically compared the emissive color's CIE Lab values to an sRGB source profile's CIE Lab values (serving as a standard) and provided an error calculation, using the ΔE 2000 formula.

The Farnsworth-Munsell 100 Hue Test was used to determine a color acuity score for each subject. This is a score that reflects the ability to discern subtle differences in

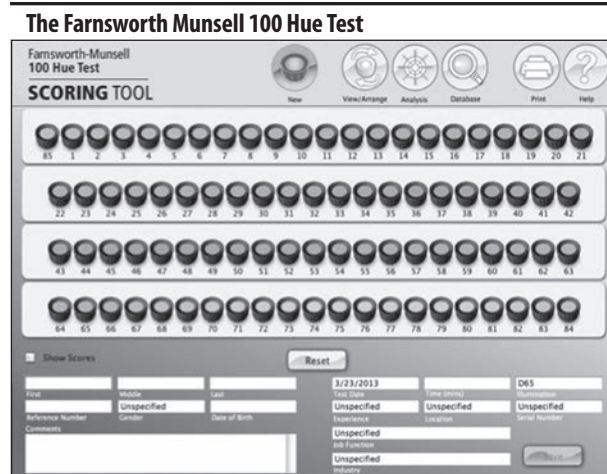


Figure 3

color, and might be used as a predictor of that person's ability to visually calibrate accurately (Figure 3). An X-rite i1 Pro, computer display, and viewing booth were each allowed adequate time to stabilize before testing commenced.

To eliminate variation from differences in spectrophotometers, a single X-rite i1 Pro spectrophotometer was used for all measurements. Any variability would be the internal variation of measurement. To remove variation in the display, all calibrations were done on the same display. To control color perception variables, each test was completed within a certified color-viewing booth under industry standard D50 lighting. There was a neutral gray curtain placed around the viewing booth to eliminate color interference from any background object reflecting off of the display surface. Participants also wore a neutral gray coat to avoid color interference from clothing colors and were required to remove all jewelry.

Procedure

The research for this experiment was conducted in three phases. Phase one involved having participants complete the Farnsworth-Munsell 100 Hue Test to determine their Total Error Score (TES) and color discrimination classification. Phase two had the participants manually calibrate a computer display using the Apple's Display Calibrator Assistant software version 4.9. Phase three involved using PatchTool Display Check software and an X-rite i1 Pro spectrophotometer to physically measure emissive light from a nine level gray scale. The software generates the gray scale on the display, guides the i1 Pro spectrophotometer to read the CIE Lab values emitting from the gray patches, and then compares measured values to an sRGB source profile's CIE Lab values (serving as a standard). A resulting averaged color error score is calculated using the CIEDE2000 formula, yield a Delta E (ΔE) score. Participants were provided a short training session, with an explanation of how to carry-out the FM-100 test, how to launch the Display Calibration software utility, and the goals in the visual adjustments required to perform the calibration. The resulting data obtained for analysis included each individual's Farnsworth-Munsell 100 Hue Total Error Score (TES), and the ΔE between (1) the visually calibrated display gray patch CIE Lab values and (2) the standard (sRGB source file CIE Lab values).

Descriptive statistics were run across all 104 subjects. For determining correlation, the dependent variables were Delta E and the independent variable was the FM 100

color acuity TES. A correlation analysis was conducted to determine the degree of association between the variables. Also, a two-sample t-test was conducted to compare whether the mean ΔE difference between the top 30 and bottom 30 TES was significant.

Results of The Study

The accuracy of the visually calibrated displays was calculated from the average Delta E with a mean of 3.83. The smallest Delta E value being 1.54 (best calibrated display) and the largest Delta E value being 13.13 (worst calibrated display), with a standard deviation of 1.79 (Table 1). For perspective on the significance of Delta E values, acceptable color tolerances for the printing trades was suggested by Heidelberg (2008), with values ranging from 0.0 to 1.0 being not perceptible; 1.0 to 2.0, barely perceptible; 2 – 3.5, moderately perceptible; and 3.5 to 5.0, clearly perceptible. Going by these benchmarks, a display might be reasonably well calibrated with a ΔE range of between zero and 2.0. Less than 20% of the subjects were able to visually calibrate the display with this level of accuracy.

Table 1: Visual Calibration Error

Variable	High	Low	Mean	Std. Dev
ΔE^*	13.13	1.54	3.83	1.79

Mean of 3.83 "clearly perceptible" on the Heidelberg scale, n=104

By way of comparison between the (1) the visual calibration method and (2) the spectrophotometric calibration method, a test of calibration accuracy with five different X-Rite i1 Pro spectrophotometers was conducted. Table 2 shows the error and variability in ΔE . Each of the five spectrophotometers was used to calibrate the same display, an accuracy measurement was then made with PatchTool software, and the results were analyzed for accuracy and variation. The mean ΔE was 1.17, with the smallest ΔE value being 1.03 and the largest ΔE value being 1.44, showing a very consistent calibration among the devices.

Table 2: Spectrophotometric Calibration Error

Variable	High	Low	Mean	Std. Dev
ΔE^*	1.44	1.03	1.17	0.17

Mean of 1.17 "barely perceptible" on the Heidelberg scale, n=5

The results of Farnsworth-Munsell 100 Hue Test (FM-100) Total Error Score (TES) distribution were similar to findings by Dean Farnsworth (1943), who reported that the distribution of populations' score of 16% would classify as Superior Color Discrimination (we found 20%),

64% would classify as Average Color Discrimination (we found 77%), and 16% would classify as Low Color Discrimination (we found 4%). The Farnsworth-Munsell 100 Hue Test (FM-100) Total Error Score (TES) had a mean of 38.88 and standard deviation of 27.59, with the best score achieved being a 4 and the worst score being 156 (Table 3).

Table 3: Farnsworth-Munsell 100 Hue Test

FM 100 Categories	Percent of Sample	
Superior Discrimination	19%	
Average Discrimination	17%	
Low Discrimination	4%	
Total Error Score	Mean	Std Dev
	38.88	27.59

n=104

No statistical significance was found correlating the FM 100 TES and ΔE (P-value = 0.525 with an alpha value of 0.05), suggesting that a person's color acuity score is not predictive of their ability to visually calibrate a display accurately (Table 4).

Table 4: Pearson Correlation of Measured Variables

Variables	Total Error Score	ΔE
Total Error Score	1.000	
ΔE	0.525	1.000
Correlation not significant at $p < 0.05$ (2-tailed), n=104		

A T-test comparing groups of the top 30 FM 100 Hue Test scores and bottom 30 FM 100 Hue Test scores was run to determine whether there was a statistical difference between error scores (ΔE) (comparing the high acuity color perception group and the low color acuity perception group) (Table 5). No statistical significance was found between the ΔE values of the top 30 FM 100 Hue Test scores and bottom 30 FM 100 Hue Test scores (p-value= 0.229). Put another way, the group with the highest color acuity has equally poor results visually calibrating displays as the group with the lowest color acuity.

Table 5: Two-Sample T-Test and CI: ΔE , Group

Group	N	Mean	St Dev	SE Mean
Top 30	30	3.447	0.905	0.17
Bottom 30	30	3.92	1.94	0.35
p-value (probability) = 0.229				

Summary

The purpose of this study was to better understand the variability of the *visual display calibration* method in color management. Also explored was whether there might be a relationship between (1) the ability to perceive small color differences (as measured on the Farnsworth Munsell 100 Test scale) and (2) the ability to visually calibrate computer displays accurately. A better understanding of this relationship might have provided insight into the most effective organizational approach to calibrate computer displays within color-managed environments.

The findings suggest that this particular visual calibration method is flawed. Anecdotally, graphic communications teachers and trainers who have attempted to visually calibrate a lab full of displays often note that all the displays "look" different. Our findings show a very significant ΔE of nearly 4.0 (3.83) among the display calibrations. Differences of this magnitude are clearly visible. By comparison, we found that the display calibrated with a spectrophotometric calibration method had a barely visible variation among five different calibrations (mean ΔE of 1.17).

We also found no correlation between human color acuity and the accuracy of visually calibrating displays, suggesting that a person's color acuity score is not predictive of their ability to visually calibrate a display accurately. This suggests that visual calibration methods have little real value, or perhaps require more extensive training beyond an overview of the process and principles provided in our research.

Perhaps this research shows a need for the improvement of the Apple Display Calibrator Assistant visual display calibration software. Apple Inc. might consider improving their Display Calibrator Assistant utility, or provide a disclaimer on the variability in calibration results to avoid misleading assumptions on calibration accuracy from the visual method. Further research might be done to determine whether other visual calibration utilities such as Windows Corp. Display Color Calibration (Windows Corporation, 2012), Adobe Gamma, Noika Monitor Test, and Samsung Color Calibration produce better results than Apple's Display Calibrator Assistant.

If the visual calibration utilities do not provide color accurate results, they should not be used in color critical environments. The results of this research strongly suggest that spectrophotometer calibration methods are

effective. This technology has become more affordable over recent years and those involved in color management should steer their clients away from visual calibration methods in favor of the spectrophotometer calibration method. For those who do not have spectrophotometric equipment, it may well be that using the original ICC profile shipped with the display provides more accurate results than adjusting the display with visual calibration utilities. It could be informative to study how much a display drifts in color error over time, compared with re-calibrating the display with visual calibration tools.

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Study of Factors Affecting Readability of Printed QR Codes

by Renmei Xu, Ph.D. • Edward J. Lazaros Ph.D. • Susan C. Londt, D.E. • Ball State University

Introduction

Quick response (QR) codes are two-dimensional (2D) matrix codes that can link print and broadcast media to a URL, share simple text data such as a phone number or a text message, or more complex information like a command. QR codes contain both function patterns and encoding region so they can be scanned and decoded (Chuang, Hu, & Ko, 2010). Function patterns include quiet zone, position detection patterns, separators for position detection patterns, timing patterns, and alignment patterns. Encoding region contains format information, version information, and data and error correction codewords. QR codes have a maximum capacity of 7089 numeric or 4296 alphanumeric characters (Gao, Prakash, & Jagatesan, 2007).

QR codes were originally developed by Japanese auto parts manufacturer Denso-Wave in 1994 for use in manufacturing to enhance inventory control (Denso-Wave, 2012). Its usage expanded to other industries, and then to consumers in Southeast Asia (Soon, 2007, and Chuang, Hu, & Ko, 2010). Consumer use of QR codes in the West occurred later, but with the rise in the sale of smartphones, there has been an increase in the use of QR codes. Hulkower (2012) stated, “as of 2012, smartphones will make up 64% of mobile phone unit sales and 85% of sector revenues.” Business has embraced QR codes for use in marketing of retail products because of the ability to store large amounts of information in a small footprint. Since QR codes are becoming a more prominent and efficient form of communication between business and consumers, more QR codes may be used in print and as branding on products. A QR code can be used anywhere that a logo traditionally appears. Creative uses of QR codes range from chocolate to temporary tattoos. More smartphones with different cameras possess the ability to read QR codes dependent on the readability of the print. Inquiries to printers in a Midwest city as well as a university print service produced no print benchmarks for readability of QR codes. The most common response was “...if our phones can read it (QR code) then we print it” (personal communication, March 2012). Bogataj, Muck, Bracko, and Lozo (2010) found that “irrespective of the printing technique, the black printed codes are the most readable, while the yellow codes are the least readable”.

Most of the existing literature focuses on how to create a QR code from an on-line generator but very little literature exists that discusses how to reproduce QR codes in a small size that remains readable.

The gap in the literature of standards for printing, size, and readability of QR codes fueled the need to discover how small a QR code needs to be to remain readable. There are many factors that affect the readability of a QR code. In this study, five of them were tested: data amount in a QR code, code size, substrate color, printing process, and light condition during scanning.

Experimental

Data Amount

Three websites were selected from those readily available.

1. The Ball State University (BSU) website <http://cms.bsu.edu> which is 18 characters long;
2. The Department of Technology (DoT) website <http://cms.bsu.edu/Academics/CollegesandDepartments/Technology.aspx> which is longer at 67 characters;
3. The Graphic Arts Management (GAM) Program website <http://cms.bsu.edu/Academics/CollegesandDepartments/Technology/DeptAcademics/BachProg/GraphicArts.aspx> which is the longest with 102 characters.

The Kaywa Internet generator <http://qrcode.kaywa.com/> was used to generate QR codes for the three URLs to test the readability of codes with varying data amounts. The three QR codes generated online were saved as JPEG files, as shown in Figure 1.

QR codes for three URL's with different numbers of characters



Figure 1

Code Size

A test form was created using Adobe InDesign CS5. It included the three URL QR codes with incremental sizes from 0.1 inch to 1 inch, as shown in Figure 2.

Test form containing QR codes with different sizes



Figure 2

Substrate Color

Seven uncoated offset grade papers of different colors were selected. Their $L^*a^*b^*$ values were measured using an X-Rite SpectroDensitometer 528 and listed in Table 1.

Substrate	L^*	a^*	b^*	Color
1	93.42	1.71	-5.72	Blue shade
2	94.99	2.40	-6.53	Blue shade
3	94.77	0.02	4.55	Yellow shade
4	94.88	-0.18	8.79	Yellow shade
5	68.72	4.59	12.74	Brown
6	61.01	-37.89	-16.83	Teal
7	77.55	40.59	56.40	Orange

The positions of the substrate colors relative to the (0, 0) point in the a^*b^* space are shown in Figure 3.

Substrates 1–2 have small a^* values and negative b^* values which means they both have blue shades. Substrates 3–4 have a^* values close to zero and positive b^* values which

Substrates' color positions relative to the (0, 0) point

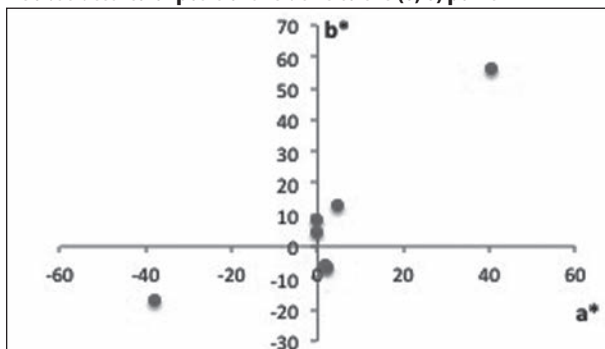


Figure 3

means they both have yellow shades. Substrate 5 has a brown color with positive a^* and b^* values. Substrate 6 has a teal color with negative a^* and b^* values. Substrate 7 is furthest away from the (0, 0) point with an orange color and positive a^* and b^* values.

Printing Process

A Hamada RS 34 II press was used for offset printing with Anthem Pro™ thermal anodized aluminum plates made on a Dimension™ 425 CtP System from Presstek. The screening ruling was 133 lpi with 45° angle and Euclidean dot shape

A wood frame and Sefar mono polyester fabric of 280/ inch mesh count were used for screen printing. Photographic liquid emulsion from Ulano was applied onto both sides of the screen fabric manually using a scoop coater. Positive image printed on vellum transparency using a laser printer was placed on the coated screen to expose the emulsion for 240 seconds using a 40-1K Mercury Exposure System from nuArc Company. The printing was done on a Vastex model V-2000 HD screen printing press.

Only black inks were used for both printing processes.

Light Condition During Scanning

Printed QR codes were scanned both indoor and outdoor. Three indoor light sources came from a Color Rendition Demonstrator (GTI Graphic Technology Inc.), which were fluorescent cool-white “store light”, 6500K fluorescent “daylight”, and incandescent “home light”. The outdoor scans were all conducted on the same afternoon in overcast conditions.

Readability Test

The best samples on each substrate were selected for the readability test. A Motorola Droid™ X2 smartphone with a built-in 8MP camera was used along with ScanLife™ as the QR code reader. All scans were given four attempts to read before being determined to be unreadable. The goal was to find the minimum readable size for each combination of data amount, printing process, substrate color, and light condition.

Results and Discussion

There were 7 different substrates printed by 2 printing processes so there were 14 different press sheets. There were 21 QR codes on each sheet, so there were 294 different QR codes in total. Meanwhile, because of the error correction feature of QR codes, small differences between

code qualities do not affect their readability. Therefore, only qualitative evaluation of the print quality was performed. Offset-printed QR codes had better print quality than screen-printed ones due to more uniform ink film, sharper edges, and finer details. There was little difference between different substrates.

Screen-printed QR codes had thicker ink films, and thus higher optical densities than offset-printed ones, as shown in Table 2.

Substrate	Optical Density	
	Offset Printing	Screen Printing
1	1.26	1.92
2	1.44	1.90
3	1.25	2.03
4	1.31	1.93
5	1.36	1.73
6	1.29	2.02
7	1.28	1.83

The readability of the three QR codes printed on different substrates using offset printing is shown in Table 3. Represented is the minimum code sizes that could be read under different light conditions.

For the the QR code with 17 characters, fluorescent cool-white store light improved readability on substrates 1 and 2 (which had blue shades). Incandescent home light increased the minimum readable size of substrate 7 with an orange color. For the QR code with 67 characters, fluorescent cool-white store light increased the minimum readable size of substrate 6 (with a teal color) and substrate 7 (with an orange color). Incandescent home light also increased the minimum readable size of substrate 5 (with a brown color) and substrate 7 (with an orange color). For the QR code with 102 characters, fluorescent cool-white store light increased the minimum readable size of substrates 6 and 7. Incandescent home light also increased the minimum readable size of substrates 1 and 2. Both 6500K fluorescent daylight and outdoor daylight didn't affect the readability of all three QR codes. Fluorescent cool-white store light has strong intensity peaks in the blue region; therefore, it might affect the color appearances of substrates with fluorescent particles which are added to increase paper brightness, like substrates 1–2. Incandescent home light has higher intensity in the yellow-red region, which might affect the color

appearances of substrates with high a^* or b^* values, such as substrates 5–7. Color contrast between code color and substrate color is very important for readability; therefore, these two light conditions affected the readability of those substrates.

BSU QR Code (17 characters)				
Substrate	Fluorescent Cool-white Store Light	6500K Fluorescent Daylight	Incandescent Home Light	Outdoor Daylight
1	0.2	0.3	0.3	0.3
2	0.2	0.3	0.3	0.3
3	0.3	0.3	0.3	0.3
4	0.3	0.3	0.3	0.3
5	0.3	0.3	0.3	0.3
6	0.3	0.3	0.3	0.3
7	0.3	0.3	0.4	0.3
DoT QR Code (67 characters)				
Substrate	Fluorescent Cool-white Store Light	6500K Fluorescent Daylight	Incandescent Home Light	Outdoor Daylight
1	0.4	0.4	0.4	0.4
2	0.4	0.4	0.4	0.4
3	0.4	0.4	0.4	0.4
4	0.4	0.4	0.4	0.4
5	0.4	0.4	0.5	0.4
6	0.5	0.4	0.4	0.4
7	0.5	0.4	0.5	0.4
GAM QR Code (102 characters)				
Substrate	Fluorescent Cool-white Store Light	6500K Fluorescent Daylight	Incandescent Home Light	Outdoor Daylight
1	0.5	0.5	0.75	0.5
2	0.5	0.5	0.75	0.5
3	0.5	0.5	0.5	0.5
4	0.5	0.5	0.5	0.5
5	0.5	0.5	0.5	0.5
6	0.75	0.5	0.5	0.5
7	0.75	0.5	0.5	0.5

Table 4 shows the readability of QR codes printed by screen printing. Light conditions did not affect the BSU and DoT QR codes. Screen-printed QR codes had higher optical densities than offset-printed ones, so color contrasts between QR codes and substrate colors were higher. Small changes of substrate colors under different light

Table 4. Minimum Sizes (Inch) of Readable Screen-Printed QR Codes

BSU QR Code (17 characters)				
Substrate	Fluorescent Cool-white Store Light	6500K Fluorescent Daylight	Incandescent Home Light	Outdoor Daylight
1	0.4	0.4	0.4	0.4
2	0.4	0.4	0.4	0.4
3	0.4	0.4	0.4	0.4
4	0.4	0.4	0.4	0.4
5	0.4	0.4	0.4	0.4
6	0.4	0.4	0.4	0.4
7	0.4	0.4	0.4	0.4
DoT QR Code (67 characters)				
Substrate	Fluorescent Cool-white Store Light	6500K Fluorescent Daylight	Incandescent Home Light	Outdoor Daylight
1	0.5	0.5	0.5	0.5
2	0.5	0.5	0.5	0.5
3	0.5	0.5	0.5	0.5
4	0.5	0.5	0.5	0.5
5	0.5	0.5	0.5	0.5
6	0.5	0.5	0.5	0.5
7	0.5	0.5	0.5	0.5
GAM QR Code (102 characters)				
Substrate	Fluorescent Cool-white Store Light	6500K Fluorescent Daylight	Incandescent Home Light	Outdoor Daylight
1	0.5	0.75	0.75	0.5
2	0.5	0.75	0.75	0.75
3	0.75	0.75	0.75	0.75
4	0.5	0.75	0.75	0.5
5	0.75	0.75	0.75	0.75
6	0.75	0.75	0.75	0.75
7	0.75	0.50	0.50	0.75

conditions did not affect QR code readability. However, light conditions affected the readability of the QR code with 102 characters, in which fine details and color contrast between QR codes and substrate colors became more important.

Comparison of minimum sizes of readable QR codes printed by offset and screen printing

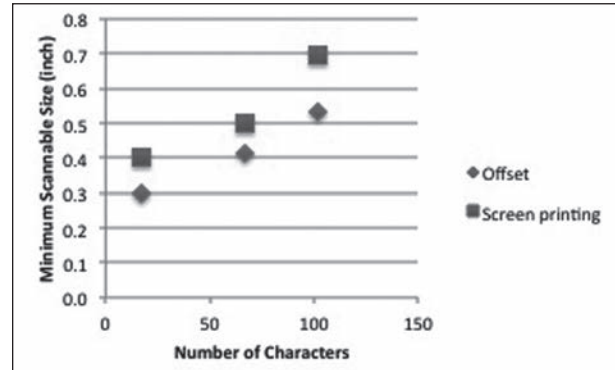


Figure 4

The readability of QR codes printed by offset and screen printing are compared in Figure 4. With an increasing number of characters in a QR code, the code size needed to be larger in order to be readable. For the same number of characters in a QR code, screen-printed codes needed to be bigger in order to be readable. Although screen-printed codes had higher optical densities, and thus higher contrasts between codes and substrate colors, it did not improve their readability. Print quality of line edges and fine details were more important factors that affected QR code readability.

Conclusions

There are many factors that affect the readability of a QR code. In this study, five of them were tested: data amount in a QR code, code size, substrate color, printing process, and light condition during scanning. It was found that readability was affected by data amount in a QR code, code size, and print quality. With increasing data amount, decreasing code size and print quality, readability went down. Substrate colors had little effect on readability of black QR codes. Light conditions during scanning only affected readability of QR codes printed on substrates that had color appearances more affected by the light source. Other factors that might be further studied include different QR code colors. QR codes do not have to be standard black and white in order to be read. Colors and images

like logos have been added in QR codes to make them more appealing, but they may affect their readability. There are also a lot of indoor and outdoor signs that use transparent film or glass with backlighting. It would be interesting to research how different backlighting affects QR code readability. Different cell phone models and QR code readers might also be studied to find out how they affect QR code readability.

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Using Transmedia Storytelling Techniques To Invigorate Graphic Communications Programs

by Philip C. Snyder, MFA • Jerry Waite, Ed.D. • University of Houston

Introduction

Defining the term *Transmedia Storytelling* can be challenging, since no single definition has been firmly established in the media culture lexicon. However, amorphous as the character of Transmedia Storytelling is, three criteria have thus far risen to the top of the discussion: multiple media, a single unified story, and avoidance of redundancy between media (Phillips, 2012). The appeal of Transmedia Storytelling for graphics professionals, including educators, lies in its inclusion of the traditional graphic arts and crafts as well as the most recent digital technological developments.

Some Definitions

In defining “Transmedia Storytelling,” it may also be helpful to point out what it is *not* in order to avoid the most common misconception. In particular, it is not “multimedia,” which is that practice of telling a single story over multiple platforms, such as video, audio, text, and photographic images. Multimedia is commonly accomplished using computer applications.

Dr. Marsha Kinder, then a University of Southern California (USC) professor and cultural theorist, originally coined the term as “Transmedia Intertextuality” in 1991 to describe works in which characters and stories appeared across multiple media. An example proffered by Kinder is the Teenage Mutant Ninja Turtles (Kinder, 1991), an entertainment franchise that first appeared in comic books, then animation, video games, feature films, toys and ancillary merchandise.

Current USC professor, Dr. Henry Jenkins, founder and former director of MIT’s Comparative Media Studies program, has emerged as the de facto dean of Transmedia Storytelling, in part due the wide acceptance of his critically acclaimed book, “Convergence Culture: Where Old and New Media Collide.” In a description of the phenomenon from his book, Jenkins states, “Transmedia Storytelling refers to a new aesthetic that has emerged in response to media convergence—one that places new demands on the consumer and depends on the active participation of knowledge communities (Jenkins, 2007).” Jenkins’ blog, “Confessions of an Aca-Fan,” posts his definitive description of Transmedia Storytelling:

Transmedia Storytelling represents a process where integral elements of a fiction get dispersed systematically across multiple delivery channels for the purpose of creating a unified and coordinated entertainment experience. Ideally, each medium makes its own unique contribution to the unfolding of the story (Jenkins, 2011).

Note that Jenkins’ definition restricts Transmedia Storytelling to “fiction.”

Another notable in shaping the cultural understanding of Transmedia Storytelling is Jeff Gomez, the member-at-large of the Producers Guild of America (PGA) East Executive Board and CEO of Starlight Runner Entertainment. Gomez was instrumental, along with members of his company, in drafting the Transmedia producer credit definition that was eventually adopted by the PGA:

A Transmedia narrative project or franchise must consist of three (or more) narrative storylines existing within the same fictional universe on any of the following platforms: Film, Television, Short Film, Broadband, Publishing, Comics, Animation, Mobile, Special Venues, DVD/Blu-ray/CD-ROM, Narrative Commercial and Marketing rollouts, and other technologies that may or may not currently exist (producersguild.org, 2013).

Gomez insists however, “The credit is not a definition of the term ‘Transmedia’ or ‘Transmedia Storytelling.’ It’s simply a list of criteria that would need to be met if you were a media producer if you want to join PGA under the Transmedia credit (Gomez, 2011).” By “credit” is meant the written attribution of the creative artists and other staff involved in a particular production. Note again that, although not being touted as a definition, the term “fictional” is included in the credit description.

Transmedia Storytelling Archetype: Star Wars

Certainly no franchise or intellectual property on earth (or beyond) exhibits the Transmedia Storytelling modalities more than the Star Wars saga. The list of products, ancillaries, and fan-produced spinoffs is endless. From feature films to animated television series and fan parody videos, from comic books and novels to magazines, from

websites and podcasts to console games, and from toys, costumes, and conventions to theme park rides—the reach of the Star Wars Transmedia Storytelling galaxy is mind-boggling. In 2012 The Walt Disney Company purchased Lucasfilm from its creator, George Lucas, for \$4 billion, adding the galaxy to its media conglomerate universe.

Disney Conglomerate

Disney was arguably the prototypical Transmedia Storytelling company, having begun crossing media platforms in 1952. It was then that Walt Disney aired *One Hour in Wonderland* on the ABC television network to promote his upcoming film, *Alice in Wonderland*. Seeing how successful his cross-platform promotional effort became, Disney again turned to ABC in 1954 to air the *Disneyland* program, promoting the development and awareness of the original theme park of the same name in California (Sheppard, 2012). Since that auspicious beginning, Disney's company has continued to successfully pioneer multiplatform storytelling utilizing its vast array of resources.

According to the Federal Communications Commission (1996), The Telecommunications Act of 1996 allowed media cross-ownership for the first time since the Communications Act of 1934 was enacted. Contrary to its stated objective to open up markets to competition by removing regulatory barriers to entry, the result was to allow an unprecedented concentration of ownership of media outlets including, for the first time, internet portals. This concentration includes both vertical integration, which consists of content distribution, and horizontal integration, which is consolidation of the means of production through the acquisition of competitors (Meyers, 2004).

Ironically, at the other end of the competitive spectrum, small companies and individuals are benefitting from a democratization of production and distribution, compliments of the digital technology age. The empirical outcome is a provision of some semblance of balance of power in the arenas of journalism and cultural influence—along with new set of ethical issues (Ward, 2012).

Fandom influence

A companion to the convergence of media technology and its democratization is the burgeoning influence of fandom—those individuals and groups who consume the entertainment, purchase, make and sell the products,

attend the conventions, create fan art and videos, and influence opinions (Jenkins, 2007). It is because of their activism that content distribution is no longer exclusively top-down from the conglomerates. Often to the dismay of the license-holders of the intellectual properties, fans are creating and distributing their own unauthorized spinoffs of the stories (Phillips, 2012)

As the voice of Jiminy Cricket for Disney, the co-author (Phil Snyder) has engaged in this practice to a small degree on his YouTube channel, voicing his own offerings of the character. He also makes celebrity appearances in fan conventions, on discussion panels, and in autograph signings. He is amazed at the high value fans put on their participation—in time, money, energy, and enthusiasm.

Emerging Example: *The Elements Club*

Co-author of this article, Phil Snyder and his wife, Karen, are partners in a Transmedia Storytelling production company, KAZAP Corporation. Using the multiplatform Transmedia Storytelling strategy, they distribute the content of Karen's romance novel series, *The Elements Club* (Snyder, 2014).

Under the pen name, "KYS Realm," Karen has written a series of romance novels set in Victorian London, each one of which is told using different modes for telling parts of the story. On the website, the dropdown menus serve as channel selection devices to choose the delivery platform from which to follow and experience disparate segments of the overall story. The user can learn about members of The Elements Club, apply for membership in the fictional investment club, buy the print version or eBook, watch high-quality live action videos of scenes from the books, download ringtones, play online games, collect trading cards, and participate in live events with characters from the books and videos.

Nonfiction Transmedia Storytelling

In an essay entitled "Digital Distribution, Participatory Culture, and the Transmedia Storytelling Documentary," Chuck Tryon, assistant professor at Fayetteville State University, builds a case for the existence and legitimacy of what he coins "Transmedia Documentary" (Tryon, 2013). Citing as an example Robert Greenwald's *Uncovered: The Whole Truth about the Iraq War*, the 2003 documentary on how the Bush administration built its case to justify the Iraq War, Tryon states:

In this sense, Greenwald helped to give form to what I am calling the Transmedia documentary, a

set of nonfiction films that use the participatory culture of the web to enhance the possibilities for both a vibrant public sphere cultivated around important political issues and an activist culture invested in social and political change. In addition, these films make use of alternative distribution models enabled by digital media, whether streaming video, digital downloads, or social media tools that facilitate public or semi-public screenings (Tryon, 2013).

While the authors agree in general with Tryon's assertions that there is niche for documentary in the Transmedia Storytelling model, they disagree that Uncovered rightly fulfills the criterion of limited redundant delivery. The documentary was distributed online via various digital platforms, however, it was as a single presentation, and not as separate parts of the story. It does not represent, as noted above, what the authors will call the minimum three legs on which a Transmedia story stands: multiple media, a single unified story, and avoidance of redundancy between media. There were certainly the implicit indications of the kinds of important success that a Transmedia Storytelling story would engender, such as social media discussion and social activism, but these are not considered parts of the model itself.

Pedagogical Applications

When considering teaching methodologies, it seems incumbent upon us as educators to explore Transmedia Storytelling as a way of injecting creative life and a sense of play into our teaching. This would most especially pertain to online and hybrid courses because of their utilization of digital delivery.

A prototypical hybrid Transmedia Storytelling course might take this tack for a National Security Agency (NSA) domestic internet surveillance story:

1. Face-to-face classroom lecture, which includes PowerPoint with embedded video links.
2. Textbook, printed news, and supplemental online reading along with video viewing assignments including Learning Management Systems (LMS) chat discussions.
3. Student-created videos of interviews of politicians, fellow students, and people on the street voicing opinions and telling their versions of the story. These videos can be uploaded to social networks and viewed during face-to-face sessions.
4. Facebook, Twitter, Pinterest, and other social media portals can be used to widen the course's discussions, eliciting feedback from a wider network.
5. "Gamification," which is the use of game thinking and mechanics in a non-game context, can engage students to attempt to solve problems of the subject—in this case, NSA invasion of privacy. This strategy can add robustness that especially appeals to students of the digital age, and need not be expensive to create (gamification.org, 2013).

The clear advantages of this Transmedia Storytelling approach are the creative utilization of digital and social media technologies and the engaging discussion activities—all across the multiple delivery platforms. Additionally, the unique tactile experience of traditional bound textbook, newspaper, and news magazine research is maintained.

Graphic Communications Course Example: *Little Red Riding Hood*

As a test run for a Transmedia Storytelling course that was being submitted for approval by the University of Houston faculty, a team of five students in co-author Jerry Waite's Spring 2013 class, Current Issues in Digital Media, produced a Transmedia Storytelling project based on *Little Red Riding Hood*. Over the course of four weeks, the students enthusiastically embraced the challenge, generating what Waite considered a surprising quantity and quality of fictional humorous content.

One of the hallmarks of Transmedia Storytelling is the *expansion* of the original storyline. So, the student team added several anachronistic twists to the classic tale. Most importantly, the fourteenth-century Little Red Riding Hood has access to all the twenty-first-century conveniences, including a smart phone, digital printing technology, and the Internet. And, she and her grandmother live in a contemporary master-planned community, complete with a homeowners association.

One of team's new storylines involved the unrequited love Little Red felt for her Huntsman savior. After her deliverance from the belly of the wolf, she and the Huntsman are interrogated by the police in different rooms. Sadly, they leave at separate times and lose track of each other. Desperate to find him, Little Red posts a personal ad on Craigslist's Missed Connections, but to no avail. The only bites she garnered in her fishing expedition were real-world men, who were intrigued by her story and apparently hoped to add to it.

The team also added an entire storyline related to the lack of security in the community in which both Little Red and her grandmother live. Furious that the Wolf was able to infiltrate the community and break into her grandmother's house, Little Red begins a futile battle with the homeowners association (HOA). Once she realizes that the HOA will not improve neighborhood security, Little Red decides to start her own security company. She tries, to no avail, to obtain financing from a bank, and then decides to raise cash by capitalizing on her story.

Little Red, truly a product of the digital media age, uses a Transmedia approach to raising money. The student team chose to use print, Internet, and collateral materials.

The group started by publishing a booklet retelling the classic unabridged version of the Little Red Riding Hood story. One of the team members posed for the cover photograph, which was then edited in Photoshop to

Little Red Riding Hood storybook

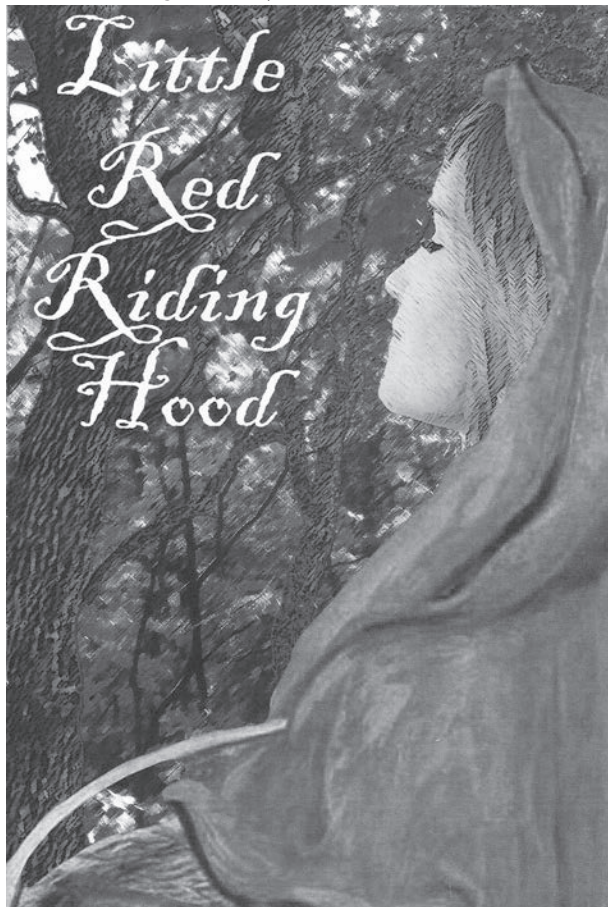


Figure 1

Little Red's Tumblr page

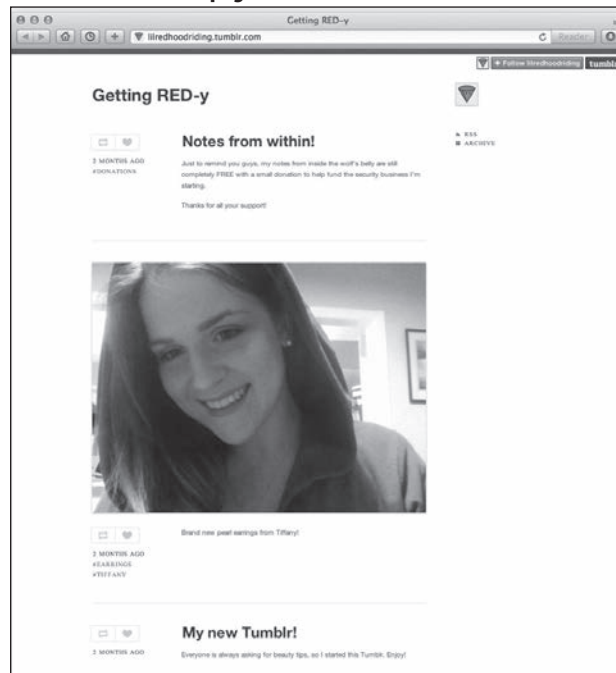


Figure 2

resemble a painting (Figure 1). The team downloaded the public-domain story from the Internet, formatted the text in InDesign, and then self-published the work using the Digital Media program's digital press.

Next, social media pages were created for "Li'l Red," as she became known, to tell her tale, to communicate with her network of followers and fans, and to sell items to raise capital to start her business. Among these were her Tumblr blog (see Figure 2) through which she sold trading cards featuring entries that she texted from inside the wolf's belly (see Figure 3). These blog entries were created by the student team by capturing screens from an iPhone, formatting the images in InDesign, and outputting on the program's digital press. The Tumblr blog was also used to promote Li'l Red's recipes (Creamy Red Pepper Soup, Red Velvet Cup Cakes, Stuffed Red Peppers, and so on), which could only be purchased, in PDF or printed-card format, on her etsy.com site.

The team also built Li'l Red a Pinterest page that contained photos and illustrations of things she loves (see Figure 4). There were also postings of "fan art" created by her fictional followers (see Figure 5). These works of art were created in Photoshop by team members in such a way that they resemble childrens' art. Of course, digitally

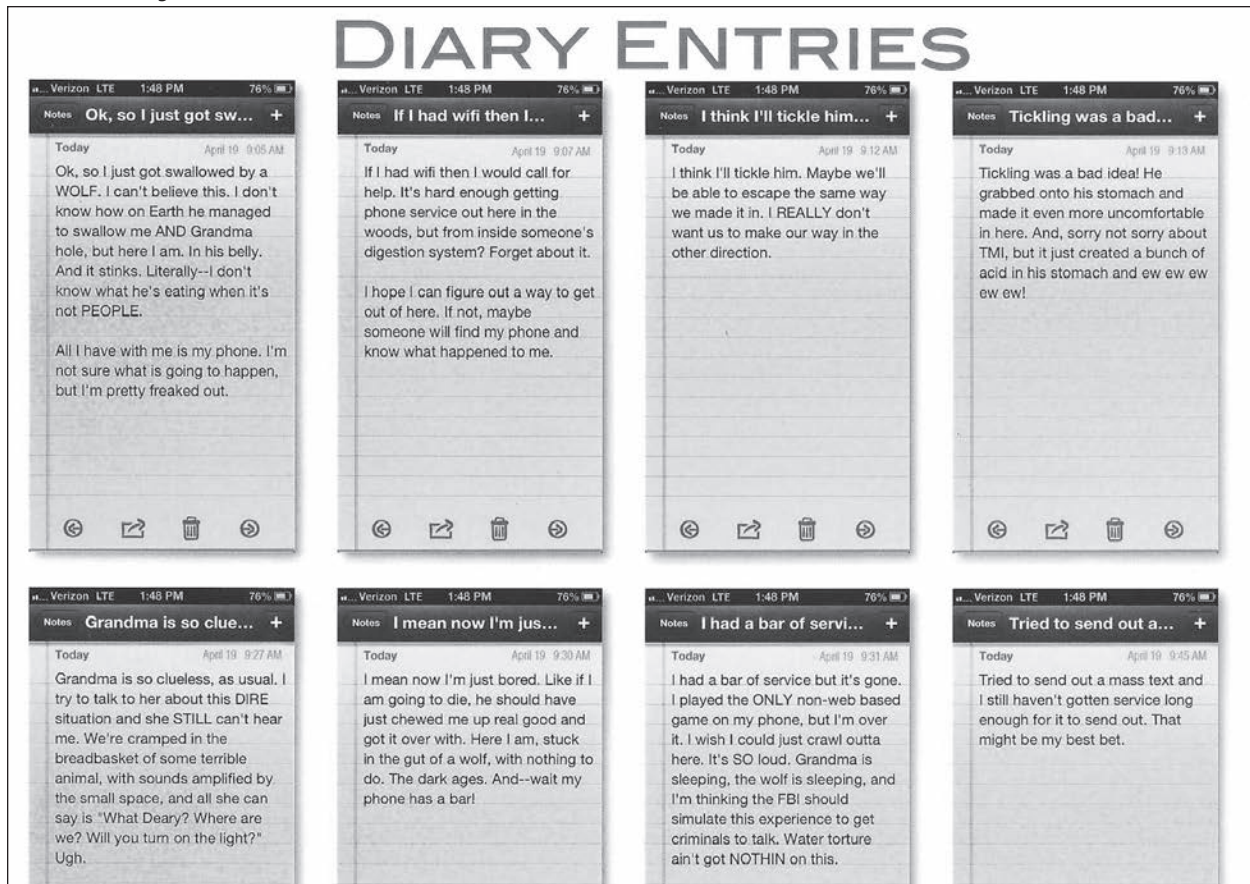


Figure 3

printed tabloid-sized prints of these works of art were made available for sale!

Eager to capitalize on collateral items, the student team also created a “gift basket” to be offered for sale online and in stores. This basket contained a copy of the self-published storybook, printed copies of the letters Little Red wrote to—and received from—her homeowner’s association and bank, a box to hold the collectible trading cards, and a red “riding hood.” Since, in the classic tale, Little Red carried a wicker basket of cake and wine to her grandmother’s house, a bottle of “A Little Red Wine” and a tin of red velvet cake were part of the gift basket.

In a debriefing after the project, Waite expressed great satisfaction with the trial run. In a mere four weeks, five students created a rich and relatively thorough Transmedia environment for Little Red. And, the students *utilized* most digital media connections while having an experience that was, in their words, “the most fun

and meaningful” they had had in college. Waite agreed with his students, noting that the only additional work he might have liked to see were a website as a central communication touch-point and video clips that could be hosted in YouTube and incorporated into Li'l Red's social media sites.

Conclusion

“Adapt or Die” seems to have, of necessity, become the clarion call for those in professions suffering the vagaries of the post-modern revolution brought on by the digital age. This is no less true in graphic communications education, where programs are being scaled down or eliminated. The authors believe that incorporating Transmedia Storytelling projects into graphic communications courses will result in increased student enrollment as word of mouth regarding the fun that students have creating these projects permeates the school environment. Of course, increased enrollment increases a program’s viability.

Little Red's Pinterest Home Page

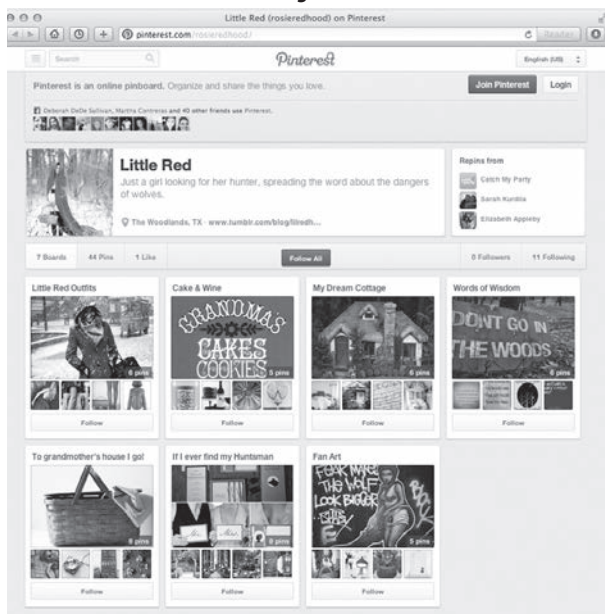


Figure 4

Little Red's Fan Art Page

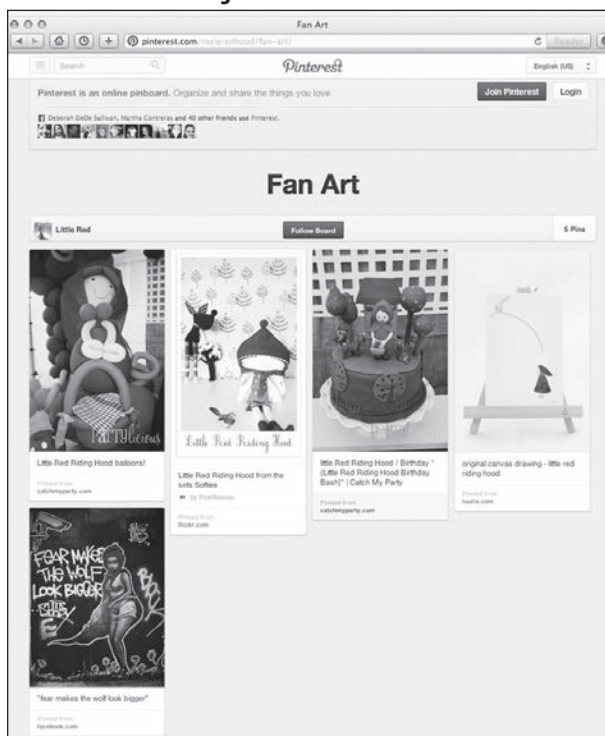


Figure 5

The authors also believe that Transmedia Storytelling projects are excellent capstone activities that will help students tie together contemporary media into a package that gets the right message to the right person. Finally, the authors believe that Transmedia Storytelling projects can help students meet core competency requirements through the incorporation of multiple disciplines, including language and art, into a multifaceted product.

The lesson to be learned from all this is that educators can adapt, change, grow, and be successful. One should not only embrace new technologies, but also celebrate and proactively promote them to enhance our courses and programs. Although disciplines such as digital photography, video, web design, and animation have traditionally been classed as under the purview of schools of the arts and humanities, the authors have demonstrated that they are a natural fit in graphic communications programs as well.

Microsoft founder Bill Gates declared in 1996 that “Content is King.” This should be axiomatic in these days of media paradigm shifts. Whether graphics educators adopt the Transmedia Storytelling paradigm or not, most salient is that what is created clearly justifies the program’s existence. If the stories students tell are compelling and effective—and fun to create—then successful growth and satisfying outcomes cannot be far off as the rewards to be reaped.

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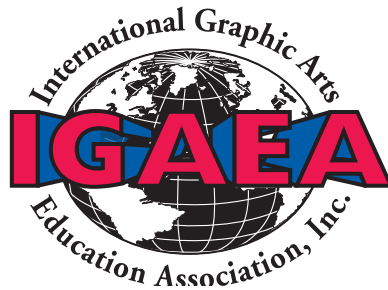
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