Visual Communications JOURNAL

FALL 2006

Tell me and I forget.

Teach me and I remember.

Involve me and I learn.

Benjamin Franklin

PRINTER,

STATESMAN,

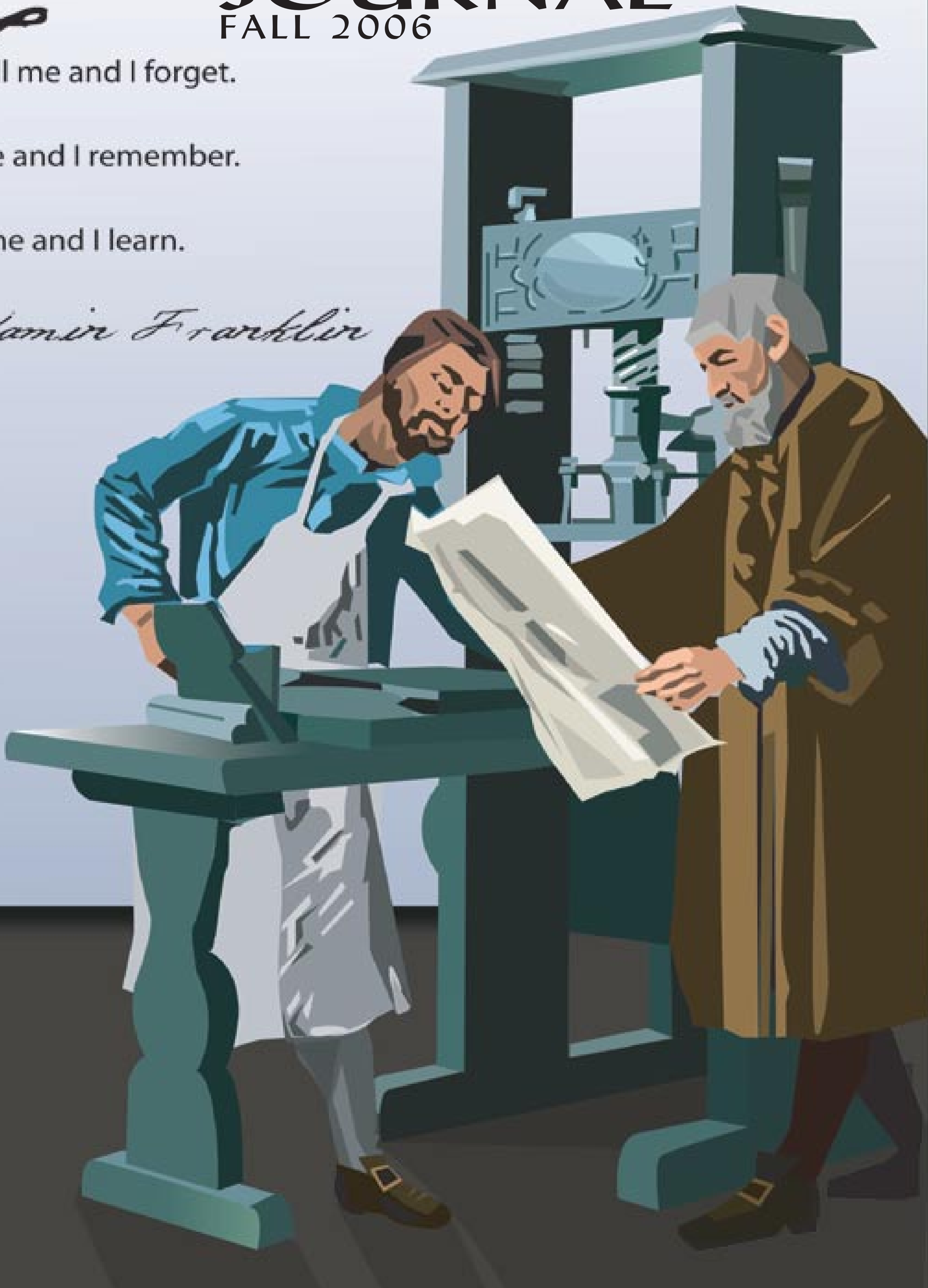
SCIENTIST,

INVENTOR,

PHILOSOPHER,

MUSICIAN,

ECONOMIST



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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 authors and do not necessarily reflect the policy or the views of the IGAEA

Article Submission
Please follow the guidelines provided at the back of this *Journal*.

Membership and Subscription Information
Information about membership in the Association or subscription to the *Journal* should be directed to the IGAEA Second Vice-President.

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* ... Mark Snyder served as a jurror for the *Journal*, but did not review his own paper.
**... Jerry Waite served as the editor of this *Journal*. However, his article was submitted blindly to the review committee.

Editor's Note

by Jerry J. Waite, Ed.D, University of Houston

Beginning with this issue, in Spring 2006, The Visual Communications Journal will be published on a bi-annual basis in the spring and in the fall of each year. This new publication schedule offers members of the International Graphic Arts Education Association numerous benefits.

Primarily, a more aggressive publication schedule insures that IGAEA members will receive up-to-date research reports and pedagogical articles in a timelier manner than in previous years. Secondly, the twice-a-year timetable will allow professors, whose careers often depend upon a two-paper-a-year record, the chance to publish twice as many peer-reviewed articles each year. Finally, a bi-annual publication schedule will allow us to increase the quality of the journal by requiring more authors to rework their submissions before they are accepted for publication.

If you are interested in publishing your work in the *Visual Communications Journal*, please read the Manuscript Guidelines on page 36 of this volume. Manuscripts to be considered for the spring issue will continue to be due on December 15. However, beginning this year, manuscripts may also be submitted by June 15 to be considered for the fall issue.

This volume of the *Journal* includes four articles submitted by IGAEA members. Two of the articles document original empirical research that can guide curriculum change while the other two offer concrete hands-on information that graphic arts educators can immediately use in their classrooms.

Dr. La Verne Abe Harris describes an empirical research project in which she implemented a learner-centered educational approach in her *Multimedia Design Planning and Storyboarding* class. Students were required to hone their decision-making, people, project-management, and attitudinal skills when creating interactive animations for an on-line organic chemistry course. Dr. Harris documents how her students improved their abilities in each of these essential skills while interacting with her, a client, and classmates.

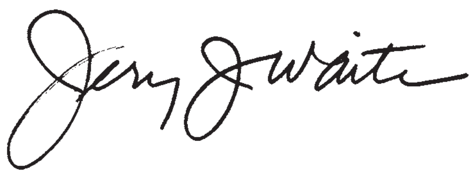
Dr. Daniel Wilson and his colleague Martin Westrick surveyed Illinois printers to find out what information technology skills that graphic communications graduates should possess. The authors report in their refereed article that their survey respondents already offer—or are likely to offer within the next two years—variable data printing services. This leads the authors to suggest that database management be incorporated in graphic communications programs. Other findings include the extent to which web publishing, and computer networking should be a part of graphic communications curricula.

In a juried article, Dr. Mark Snyder provides a theoretical and historical perspective of Radio Frequency Identification (RFID) and shows how the emergence of these devices as an integral part of manufacturing and retail logistics and distribution can be a major boon to label printers. These devices, including their antennae and batteries, can be printed by a variety of processes including flexography, screen-printing, and gravure.

For the past several years, I have been working on methods to implement printing industry standards, such as GRACoL, in graphic communications classrooms. Thanks to a half-time sabbatical I received in Fall 2005, I was able to prepare a concise document that summarizes those guidelines in SWOP, SNAP, GRACoL, and FIRST that graphic design faculty should include as an integral part of their lessons. My report, in the form of a juried article, is also included in this volume of the *Visual Communications Journal*.

It is important to note that two articles in this *Journal* were written by those involved in the editing and/or reviewing of the articles. Mark Synder served as a juror. However, he did not review his own paper. Instead, three other jurors blindly reviewed it and their votes were tabulated to determine that his paper should indeed be published as a juried article. Similarly, I served as the *Journal's* editor and a contributor. My paper was submitted for blind review to three jurors. Documentation regarding the voting on these two articles is available by contacting Jerry Waite at **jwaite@uh.edu.**

Four new jurors joined the staff of the *Journal* this year. They include: Cynthia Gillispie, from North Carolina A&T State University; Robert Chung, from Rochester Institute of Technology; Mark Snyder, from Millersville University; and Lenore Collins, from Rhode Island College. Jim Tenorio, from University of Wisconsin, Stout; Malcolm Keif, from California Polytechnic State University, San Luis Obispo; Robert Cox, former IGAEA President and emeritus professor from Southeast Missouri State University; and Z.A. (Zeke) Prust, former IGAEA President and emeritus professor from Arizona State University again served as jurors. Thanks to all eight of these well-respected individuals for spending their time to critique the work of their peers.



The Shifting Roles in the Emergence of the Innovative Graphic Technologist

by La Verne Abe Harris, PhD, CSIT, Arizona State University

What is Learner-Centered Education (LCE)?

There is a quiet revolution occurring in higher education — a changing of philosophy on how one teaches, how one learns, how a classroom is structured, how faculty and college students relate to each other, and the nature of the curriculum. What role do faculty and students play in learner-centered education? How does the philosophy of learning encompass issues from society, the quest for lifelong learning, the culture of the evolving university classroom, and the emergence of the innovative graphic technologist?

The learner-centered approach is to shift the responsibility of learning to the student, so that the student becomes the center of the educational process and becomes an active decision-maker by making choices on how his or her learning will take place. The professor's role is transformed to that of a facilitator and supporter of the learning process. Learner-centered education prepares students for lifelong learning and skill sets that are transferable to industry.

Bridging the Gap Between Industry and Academia

The majority of the world is overwhelmed with digital information that is changing at an alarming rate. The Internet, print, television, and other media are evidence of the importance of communicating through visual communication, the written word, and auditory cues. Learning how to communicate through technology helps to confirm technology as a catalyst for change in our society. The majority of careers in the United States are threaded with technology. The lack of technical and visual literacy in the workforce is a prevailing problem in the United States, especially because many jobs require this knowledge (Donofrio, 2004).

The economic health of the United States is dependent on research, innovation, and a well-educated workforce. Thomas Jefferson declared that informed decision-making in a democratic society is dependent on educated citizenry (Lipscomb & Bergh, 1903-04). But technical and visual literacy is not all that is necessary for sustainable economic growth. In order to produce economic results, American and international businesses in the 21st Century need strategic employees who know how to think creatively, apply knowledge to solve problems, and who understand people, as well as technology.

In Arizona, the university system Board of Regents defined LCE and produced a Statement of Principles for Learner-Centered Change (ABOR, 2000, 2004). They mandated that it is the responsibility of the academy to create an environment that is conducive to learner-centered education.

Research in 1996 confirmed previous results that only 6% of higher education class time was spent on student participation (Weimer, 2002). The challenge for today's graphic technology faculty is to increase student participation by producing a climate for LCE. The professor can introduce more activity design work, model behavior, and give more feedback. Then the professor should take a less dominant role in learning by giving fewer instructions, fewer answers, and less content organization. Today's challenges for university students are to take responsibility for their own learning through discovery and learning from each other (Weimer, 2002). Though active engagement, critical and creative thinking, and problem solving, students learn to apply their "technological expertise, skills, and knowledge," which results in Arizona and the nation becoming globally competitive (ABOR, 2000).

Goals and Objectives

The goal of this team project was to facilitate higher-level thinking and learning and propel lifelong learning behavior (McKeachie, 1986). Because a goal describes in broad terminology the long-term intent of the activity (Carter-Goodrumn 1998; ADOE, 2003), the ultimate goal of this team project was to provide an effective and accessible learning-centered activity for linking the interdisciplinary nature of multimedia technology to other unrelated university curricula. The objectives of the team project, on the other hand, were more specific in nature, short-term, and measurable (ADOE, 2003). They addressed higher-order thinking and required problem solving, application, evaluation, synthesis, and analysis, which are reflective of the domains of Bloom's Taxonomy (Bloom et al., 1956). Objectives were measured by observing, listening, and analyzing work. In addition, they were measured by pre/post tests, and self, peer, and teamwork evaluations.

In an industrial work environment, learner-centered psychological principles need to be applied in order to ensure the success of the learning process (APA, 1997). The principles are applied through cognitive, affective, and skill set objectives. The knowledge and intellectual skills necessary for developing thinking skills fit in the cognitive category. This is informational knowledge that students did not know before the learner-centered activity took place. The development of new values, attitudinal changes, new interests, and "social dimensions of outcomes" belong in the affective category (BSU, 1999). Bloom (1956) presents the third level of learning as the "psychomotor." The present author includes both cognitive and psychomotor skill objectives in the third domain, with activities such as presenting, writing, and so on, as outcomes. Critical and creative thinking skills were developed in this course through learned activity, inquiry, balancing thinking with theories, focusing on processes, establishing a non-judgmental setting, and problem solving (Kurfiss, 1989).

Methodology

The methodology of this case study was based on multi-method survey and focus group activities that were both quantitative and qualitative in nature. The success of the project was determined by the analysis of the data from the pre/post tests, focus groups, and evaluations through process measures used to assess student involvement, skills, knowledge, and educational progress. Twelve graphic information technology (GIT) students at Arizona State University, who were enrolled in *GIT 314 Multimedia Design Planning and Storyboarding*, participated in this study. There were nine males and three females. The mean age was 23, which was mature enough for a student-initiated approach to learning.

Students applied their technical and innovative skill sets to solve real and simulated industrial problems. Students were assessed on their critical and creative thinking skills, the application of their technical and creative knowledge, their teamwork skills, and how they incorporated problem solving. The competency-based assessments through pre/post tests (Refer to Appendix B), scientific lab reports, evaluations, teamwork, and electronic presentations met the rigor and standards of the academy. Instruments were developed around authentic assessment strategies, such as the use of rubrics to describe the attainment of parameters of competency, and reviews of student activities through self, peer, team, and faculty evaluations (Refer to Appendix A). Self-assessments and peer performance assessments were confidential.

The Project Management Process

The students were given the expectations of the final outcome. Twelve animations of molecular structures were to be developed as a supplement for an online organic chemistry course. How this goal was to be reached was the ultimate responsibility of the students in the class. The requirement was that each animation ("learning object") had to be consistent in design and technology solutions.

At the beginning of the team project, the class was engaged in open discussion on the roles and responsibilities of each person on a multimedia team. Twelve job titles from project manager to technical support were developed in order for tasks to be completed. Each student was presented as a resource to every other student, and part of their success of this project was to be determined by how they shared their talents and strengths with each other. Individual success was determined by the success of the other team members, so it was in each person's best interests that the other members completed their tasks.

Because of the inexperience of the students, they allowed the client to control the interview and ended up getting a lecture on organic chemistry. This was a valuable part of the learning experience. It was explained to the team that it is their responsibility to prove the significance of the project to the client. The students needed to come to the interview more prepared with suggestions to give the client, instead of asking the client what he wanted. This reflective process was invaluable.

Before the students could determine how the project was going to be implemented, they had to determine a strategic plan. No one knew what to do first, so a strategic plan was developed with a list of all the tasks that needed to be accomplished, areas of responsibility, and a timeline. It was determined that it was the project manager's responsibility to organize these tasks and keep everyone on task. Each person was required to sign off as soon as his or her task was completed, making each team member accountable to the others. The team developed timecards and an approval process.

Because all molecular structures had to be consistent visually, technically, and content-wise, a stylebook was developed.

The multimedia design process (brainstorming, scriptwriting, sketching, storyboarding, animation), which was learned individually the first half of the semester, had to be applied to the team project. The storyboards were the blueprint for design activity, and the molecular structures were implemented using *Macromedia Flash*, a vector-based animation software.

Students have traditionally relied on the professor for answers. For this project, the professor responded to questions in class by asking the students more questions, rather than giving packaged answers, such as: "Did you discuss this with the R&D person? Have you thought about …? What do you believe the next priority is in this project? Have you compared how other universities have solved this problem?" Students had to learn to be resourceful and rely on their own initiative, as well as on each other. This was somewhat stressful for students, until they realized that finding the answers was their responsibility.

Findings

Finding 1: Assessment Outcomes. Visual and technological literacy increased substantially during the semester. Based on the results of the pre- and post-tests, the students overall increased their score to 7.5 times that of the pre-test. Initially, 92 percent of the students failed all areas of the pre-test. One student passed the technical knowledge section, but did not pass the creative section. The pre-test scores did not count against the students. This assessment was only used to determine the level of their knowledge base at the beginning of the semester.

At the end of the semester, 100 percent of the students not only passed the post-test, but scored an A or B (98% – 81%). The post-test mean score was a B+ (90%), which was substantially higher than previous semesters. The creative knowledge base of multimedia design planning and storyboarding increased though the implementation of LCE. Knowledge was also gained in the technical knowledge base of the Flash technology through the application of multimedia skill sets. Mean scores on the post-test increased from 3% to 90% successful answers. Performance levels were analyzed by reviewing the individual animations, storyboards, sketches, scripts, and lab reports. Only one student had previous Flash experience prior to taking the course. By the end of the semester, everyone was competent in creating a dynamic learning object for the organic chemistry Web site.

Finding 2: Decision-Making Skills. The innovative use of multimedia learning objects included in the online curriculum provided a delivery consistent with learner-centered education goals by giving students many choices in learning methodology — from collaborative team work to individual reflection. The students in the learner-centered activity contributed by (1) establishing goals and objectives for the project, (2) assessing and monitoring their own progress, (3) establishing standardization guidelines to determine evaluation criteria, and (4) planning and being held responsible for the activity. At one point, an unexpected task for the team was added — individual detailed lab reports. These reports were in the initial requirements of the project and were introduced intentionally in order to observe the response of the students. The project manager became concerned and expressed that concern. It was determined that with the time allocated, the deadline of this task was not going to be feasible. The negotiations were successful and the students developed higher order (meta-cognitive) skills.

An online supplement to the face-to-face *Multimedia Design Planning and Presentation* course was accessible to the students in the class. This allowed for the accommodation of a variety of learning styles. It guaranteed students had available time to contribute to group discovery through online class discussion, as well as in class. The traditional lecture was not the prevalent mode of course delivery, but it was used to deliver academic content and assessment of procedures. Even though the least learning-centered format is the lecture, often a plethora of material must be covered, so the lecture format must be used on occasion. Presenting the content in an interesting manner was the challenge.

Finding 3: People Skills. Learning how to problem solve with people instead of machines was a new experience for most of the technologists. They discovered that people skills were necessary in the majority of the activities.

Because the students shared ideas and skills, a diverse learning community was formed. The result was a positive working environment with increased personal and professional relationships. The classroom environment in a successful learner-centered project should be a nurturing one. Eliminating the fear of failure helped the students take more risks, increase their motivation, and interact more frequently with each other. They felt like they "owned" the organic chemistry animation project and therefore took full responsibility for its success. The climate of the classroom supported the individual student with varying learning styles, skills, and cultural backgrounds.

The material was appropriate to the students' level. The students learned that the client was the content provider and they had to take the information and determine how best to disseminate it to the target audience. Because of this, the students had to collaborate with others on the instructional tasks. They often stayed two hours after class had ended to interact with each other in the lab and to discuss how best to solve a problem. They learned to respect each person's contribution to the team.

Finding 4: Project Management Skills. The project manager created a timeline with slack time incorporated into it. His responsibility was to monitor the completion of the individual tasks and to determine if the deadline was going to be met. He constantly had to reassess the appropriateness of the deadlines.

The students approached their learning experience as a way to solve an industrial problem. They not only had to learn the concept of the subject matter, but also develop their Flash skills. In other words, they had to become strategic thinkers by deciding what methods worked and what did not through observation and interaction with their team members.

Many students successfully master the course content in individual courses, but have a difficult time interconnecting the relationships between another discipline and technology. The traditional approach to curriculum usually does not integrate fields of study. The interdisciplinary approach demonstrated how multimedia can be threaded throughout all academic disciplines. It helped the student use their mind to "think outside of the box." The interdisciplinary multimedia project increased teamwork skills, creativity, student access to technology and created synergy between curricula in different departments.

Finding 5: Attitudinal Skills. The students in the case study learned to take full responsibility for their actions. If an event occurred, they found that the outcome was based on their response. Attitude was the one thing they agreed they could control. The students learned through failure. Success was ensured through constant instructor feedback. Mild anxiety was found to be motivational. And, effort was found to be a reaction to one's motivation to learn.

The instructor facilitated the process by guiding the effective strategies of production and teamwork, such as concept mapping and categorizing. Occasionally, the students were allowed to fail at a task in order to learn. An example was when the students interviewed the client and did not get the content they needed in order to do the animations. The students learned the significance of guiding and controlling the client interview in order to get the content needed to successfully complete the task. They learned that advanced planning of questions is necessary.

Curiosity, along with mild anxiety, propelled student performance and motivation for completing the project. Too much stress and worry about competence detracted from the learning process. When those moments came, the process was stopped. The students were given a creative or technical demonstration and/or time for a discussion. They got back on track. The tasks were novel enough to stimulate natural curiosity, difficult enough to create mild anxiety to learn to be competent, but reachable enough to succeed. This created intrinsic motivation to learn.

Effort is also a reaction to one's motivation to learn. Because the individual's work had to meet the specified standards, peer pressure was the guiding force for individual accountability. The students perceived that the tasks were relevant to reaching the end goal and they held each other accountable.

Conclusions

By the end of the semester, the students had experienced a successful LCE activity. The lifelong-learning skills were observable in the areas of teamwork, collaboration, client relations, standardization, and acceptance of responsibilities. Goals were reached through completion of learning objectives. Decision-making skills were improved through investigating many choices. Negotiation skills, discovery skills, and people skills were developed. A learning and knowledge community was formed when the diverse student population began to collaborate and share ideas with each other. Through the process of project management, students learned to think strategically and to successfully complete the tasks of threading technology with an interdisciplinary focus. The affective skills that were developed changed the attitudes of the students and the way the students perceived failure. Students also realized that success is more obtainable if there is feedback, that mild anxiety is motivational, and that the amount of effort they applied to an activity is a direct indication of their desire to learn.

Because technology is socially, culturally, economically, and politically constructed by our society, technology changes the way in which people work, and subsequently changes our society. Shifting the university pedagogy to that of LCE, can transform a classroom project into transferable learning, and a student into an innovative graphic technologist.

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APPENDIX A:
HARRIS TEAM ASSESSMENT
(Peer, Self, Project)

Name: ____

PEER EVALUATION

DEFINITIONS

Face-to-face promotive interaction = Member promotes other employees' productivity by helping, sharing, and encouraging efforts to produce. Member explains, discusses, and teaches what he knows to others.

Social skills = Overall ability to work well with others toward the success of the company; Having interpersonal and small group skills, which are considered job performance skills, including: decision-making, trustbuilding, communication, conflict-management and instructorship skills.

Positive interdependence = Overall attitude and action that the successful outcome of one group member is dependent upon the successful outcome of each group member

Individual accountability = Assessment of the quality and quantity of each member's contributions;
Ability to complete tasks efficiently and effectively toward the success of the team and overall success of Danté Multimedia Works

PEER EVALUATION SCALE

5	Outstanding (above and beyond expectations)
4	Above average
3	Met requirements
2	Needs improvement
1	Significantly below average

					CONTRIBUTION	
	Name	Face-to-face interaction (Evaluate ALL employees)	Social skills (Evaluate ALL employees)	Positive interdependence (Evaluate ALL employees)	Individual accountability (Evaluate YOUR team only)	Individual accountability (Evaluate ALL employees)
TEAM 1	X	0	0	0	0 %	0 %
	X	0	0	0	0 %	0 %
	X	0	0	0	0 %	0 %
	X	0	0	0	0 %	0 %
TEAM 2	X	0	0	0	0 %	0 %
	X	0	0	0	0 %	0 %
	X	0	0	0	0 %	0 %
	X	0	0	0	0 %	0 %
TEAM 3	X	0	0	0	0 %	0 %
	X	0	0	0	0 %	0 %
	X	0	0	0	0 %	0 %
	X	0	0	0	0 %	0 %
					TEAM = 100%	TOTAL = 100%

Harris Team Assesment • Page 1

PEER EVALUATION
Name: ____

Group processing = Processes in place to improve effectiveness

1. List at least three member actions that helped the organization be successful:
   a.
   b.
   c.

2. List one member action that could be added to make the organization even more successful:
   a.

3. **Did your team have** *(underline):*

Yes No Mutual goals?

Yes No Shared resources?

Yes No Assigned roles?

Yes No Joint rewards?

Harris Team Assesment • Page 2

SELF EVALUATION

Name: ____

What worked?
1. What was the most successful part of YOUR contribution to the team?

2. Did you end up doing anything outside of your job description that you felt was a major contribution to the team effort?

What didn't work?
3. Of the tasks and responsibilities you were responsible for, what were you most surprised didn't work?

4. Did you have to change your approach or was the problem unresolved?

Harris Team Assesment • Page 3

5. Did you perceive you did more or less than the other employees?

6. How did you deal with others not pulling their weight? Did it matter to you?

Reflection on what you would change.
7. You now have hands-on experience with the project management of a technological project. What was the most significant thing you learned from this experience?

8. If you were in a work situation, what would you do differently next time?

Harris Team Assesment • Page 4

Name: ______________________________

Evaluate your own project as well.

PROJECT
EVALUATION

PROJECT EVALUATION SCALE

5	Outstanding (above and beyond expectations)
4	Above average
3	Met requirements
2	Needs improvement
1	Significantly below average

	PROJECT	QUALITY OF WORK COMPLETED	QUANTITY OF WORK COMPLETED	COMMENTS?
TEAM 1	X	0	0	X
	X	0	0	X
	X	0	0	X
	X	0	0	X
TEAM 2	X	0	0	X
	X	0	0	X
	X	0	0	X
	X	0	0	X
TEAM 3	X	0	0	X
	X	0	0	X
	X	0	0	X
	X	0	0	X

Harris Team Assesment • Page 5

PROJECT EVALUATION
Name: ______________________________

1. What was the major difference between the individual project completed at the beginning of the semester and the team project?

2. Were some projects more complex than others?

3. What was done to even out the workload? Or should it be evened out?

4. Did you enjoy doing the project?

Harris Team Assesment • Page 6

APPENDIX B:
MULTIMEDIA DESIGN PLANNING AND STORYBOARDING
GIT 314 Pre- and Post-Test

1. What is a storyboard?
2. Describe the different camera frames, angles, and movement for a storyboard shot.
3. What is the aspect ratio of a storyboard?
4. Describe the design process when planning and implementing a multimedia learning object for a distance learning course.
5. What is a target audience?
6. What is an interactive infographic?
7. What is a stylebook and what is its purpose?
8. What is a script?
9. What is Flash?
10. What are the tag extensions used in Flash? Give examples of their use.
11. How should images be saved for a Flash animation (specifically resolution, color mode, and format)?
12. Define a symbol and its use.
13. Define an instance and its use.
14. What is a library?
15. What is motion tweening? Describe the effect it has on the timeline?
16. What is shape tweening?
17. What is action scripting?
18. How are movies published?
19. How is sound added to an animation in Flash?
20. How do you create a rollover button with text?
21. Why are different layers used?
22. What is onion-skinning?
23. How do you import and compress a bitmap?
24. How do you import video into a Flash file?
25. How do you create a movie clip?
26. What is the difference between working with static text and device fonts?

Harris Team Assesment • Page 7

Information Technology Content in Graphic Communications Curricula: A Needs Assessment

by Daniel G. Wilson, D.I.T. & Martin A. Westrick, Illinois State University

Introduction

The graphic communications industry has experienced unprecedented changes in recent years. Most of these changes are a result of a rapid increase in the integration of computer technologies into the print media procurement and production processes. According to the U.S. Department of Labor (2005), information technology (IT) is the fastest growing segment in the economy, with 92% of all IT workers in non-IT companies, 80% of whom are in small companies. In the printing industry, the Internet, file exchange, and database technologies are playing a key role in automating customer interfaces, allowing customers to submit job specifications for quotes on-line, and providing management of digital assets (such as images and document files) with full access and control from the web portal. Databases and networking technologies are allowing for the control and monitoring of job specification gathering, job quotes, job content, order entry, job planning, and electronic proof distribution and approval. Variable data printing has matured as well, and requires database management. (Seybold Report, 2003, 2004, 2005). A decade ago, GAMIS (1994) reported that electronic data interchange was a growing medium and would be instrumental in communicating information between customers, suppliers, publishers, and printers. These predictions have proven true in most segments of the graphic communications industry and today these changes need to have an impact on graphic communications curricula.

For students to possess the necessary skills and knowledge required for employment, educational institutions must be responsive and adapt their curricula to meet the changing needs of employers (Finch & Crunkilton, 1993). This research involves a needs assessment, done to determine the degree to which information technologies have infiltrated traditional printing businesses and the perceptions of industry leaders as to the knowledge requirements of university-level graphic communications graduates with regard to information technology. The data presented here may provide guidance to graphic communications curriculum planners as they integrate information technology into traditional print media production and management course content.

Needs Assessment as a Curriculum Development Tool

Needs assessment can be defined as any systematic approach to setting priorities for future action within an academic program (Dick, Carey, & Carey, 2000) (Witkin & Altschuld, 1995). According to Kaufman (1985), needs assessment involves identifying gaps in program outcomes and placing the gaps in prioritized order for attention. Needs assessment may be carried out on a global scale for entire programs or for more focused needs, down to a module within a course (Burton & Merrill, 1977). Regardless, the process of needs assessment is primarily one of data gathering from a variety of sources.

In a technology-based program, such as graphic communications, sources of data may include current and former students, employers, content experts, and discipline-specific literature. Three basic survey methods for collecting needs assessment data include questionnaires, interviews, and the critical incident technique. Of these, the written questionnaire is the most common method of collecting needs assessment data (Witkin & Altschuld, 1995).

Research Questions

A survey instrument was developed to help answer a number of research questions identified by Illinois State University faculty and the graphic communications program advisory board as addressing possible curricular gaps in the program. The program has existed for decades as a traditional print-centered program, preparing students for management-oriented careers in the printing industry.

Commonality among these questions was a focus on information technology in the Illinois printing industry and the expectations of executives on the knowledge base of university-level management-oriented graphic communications majors. Four research questions emerged as a result of extensive discussion.

1. To what extent is the industry embracing information technology-enabled print media production and management functions including variable data printing technology and digital asset management technology?

2. Who within the organizational structure is responsible for information technology functions including web publishing, database maintenance, and networking maintenance?

3. How did individuals responsible for information technology functions including web publishing, database maintenance, and networking learn these functions?

4. Do printing industry executives expect those receiving college-level degrees specializing in graphic communications to have information technology knowledge and skills?

Research Methodology

The sample for this study consisted of principal officers, or their designees, from printing organizations in Illinois employing more than 10 individuals. Census information and a database obtained from Dunn and Bradstreet indicates that there were approximately 1,416 graphic arts organizations (SIC 27) with 10 or more employees located in Illinois as of March 2001 (Note: the current North American Industry Classification System (NAICS) was not used for this data). Nine subgroups representing the various print media markets were targeted for the survey.

Industry SIC Code	Industry Classification	Total Number of Organizations	Organizations with 10 or more employees
27	Printing and publishing	3,459	1,416
271	Newspapers	422	247
272	Periodicals	277	147
273	Books	219	96
274	Miscellaneous Publishing	103	76
275	Commercial printing	1,930	683
276	Manifold business forms	62	26
277	Greeting cards	5	10
278	Blankbooks/bookbinding	101	69
279	Printing trade services	258	62
Totals of	3-digit subgroups	3,377	1,416

Table 1 SIC 27 Printing and Publishing: Number of Organizations in Illinois

Source. The data in column 1 through 3 are from the U.S. Department of Commerce, Economics and Statistics Administration, Bureau of the Census. (1996). County business patterns 1996: Illinois. (CBP/96-15). Washington: Author. The data in column 4 is from an industry list purchased from Dunn and Bradstreet (2001).

A single-shot mail survey approach was used to collect the data. The survey was designed as a four-page, 8.5 × 11-inch trim self-mailer. Business reply status required the responder pay no postage to return the survey. A cover letter explaining the importance of the study and information about the graphic communications program at Illinois State University was incorporated into the design. To encourage a high response rate, check box-type answers assured that responses could be provided quickly, accurately, and with minimal effort. No follow-up survey was mailed.

The number of organizations needed to sample the population was calculated using the Krejcie and Morgan (1970) equation at $\alpha = .05$. Using the population size of 1,416 graphic arts organizations, a random stratified sampling procedure yielded 670 surveys to be mailed. The return yielded 59 usable surveys (9% return rate) that were used for data analysis. It is discouraging that the return rate was not higher, as the survey was well designed in color and included an explanation that the results would be of critical importance to graphic communications education. The return was too small to enable data analysis of individual markets. However, the return was sufficient to analyze data for the entire printing market as a whole.

Limitation

The survey instrument was designed to solicit data from a sample of Illinois printing industry. The sample may not be random and representative of the entire population within the broader graphic communications industry.

Data Analysis

1. To what extent is the industry embracing information technology-enabled print media production and management functions including variable data printing technology and digital asset management technology?

Printing firms were asked whether or not digital asset management was implemented and used a value added service. This would include storing and organizing customer rich-media files in a database on a server while providing access through a web portal. Customers could browse, sort, and select files for their use and printers could use the system in production workflow. There are a variety of software solutions for digital asset management, among them Canto's Cumulus, ImageFolio, and Extensis Portfolio.

While 61% of firms surveyed do not employ digital asset management, 23.7 % offer the service to their customers and another 15.3 % intend to implement the technology within the next two years (Table 2). With over one third of all printers employing or planning to employ digital asset management solutions, this technology has clearly become mainstream.

	Frequency	Percent	Cumulative Percent
No	36	61.0%	61%
Yes	14	23.7%	84.79
Plan to with 2 yrs	9	15.3%	100
Total	59	100%	

Table 2: Companies That Manage Customer Digital Assets as a Value-added Service

Printers were also asked about variable data printing. This technology requires a digital printing device—such as a Xerox iGen 3 or an HP Indigo press—though variable data printing can also be done on low-volume laser printers. The technology also requires a database of content, thus requiring printers to structure and manipulate databases. Nearly one third of printers surveyed (30.5%) responded that they are offering variable data printing services (Table 3). Another 11.9% of printers responded that they are likely to add variable data printing services to their production offerings within the next two years. These data suggest that over 40% of printers will offer variable data printing in the near future making this technology well dispersed in the industry.

	Frequency	Percent	Cumulative Percent
No	34	57.6%	57.6%
Yes	18	30.5%	88.1%
Plan to with 2 yrs	7	11.9%	100%
Total	59	100%	

Table 3: Companies that offer Variable Data Printing Services

2. Who within the organizational structure is responsible for informat ion technology functions including web publishing, database maintenance, and networking maintenance?

Illinois printing firms were asked about their organizational structure with regard to information technology responsibilities in the areas of web publishing, database management, and network maintenance. Specifically, the survey aimed to determine whether printers employed a dedicated IT person to handle web publishing, database, and network development and maintenance or whether these functions were handled by prepress personnel or by an external service.

With regard to web publishing, 32.2% of printers surveyed employ a dedicated person to handle web publishing functions (Table 4). Prepress personnel were responsible for web publishing in 22% of the printing firms surveyed and 27.1% or printers had an external service manage their web sites. The survey results suggest that nearly 1 out of 5 (18.6%) printers surveyed do not have a web site.

	Frequency	Percent	Cumulative Percent
Dedicated IT Personnel	19	32.2%	32.2%
Prepress Personnel	13	22.0%	54.2%
External Service	16	27.1%	81.4%
Not Part of Operation	11	18.6%	100
Total	59	100%	

Table 4: Who Develops and Manages Web Sites Within the Company

The data suggest that nearly one third of printers (30.5%) do not manage databases as part of their business (Table 5). However, 69.5% do, with 42.4% of printing firms surveyed employing dedicated IT personnel for the task. 18.6% of printers ask prepress personnel to manage databases and 8.5% use an external service.

	Frequency	Percent	Cumulative Percent
Dedicated IT Personnel	25	42.4%	42.4%
Prepress Personnel	11	18.6%	61.0%
External Service	5	8.5%	69.5%
Not Part of Operation	18	30.5%	100
Total	59	100%	

Table 5: Who Manages and Configures Databases Within the Company

As for network systems, about half of the printers surveyed (50.8%) employ dedicated IT personnel to handle network maintenance (Table 6). Prepress department personnel manage networks in 22% of the printing firms and 15.3% require an external service. Out of all surveyed printers, 11.9% indicated that they do not have a computer network.

	Frequency	Percent	Cumulative Percent
Dedicated IT Personnel	30	50.8%	50.8%
Prepress Personnel	13	22.0%	72.9%
External Service	9	15.3%	88.1%
Not Part of Operation	7	11.9%	100
Total	59	100%	

Table 6 Who Maintains Network Systems Within the Company

3. How did individuals responsible for information technology functions including web publishing, database maintenance, and networking learn these functions?

To get at the question of how key IT-oriented personnel were educated, printers were asked to indicate the closest match to explain how these professionals ascended to their positions overseeing web site development and maintenance, database management, and network maintenance. As for web site development and maintenance, the data suggest that most personnel (42.8%) responsible for this function ascended to the position through the prepress department. About one out of five companies hired a person for web site maintenance out of a computer-science oriented degree program. Some of the firms hired web publishing personnel out of graphic communications (14.3%) programs. Interestingly, only 9.5% of the firms hired personnel out of graphic design degree programs, while many of these programs focus on web publishing as a major thrust of their curriculum.

	Frequency	Percent	Cumulative Percent
Hired for job with art/design degree	4	9.5%	28.6%
Hired for job with graphic arts/graphic communications degree	6	14.3%	42.9%
Worked in prepress and acquired skills on the job or through training classes	18	42.8%	85.7%
Others	6	14.3%	100%
Total	42	100%	

Table 7 How Key Employee Ascended to Web Site Development/Maintenance

For database development and maintenance, 23.3% of the firms surveyed hired computer science-oriented degree graduates for the job (Table 8). But the majority of printing firms (51.2%) found prepress personnel for the responsibility. Only 11.6% of printing companies hired people out of graphic communications degree programs to handle databases as a part of their responsibilities.

	Frequency	Percent	Cumulative Percent
Hired for job with computer science oriented degree	10	23.3%	23.3%
Hired for job with graphic arts/graphic communications degree	5	11.6%	34.9%
Worked in prepress and acquired skills on the job or through training classes	22	51.2%	86.0%
Others	6	14.%	100%
Total	43	100%	

Table 8 How Key Employee Ascended to Database Development/Maintenance

Network maintenance most commonly fell under the auspice of prepress personnel, including 47.6% of companies (Table 9). The next most common practice was to hire professionals with a computer science-oriented degree to handle network maintenance. Very few (only 8.4%) individuals were hired for network maintenance with a graphic communications degree. This certainly is not surprising, given that network maintenance is not the focus of graphic communications programs. It is also not surprising that network maintenance is be handled in many companies by prepress personnel, as these individuals would be expected to have computer systems savvy.

	Frequency	Percent	Cumulative Percent
Hired for job with computer science oriented degree	13	27.1%	27.1%
Hired for job with graphic arts/graphic communications degree	4	8.4%	35.4%
Worked in prepress and acquired skills on the job or through training classes	23	47.9%	83.3%
Others	8	16.7%	100%
Total	43	100%	

Table 9 How Key Employee Ascended to Network Maintenance

4. Do printing industry executives expect those receiving college-level degrees specializing in graphic communications to have information technology knowledge and skills?

This research question was studied to determine the perceptions of printing industry executives with regard to the need for information technology-oriented content in graphic communications degree programs. The data suggest that including IT content is strongly encouraged. With regard to web publishing, 72% of printers expected to see moderate to extensive amounts of coursework in web publishing (Table 10).

	Frequency	Percent	Cumulative Percent
Not Needed	5	8.8%	8.8%
Minimal	11	19.3%	28.1%
Moderate	29	50.9%	78.9%
Extensive	12	21.1%	100%
Total	57	100%	

Table 10 Extent of Coursework Needed in Web Publishing

For database management content, an even higher percentage of printing executives expect graduates to have studied this topic, with nearly three out of four (73%) responding that a moderate to extensive amount of course work is needed (Table 11). Of these responders, 21.1% would like to see an extensive amount of coursework in database management as a component of graphic communication programs.

	Frequency	Percent	Cumulative Percent
Not Needed	5	8.8%	8.8%
Minimal	10	17.5%	26.3%
Moderate	26	45.6%	71.9%
Extensive	16	28.1%	100%
Total	57	100%	

Table 11 Extent of Coursework Needed in Database Management

As for network maintenance content, 28.1% of printing executives responded with a need for extensive coursework (Table 12). Only 7% thought that networking was unimportant. For each area studied, networking maintenance, database maintenance, and web publishing, the majority of responders suggested that a moderate amount of coursework would be ideal for graphic communications majors (Table 13). For each area, the data show a mean of 2.84 for web publishing, 2.93 for database management, and 2.91 for computer networking on a Likert-like scale rated from 1 to 4, with 3 being moderate. The standard deviation for responses in each content area show a high degree of agreement among those surveyed.

	Frequency	Percent	Cumulative Percent
Not Needed	4	7.0%	7.0%
Minimal	13	22.8%	29.8%
Moderate	24	42.1%	71.9%
Extensive	16	28.1%	100%
Total	57	100%	

Table 12 Extent of Coursework Needed in Computer Networking

	N	Minimum	Maximum	Mean	Standard Deviation
Web Publishing	57	1	4	2.84	.862%
Database Management	57	1	4	2.93	.904%
Computer Networking	57	1	4	2.91	.892%

Table 13 Industry Executives Perception of Importance of IT Knowledge for Graphic Communications Graduates

Summary

The data suggest that information technology-oriented production and management practices have become quite common in the printing industry. These include database management for variable data printing and digital asset management, web publishing, and sophisticated computer networks to support file exchange and management of production activities. The data also suggests that more printers will begin offering information technology-oriented production services within the next few years.

It appears from the results of the study that those responsible for traditional print production are taking on information technology-oriented tasks like network maintenance, web site construction and maintenance, and database maintenance. Of those taking on these duties, the largest majority work or worked within prepress departments and learned the technology on-the-job, which is logical given that these individuals tend to be the most computer savvy individuals in many companies. Another finding suggests that most companies have a full-time IT person, with the next category of company asking prepress personnel to take on IT-oriented tasks along with their prepress responsibilities. This trend suggests that those individuals entering employment in prepress departments today as production and management personnel will likely be expected to have a knowledge base in IT subject areas along with an understanding of prepress workflow and technology.

These trends suggest a need for graphic communications curricula to address information technology content. Those programs not addressing this need may consider adding content that better prepares students for the changes occurring in the industry today. Most of the executives surveyed responded that moderate to extensive amounts of networking, database, and web publishing course content is expected among graduates with graphic communications degrees. Graduates entering these environments will be managing within an information technology infrastructure and would be well served by understanding the technology.

As educators, it is our charge to keep our curriculums current in the face of fast changing technology. This can be a challenge in today's graphic communications environment, as the knowledge and skill base within the discipline is very broad, covering business management (such as accounting, supervision, quality assurance, and marketing) electrical-mechanical systems (such a operational principles of presses, output devices, and bindery equipment), chemistry and physics (such as inks, toners, dampening systems, environmental controls, and light), aesthetics (including design principles and color), as well as computer software systems (including operating systems, media composition software, and production workflow). Add to this information technology content and we have a curriculum that spans a wide gamut of academic subjects, perhaps like few others.

A logical follow-up to this research is to conduct a content analysis, defining what specific technologies need to be taught and to what degree of depth. Input from educators within the discipline already teaching the subject matter, as well as industry subject matter experts could help to build a framework for curriculum development. This kind of information could be very valuable to those looking to increase graphic communication-specific information technology content into their curriculums.

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RFID: An Opportunity for Label Printers

by Mark Syner, Ph.D., Millersville University

Introduction

Radio Frequency Identification (RFID) is emerging as a significant benchmark in modern technology. The scope of RFID technology is representative of a broader communications model called automatic identification (autoID). Many related autoID technologies, such as fingerprint, facial, or iris scanning (a.k.a. biometrics), fit conveniently into the framework of visual communications while others, like RFID, might better fit an electronic communications schemata. Even so, RFID technology is being used in conjunction with traditional printed products, such as labels, thus creating definite business opportunities for companies willing to learn about RFID and adapt to producing "smart labels." A recent survey has revealed, among other findings, that people in the printing industry generally agree RFID provides significant potential for new business. RFID tags and labels are already being produced. However, according to the study, the next two years seem to hold a great deal of promise for more widespread application of this technology in the label printing segment (Snyder, M., Cook, E., & Sperry, J. 2005).

What is RFID?

There are several technologies being used today for automatic identification and data capture. These generally involve systems of identifying objects or people, capturing information about them, and entering it directly into computer systems without human involvement. Technologies normally considered part of auto-ID would include bar codes, biometrics, voice recognition, and RFID. The RFID concept is relatively straightforward (given current available technologies) and numerous applications are being developed across many markets.

Radio frequency identification uses radio waves to identify things automatically from a limited distance without necessarily seeing it directly. Typically, unique information (such as a serial number or any other code) that identifies a product, person, animal, or object, and perhaps additional information, is stored on a microchip that is attached to an antenna. Together, the antenna and chip are known as a RFID transponder or tag. The antenna is necessary for the chip to transmit any stored identification information to a receiving device. Traditional copper coils are often used to create an antenna but conductive inks can also be used. A receiver then converts the radio waves from the RFID tag into digital information that can be used in computers. (Roberti, 2005, ¶1).

RFID was first developed in World War II as a means of identifying friendly versus enemy aircraft. Research on the use of radio frequencies for identifying objects continued through the 1950's and 60's and then development started to take off in the 1970's with the first U.S. patents being established in 1973. The U.S. government also applied the technology for tracking nuclear materials during the 1970's. As more and more uses for RFID are being devised, the main drawback has been cost. That issue is close to being solved and any breakthrough will likely open the floodgates.

One modern application for RFID is similar in practice to bar code identification for product packaging. This is often referred to as "item level tagging." In fact, RFID holds the promise of substantially increasing the capability of identifying and tracking items well beyond the current limitations of bar code technology. A primary advantage over barcoding is that RFID does not require line-of-sight reading systems and transmits across longer distances. When shopping in the future, instead of passing all the items in your cart over the barcode reader, you may be able to just push your cart through the checkout and everything in the cart will be accounted for automatically because the packages themselves send a signal to a receiver in the checkout counter.

RFID also enables read and write capabilities. Since RFID tags are comprised of a silicon chip and an antenna, the chip can actually transmit and receive the data (such as a product identification number) using the antenna. Again, the radio signal is picked up by another source, such as a computer or scanner, which then reads the information that is being transmitted. This particular feature is what causes concern for some. "…RFID-enabled items are promoted by retailers and marketers as the next revolution in customer convenience. Consumer advocates say this is paving the way for a nightmarish future where personal privacy is a quaint throwback" (Beckel, 2005, ¶2). In this scenario, once you have brought your products home, they continue to emit signals that can be used by business and/or government to share information about, or even track, individuals. From a business perspective, the goal is to help companies "to implement the technology and integrate it seamlessly into manufacturing operations—the objectives of which are to achieve a reasonable return on investment and to increase competitiveness" (Bearing Point, 2005, ¶7). The potential for less benign purposes, however, continues to cause concern for some.

Printing RFID Antennae

Many different printing processes are used to print labels, but a new vision for making RFID more affordable involves printing the RFID antenna inline as the rest of the label is produced. The key to enabling this possibility has been the development of conductive inks. These inks have been demonstrated to work—typically using flexography, gravure, and screen-printing—and create printed antennae conductive enough to transmit a RF signal. John Costenoble, of Stork Prints, reported that "rotary screen printing enables precision control over the thickness and width of the ink layer." He also stated, "rotary screen printing is most competitive when smaller volumes (shorter runs) are required" (2005, ¶8). Flexography and gravure have also proven to work effectively as a means of printing RFID antennae.

The advantages of printing the antennae for RFID tags are that production speeds can be increased, there is more flexibility in the design process and, most importantly, costs are driven down. The catch is that the semiconductor chip (the heart of the RFID tag) then needs to be precisely embedded into the label so it will connect with the antenna. The *EDSF Report* recently published information regarding companies that are exploring manufacturing processes that employ organic methods to replace silicon-based circuitry in RFID tags. It stated: "Several leaps in technology are still needed to get the technology to the point where it costs one cent per tag, or less, and where it can be used on individual items for inventory tracking and management" (EDSF, 2005, ¶4).

Another minor problem is that conductive inks typically include heavy concentrations of silver particles that require drying at high temperatures with considerable dwell times in order to reach appropriate levels of resistivity. Nevertheless, these difficulties can be overcome through automation and adaptation of press systems to produce smart labels with printed antenna systems. Conductive inks are already being used in RFID applications for smart labeling, packaging, and warehousing. They are also being tested with printing processes such as digital printing and are emerging in retail inventory applications.

RFID and "Smart" Labels

RFID technology is being applied in at least one category of what is generally referred to as "smart labels." Smart labels can be described as any label that can interact with another device. Basically, there are three types of RFID tags: passive, semi-active, and active. Passive tags are the simplest. They obtain power from the radio frequency field of the reader and do not require an internal source of power. Semi-active and active tags employ an integrated power source. This enables them to either extend their range or record data from a sensor.

Smart labels that fall into the active category can track, process and store data. Retailers are especially interested in this technology, as it will make supply chains more efficient and serve customers better. These labels provide manufacturers and distributors with real-time visibility in inventory and can help a manufacturer monitor conditions and locations anywhere in a supply chain system. A survey conducted by the National Retail Federation concluded "that 35 percent of retailers would deploy some type of RFID system in the next year" (Guest, 2005, ¶3). However, according to the RFID division of Avery Dennison, "active tags will have an important role, but they tend to be for larger, more expensive items" (Genuario, 2005, p.68).

Also, smart RFID labels are "being used in the food industry as a means of ensuring traceability along the supply-chain" (Decision News Media, 2005, ¶3). Another example of how smart labels can be used in this niche is to monitor packaged foods and pharmaceuticals that must be stored and shipped at precise temperatures. A smart label using a conductive ink antenna and a battery can potentially gauge the temperature in shipment and alert a supplier to damaging temperature changes. Finally, smart labels will be very useful for security applications such as tamper evident labels, tickets that would be very difficult to counterfeit, and identification badges.

Outlook for RFID Labels

The 2005 *PIA/GATF Technology Forecast* stated: "As this year has progressed, mandates from retail companies have increased and will continue to increase from pallets and cases to item-level packages. It has become more evident that the natural fit for RFID tag manufacturing is with printers and packaging companies" (GATF, 2005, ¶73). RFID tags and labels can be produced using a number of printing processes.

Research and development in press systems, conductive inks, and compatible substrates is well underway in the search to find the most cost-effective means possible for producing RFID tags and labels.

According to a recent survey of the printing industry sponsored by the Electronic Document Systems Foundation, the majority of the 171 respondents had only learned about RFID within the past three years yet they generally agreed that the projected impact of RFID was justified. Also, despite public concerns about invasion of privacy (due to the read/write capability of some RFID tags), the survey determined that the nearly 60% felt ambivalent about the issue and the rest were split in their opinions of whether RFID posed any security threat to the privacy of individuals. Most felt that RFID would be a new growth application for the printing industry with significant advancements in the next two-to-five years. About 15% declared that they already had commitments to produce printed matter employing RFID technology within the coming two years. Finally, even though some were already using flexography, 70% felt that digital printing would predominate the long-term future production of RFID tags and labels (Snyder, Cook & Sperry, 2005).

According to Genuario, "despite current obstacles in privacy, cost, standards and technology, many are optimistic that widespread item level tagging will be achieved within a decade, and it will be achieved through printing" (2005, ¶66). Again, the biggest obstacle to advancement is cost. "The growth of the RFID market depends a lot on reducing the size of the chip–or finding an alternative solution to the chip. Chipless circuits will take RFID into new areas because they appear to be the cheapest to produce; this technology therefore is the industry's best route to the $0.01 tag" (Costenoble, 2005, ¶10).

Another immediate challenge facing the industry is the limited number of people who understand the technology enough to help companies succeed in the RFID arena. The Computing Technology Industry Association (CompTIA) recently reported that "eighty per cent of companies participating in a survey said they do not believe there are sufficient numbers of professionals skilled in RFID to hire from today" (Pitman, 2005, ¶2). Many companies will be forced to train and educate their own employees and then make sure they can hang on to them. "CompTIA says it is working with a cross section of major players in the RFID market to address the skills shortage" (Pitman, 2005, ¶5). In fact, many in the field are working together to develop a form of professional certification for people working with RFID technology.

While the advantages of RFID are becoming increasingly well known, some companies are not yet fully aware of what it can do for them. As costs decrease, its ability to transform the label printing industry is increasing all the time—but only for those who understand the implications of this milestone in modern technology.

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What to Teach Graphic Design Students About Printing Industry Guidelines

by Jerry J. Waite, Ed.D, University of Houston

Abstract

Prepress departments in printing companies are, for numerous reasons, downsizing. As a result, there are fewer people on hand to correct errors in jobs presented to the printing company by graphic designers. Therefore, it is more important than ever for designers to prepare completed files as accurately as possible. National and international associations have produced guidebooks, such as SNAP, GRACoL, SWOP, and FIRST. If students of graphic design know and utilize the guidelines included in these guidebooks, they are likely to prepare files that will effectively pass through the print workflow. This article reviews a few of the more important recommendations of SNAP, GRACoL, SWOP, and FIRST that graphic design students must know to be effective practitioners in the twenty-first century publishing profession.

Introduction

Over the past decade, there has been an unmistakable trend in printing companies to downsize prepress departments. A firm may have once employed dozens of people who operated cameras, retouched film, duplicated films, operated scanners, assembled film onto flats, and made proofs and plates. Today, that same firm may function with five or six prepress personnel.

Why is this occurring? Prepress department downsizing is primarily due to price competition that is a consequence of, among other things, the recession of the early 2000's, tighter corporate print-buying budgets, internet portals that allow buyers to get quotes from multiple printers from their desktops, shift of content from print to electronic media, and improved technology that allows printers to do much more work in far less time. In addition, advertising agencies realized that a great deal of their potential revenue was being lost to prepress service providers. In their minds, bringing prepress processes in-house would allow them to acquire that revenue and increase their profitability (R. Zucca, SWOP Chair, telephone communication, August 19, 2005). However, none of these issues would have precipitated prepress department downsizing if the power and price of robust computer hardware and software had not dropped to the point that graphic designers and ad agencies could afford to buy their own robust workstations.

In the past, graphic designers had to rely on printers and/or prepress service providers to purchase prohibitively expensive equipment and hire specialized, highly trained, and well-paid employees to run them. Graphic designers and ad agencies can now purchase a powerful computer workstation, high-resolution scanner, and a suite of image creation, editing, and layout software for less than $10,000. Creatives have taken advantage of these low prices to outfit themselves with everything they need to—conceivably—do the work that was once accomplished by numerous prepress employees. "Conceivably" is an important caveat: although today's hardware and software can allow a single individual to do the work of many, it is unlikely that a single person will have the sum total *knowledge* and *skill* that those several prepress people once possessed. In particular, people who used to work in prepress knew how the ink, substrate, printing process, and individual press would affect the printed outcome and would use this knowledge to adjust their processes so the outcome would meet the customer's needs. A graphic designer, working in isolation from those who will ultimately put ink on paper, cannot possibly know all the interactions and permutations between ink, paper, process, and press. In fact, the designer may not even know which company is going to produce the end product. Thus, work skillfully and effectively designed using all the right software may not result in a printed job that meets customer needs.

When graphic designers first started creating digital files using their own workstations, printers assumed that those files would be defective in one way or another. Thus, elaborate preflighting (checking) and file intervention (repairing) processes were put into place. Prepress people were kept in place to repair customer files and make specific changes to optimize jobs for the company's presses. However, when competition became fierce, printers invested in more capital-intensive equipment (such as sophisticated Raster image Processors [RIPs] and platesetters) so that expensive labor could be reduced. Although printers still do not assume that incoming files are completely accurate, the burden of preparing accurate files has been pushed out of the prepress department to the graphic designer. As a result, the prepress departments of many printing companies now specialize in just a few activities: preflighting, imposition, trapping, RIPing, proofing, and platesetting. Most importantly, price quotations often include only these prepress functions. File intervention activities are often treated as customer alterations and billed separately.

To minimize faulty files, high-volume printers—those who print large quantities of products by gravure, flexography, and web offset—banded together and formulated documents that imposed specifications on both designer and printer. In theory, if the designer and printer follow the specifications, the final product will be as desired by the customer. These specifications were gradually introduced and, in many cases, are now demanded by printers. Incoming files that do not meet the specifications may be rejected.

Encouraged by the apparent success of high-volume printing process specifications, commercial printers are in the process of formulating their own guidelines. Once these guidelines are validated, files for short-to-medium run printing jobs may also have to meet them.

Because of the increasing emphasis on specifications and guidelines, it is vital for students of graphic design to know, understand, and be able to implement them. It is no longer financially feasible for designers to simply assume that "the printer will fix it." In addition, it is important for students to know that each set of guidelines is *different*. Thus, if the same ad is to be printed in a flexographically-produced newspaper, a web-offset-produced magazine, and a sheet-fed-offset-produced flyer, three *different* files must be produced.

Printing Industry Guidelines

The dissemination of the *Specifications for Web Offset Publications* (SWOP) was the first attempt by the printing industry to promulgate specifications. After beginning discussions in 1974, a group of graphic arts industry representatives wrote and published the first SWOP booklet in 1976. SWOP, updated nine times since it was first disseminated, provides "specifications for everyone involved in graphic arts workflow, which includes all forms of magazine advertising and editorial input, whether analog or digital" (SWOP, 2005). For the most part, printers using the gravure printing process abide by—and expect compliance to—SWOP. SWOP can be obtained at **http://www.swop.org/**

The Specifications for Newsprint Advertising Production (SNAP) were originally published in 1984 and are intended for "advertisers, advertising agencies, publishers, pre-press managers, material suppliers, and commercial and newspaper printers" (Newspaper Association of America, 2000). These guidelines are applicable to newspapers and advertising inserts printed by offset lithography, direct lithography, letterpress, and flexography. SNAP can be obtained at **http://www.naa.org/artpage.cfm?AID=1451&SID=214**

The Flexographic Technical Association first published the *Flexographic Image Reproduction Specifications and Tolerances* (FIRST) in 1997. FIRST, which was subsequently revised in 1999 and 2003, provides "all participants in the flexographic reproduction process with a common set of guidelines, tutorials and data that can be used as communication and production tools" (Flexographic Technical Association, 1999). FIRST focuses primarily on the production of packaging using the flexographic process on film, corrugated board, paper, and paperboard. FIRST may be obtained at **http://www.ftastore.com/store/**

In 1996, the Graphic Communications Association, now IDEAlliance, formed a task force to "develop a document containing general guidelines and recommendations that could be used as a reference source across the industry for quality color printing" (IDEAlliance, 2001). The resulting guidelines, known as the *General Requirements for Applications in Commercial Offset Lithography* (GRACoL) helps print buyers, designers, and specifiers work more effectively with print suppliers. At present, GRACoL is not a set of specifications because the aim points have not yet been perfected. However, a series of successful research pressruns conducted in 2004–2005 is moving GRACoL toward full reliability and acceptance by the commercial offset printing industry. GRACoL can be obtained at **http://www.gracol.org/**

Why Teach Printing Industry Guidelines?

Members of the GRACoL Committee were asked, through an e-mail-based survey, to identify the most important thing about GRACoL that they think students of graphic design should know about. Although these individuals speak only for themselves and for GRACoL, their comments share common themes and can be easily applied to the other guidelines.

> I think that the key thing about GRACoL, or any other of the existing and emerging specifications for graphic

arts, is the discipline of understanding the process, defining aims, and implementing procedures that measure and control the process parameters to tolerance. This forms the basis of continuous improvement, consistent performance and effective troubleshooting. The other overarching concept that follows from this process control philosophy is the ability to define industry wide specifications and standards that enable reliable exchange of information between the many enterprises in the graphic arts chain. This is key in making cross-enterprise industries operate with the efficiency expected in a digital world. (M. Rodriguez, RR Donnelley, e-mail communication, November 19, 2004)

From my perspective, students need to hear the following two items: 1) GRACoL is important to the commercial printing industry to support worldwide production with controlled color. 2) GRACoL is just one of the US industry guidelines/specifications; there is a close relationship to SWOP, SNAP, FIRST etc. since input materials are used throughout the printing food chain. (L. Steele, RGB Metrology, e-mail communication, November 24, 2004)

I think that we can all agree that technical development in the commercial print industry is moving at a feverish pace. But our end product, the printed sheet, remains largely a result of the "craft" so-to-speak. The commercial print industry needs to have some points of reference to keep technology moving along. In some respects, workflow automation, color management, and process control all depend on having some points of reference in order to move forward. GRACoL can certainly provide some of those points of reference. Let's face it, if you send duplicate plates to several commercial printers, you'll get VERY different results. For any of them to claim printing to "SWOP" is almost meaningless. We need some real world guidelines that actually help us communicate in the commercial graphics industry. (T. Kang, LAgraphico, e-mail communication, November 22, 2004)

Without GRACoL standards, I would have no standard with which to set my electronic digital workflow. Everything we do is subject to the press running to the standard after each makeready. The standard is the foundation for all my daily operation. The standard allows me to automate many steps in the prep and press process. It serves as the stable constant in the process of lithography. (D. Motheral, Motheral Printing Co., e-mail communication, November 19, 2004)

To me, the most important thing college students should know, about GRACoL or any other "graphics/printing standard," is the admonition to start an early conversation with their printer. No matter to what "standard" their printer subscribes—and many don't subscribe to any, other than their own—it is paramount that they start talking about what they want to do—what they want to achieve—as early in the process as possible. Printers want to produce a piece that they can be proud of as much as they want to produce a piece that the designer or art director can be proud of. They know their equipment and they know their capabilities… and working closely together, the piece can be produced in the best possible way—in time and on budget—as long as the communication between the originator and printer is on going and that neither party assumes anything. (J. P. Forster, NORTHLICH, e-mail communication, November 19, 2004)

Several themes permeate these comments, themes that instructors and professors of graphic communications ought not ignore. First is the issue of communication. Guidelines, such as SWOP, SNAP, FIRST, and GRACoL, all facilitate communication and understanding between client and printer. Since designers are now doing much of the technical work formerly accomplished in printing companies, this communication is essential if a project is to be effectively produced.

A second theme is consistency and stability. Guidelines enable designers to create projects with a particular goal in mind. Without guidelines, a job would have to be designed for a particular press in a particular plant using a particular paper and particular ink. Using guidelines, a designer could create one set of files for an ad to be produced in numerous magazines that adhere to the SWOP specifications. Of course, another set of files would be required for a newsprint reproduction of the ad. However, a different file would not be necessary for Magazine A, Magazine B, and so forth. Consistency is also valuable for the printer: files created to specifications need not be extensively "tweaked" on press.

A third theme is control. Tweaking and modifying presses to make non-compliant files print properly costs time and money. In essence, such tweaking throws the process out of control. If file content conforms to guidelines, presses can be kept under control, makeready times can be shortened, and costs reduced. Control requires aim points: ink density, ink color, tonal value increase, print contrast, and so on. Guidelines provide cooperating printers with such aim points.

Guidelines Important to Graphic Design Students

Teachers of graphic design should procure, read, understand, and teach the relevant specifications that correspond to the industry segment in which their students are likely to be employed. For example, virtually all students of design should be specifically instructed in SWOP's guidelines since many—if not most—ads are carried in publications printed by web offset or by gravure. Publications strictly enforce SWOP and failure to adhere to these specifications may result in an ad file being rejected (Time Incorporated, 2005).

Although it is fairly easy to comply with SWOP specifications—since most vector and pixel-based image software, as well as page layout programs, have SWOP presets—using SWOP presets for a job to be printed by sheetfed offset lithography will result in less-than-optimal results. Similarly, SWOP is inappropriate for newspaper ad production since SNAP specifications vary greatly from those in SWOP. Therefore, students also need to be taught the GRACoL and SNAP guidelines as well as how to prepare the same image file to correspond to multiple specifications.

Flexography is widely used for the production of packaging. Therefore, students being taught to design folding cartons, wrappers, corrugated boxes, poly bags, labels, and other packaging materials should be familiar with FIRST. In particular, bar codes are included in virtually every packaging application. Therefore, FIRST's extensive section on bar code design, size, and placement is must-know information.

Although by no means exhaustive, the following paragraphs highlight some of the particulars that graphic design students must know about printing industry specifications.

File Format

When preparing pages for printing, students generally use page layout programs to provide the structure and design for the job. Page layout files include the overall page design elements (rules, columns, screen tints, and so on) as well as text. These files, also known as native files, vary in format from one program to another and generally do not contain photo or illustration files. Instead, graphic files are linked to the page layout file. In addition, page layout files do not contain the fonts used to display and output the typefaces used in the document. Thus, jobs delivered by the designer to the printing company or other service provider in the native format must be accompanied by both the fonts and image files. Page layout programs provide a method to "collect" or "package" the supporting files that must accompany a native page layout file in order for that file to output properly.

The complexity of packaging and transferring native page layout files plus perhaps hundreds of additional support files (photos and fonts) that are required for a given job often leads to glitches during file output. To prevent such glitches, and to protect their equipment and revenue, printers have set up elaborate preflighting routines to catch errors at the onset of production. Even so, preflighting catches errors. It does not prevent them and may lead to animosity between printer and client.

TIFF/IT-P1: To decrease the chance for error, all-encompassing file formats have been designed. Manufacturers of computer electronic prepress systems (CEPS) developed the Tagged Image File Format/Image Technology, Profile 1 (TIFF/IT-P1) format to exchange files from dissimilar high-end prepress systems. These systems converted PostScript files into internal raster data prior to imaging them. TIFF/IT-P1 is an internationally-accepted format accredited by the International Standards Organization and known as ISO 12639:2004. "ISO 12639:2004 specifies a media-independent means for prepress electronic data exchange using a tag image file format (TIFF). ISO 12639:2004 defines image file formats for encoding colour continuous-tone picture images, colour line-art images, high-resolution continuous-tone images, monochrome continuous-tone picture images, binary picture images, binary line-art images, screened data, and images of composite final pages" (International Standards Organization, 2004).

A TIFF/IT-P1 consists of three files: continuous tone (300 ppi), line work (1200–2540 ppi), and final layout file. Only CMYK or monochrome images can be included in a TIFF/IT-P1 set. All photographic and illustrative images as well as typefaces are incorporated into these files. Thus, there is no need to include fonts or linked graphic files with page layout files (SWOP Incorporated, 2005).

PDF/X1a: A second, and more widely adopted, all-inclusive file format relevant to the printing industry is based upon Adobe's Acrobat PDF format and is known as PDF/X1a. Whereas TIFF/IT-P1 files are raster data, PDF/X1a files are object-oriented. A single file contains the page structure, text (including relevant fonts), photos, and illustrations.

Instead of requiring fixed resolutions for graphic images, as do TIFF/IT-P1 files, PDFs can be created at varying levels of "quality" depending upon the outcome intent of the document. For example, PDFs can be made specifically for computer-screen-viewing, desktop printer output, or printing press output.

A PDF/X1a file is a specific type of printing press output PDF that contains all the criteria and content required to output a job using high-resolution printing presses. Thus, page layout files, linked graphics, and fonts do not need to be transmitted to the output provider or printer. A PDF/X1a file: can only contain CMYK color, spot color, grayscale, or monochrome graphics; must contain all fonts required to output the job; does not allow for Color Management, transfer functions, or halftone screening specifications; and allows trapping to be included. Software used to create a PDF/X1a file automatically enforces compliance with the format's specifications and will not allow the creation of a non-compliant file.

PDF files can be generated within applications such as InDesign, directly by the Macintosh Operating System through the Print Menu, using menus that Acrobat automatically installs within other applications such as Microsoft Word, or through the use of Acrobat Distiller. Of these methods, only two are suitable to make PDF/X1a files for print production: PDF creation routines (oftentimes called "Export" routines) built into high-end graphic applications, such as InDesign, and through the use of Acrobat Distiller. For example, InDesign's Export routine allows the graphic designer to create a PDF/X1a file without ever leaving InDesign. It is a one-step process. On the other hand, Acrobat Distiller requires the graphic designer to "print" the page layout document to a PostScript file and then "distill" it into a PDF using Acrobat Distiller. This two-step process is more time consuming than PDF Export routines but, in the experience of the author, often identifies fatal errors that cause the resultant PDF file to be unprintable. For this reason, the use of Acrobat Distiller is highly recommended.

Printing Specifications and File Formats: SWOP *requires* that files be submitted only in the TIFF/IT-P1 or PDF/X1a format. "The use of non-standard, application or native file formats is not allowed" (SWOP, INC. 2005). Although SWOP allows designers to save files in either format, a review of the specifications pages for numerous publications reveals that the trend is toward PDF/X1a and *away from* TIFF/IT-P1. For example, see Time, Inc., Specifications for Digital Ads.

SNAP *recommends* the use of PDFX/1a and recognizes the value of TIFF/IT-P1. As in the case of magazine publications, the trend in newspaper ads is toward PDF/X1a and away from TIFF/IT-P1 and native files. For example, the *Houston Chronicle* accepts ads only in camera-ready hard copy form or as PDFs (Houston Chronicle, 2003).

GRACoL 6.0 (IDEAlliance, 2002) devotes nearly six pages to file formats and concludes by recommending native files for work in progress; PDF/X1a, /X2a, or /X3a or TIFF/IT-P1 for file exchange within the graphic design studio and between designer and printing company; and PDF/X1a, /X2a, or /X3a or XML for archival and repurpose.

Interestingly, FIRST is the most flexible of all the specifications. "It is not the purpose of FIRST to dictate which formats are to be used in the creation of flexographically reproduced artwork; however, it is highly recommended that digital artists understand the significant differences between the formats. The prepress provider is in the best position to describe the advantages and disadvantages of each format for a specific purpose" (Flexographic Technical Association, Inc. (2003). Even though FIRST provides for some latitude in file formats, pages 36–39 are devoted to PDF/X1a.

Preflighting: To insure that files meet the requirements of the PDF/X1a file format, files should be preflighted *before* and *after* the PDF file is generated. Page layout programs, such as Adobe InDesign, have built-in basic preflighting routines. These routines, *at a minimum*, should be employed by the graphic designer prior to saving a document in the PDF/X1a format. However, stand-alone software, such as Markzware's *FlightCheck Designer* (**http://www.markzware.com/**) perform much more thorough checks that can be customized according to the specific output application. For example, if an InDesign file is to be converted to a PDF/X1a file, *FlightCheck Designer* can be set to insure compatibility prior to conversion. After a PDF/X1a file has been generated, Acrobat 7 can check *and repair* PDF/X1a files. In addition, Markware's *FlightCheck Professional* can check PDF/X1a files for compliance. Instead of purchasing preflighting software, graphic designers can also utilize on-line resources to check their files. CertiFyle.com, for example, is a fee-for-service "server-based solution that can be accessed via the Internet. The creative agency prepares an ad for proofing and production. Once the ad is approved, fill in a simple electronic order form then drag and drop the final PDF file onto the CertiFyle client that resides on your desktop. CertiFyle will validate the X-1a files, then deliver them via the most efficient and cost effective service...” (CertiFyle, 2005). Not only does CertiFyle examine PDF/X1a files to insure compliance, but they also certify that the files meet the needs of numerous printers and publishers.

Recommended Instruction: Due to the overwhelming support for the PDF/X1a format in current printing industry guidelines, it is recommended that students be taught how to make these themselves after their page layout files have been preflighted. Most page layout programs can export documents in the PDF/X1a format. In addition, Adobe Acrobat Distiller can create PDF/X1a files from PostScript print files made from native files. Whenever possible, PDF files should be created using Adobe Acrobat Distiller. This software program provides more feedback on acceptably- or unacceptably-created PDF/X1a files than do the routines built into page layout programs. Once the PDF/X1a file is created, it too should be preflighted to insure compliance. Native files should only be used for work in progress.

Color Separation Settings

Since printing guidelines generally require or recommend the PDF/X1a file format, and because PDF/X1a files can only contain CMYK or spot-color color images (rather than RGB), it is important to properly separate color images before placing them into page layouts. It is easy to separate RGB images in Photoshop using SWOP specifications because these specifications are so widely implemented that Adobe has included presets in the Color Settings Dialog Box. Simply click the Photoshop Menu and select Color Settings (Figure 1). Note that U.S. Web Coated (SWOP) v2 is available as a preset. Simply choose that preset and then separate RGB images into CMYK by clicking the Image Menu, choosing “Mode,” and then selecting CMYK. The RGB image will be separated according to Photoshop’s SWOP specifications. However, it should be noted that Photoshop’s SWOP settings are not the same as SWOP’s actual parameters. For example, the dot gain values specified in Photoshop’s SWOP CMYK preset (see Figure 2) *are not the same* as SWOP’s. In addition, the L*a*b values for CMYK inks used by Photoshop (see Figure 3) do not match those specified by the International Standards Organization document ISO 2846-1 (International Standards Organization, 1997).

If a specification other than SWOP is appropriate for the image being created, it is essential to set Photoshop to optimally separate RGB images into CMYK. This can be a daunting task because there are so many variables to consider when converting an on-screen RGB image into on-substrate CMYK image. These variables include: 1) lighting; 2) characteristics of the ink/toner used to reproduce the image; 3) characteristics of the substrate; 4) characteristics of the specific printing press that will be used to print the job; and 5) the interaction between variables two through four.

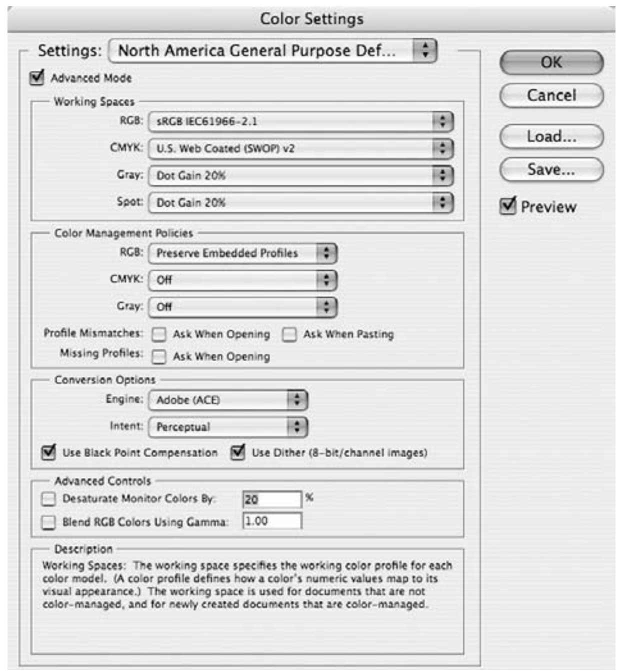

Figure 1

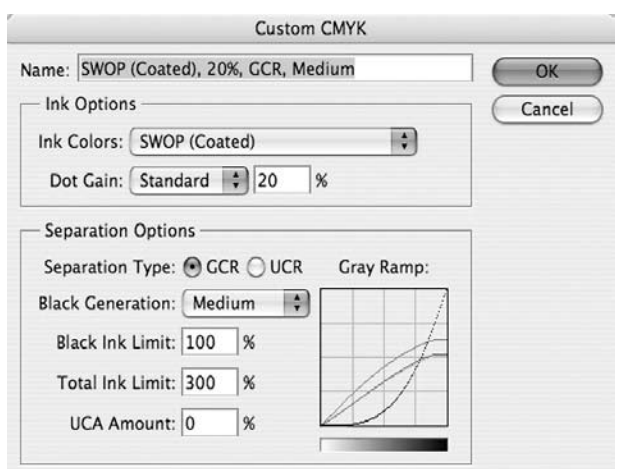

Figure 2

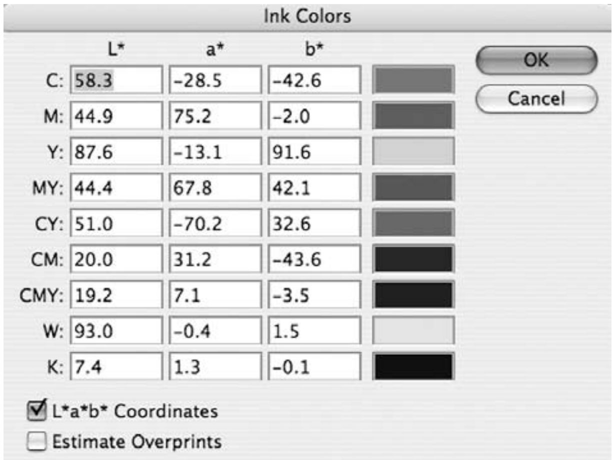

Figure 3

Variables two through four are often unknown by the graphic designer because they depend on *choices the printing company makes* while the job is in production.

So, what's a designer supposed to do? Joseph Marin, senior prepress technologist/instructor for Printing Industries of America/Graphic Arts Technical Foundation, suggests a three-step process (Marin, J., 2005). First, designers should carefully calibrate their monitors and work areas to standardize the lighting. Second, creatives should contact the printing company that will produce the job in question (if known) and ask for specific settings for Photoshop's Custom CMYK and Ink Colors dialog boxes (see Figures 2 and 3). Printing companies may choose to provide numeric data for each of these dialog boxes *or* provide a Color Management *ICC Profile* that can be saved on the designer's hard drive and chosen via Photoshop's Color Settings dialog box. Third, if the printing company is unknown, or is unable to provide specific numerical data or a profile, Photoshop's U.S. Web Coated (SWOP) v2 CMYK preset may be used *as a last resort*.

If Color Management ICC Profiles are used to make color separations, graphic designers have three responsibilities: 1) to calibrate their computer monitors using routines built into the Macintosh and Windows operating systems or by using specially-designed hardware and software; 2) to obtain relevant ICC profiles from the printing company that will print the job and install those profiles on their computer workstations (see documentation or on-line help to install the profiles on Macintosh or Windows computers); and 3) to choose the appropriate ICC profile from the Photoshop Color Settings dialog box. For a more complete description of Color Management, see, for example, the X-Rite *Complete Guide to Color Management* (X-Rite, 2005).

Calibrating Monitors and Work Areas: An image displayed on a computer monitor or reflected from a substrate is dependent on the light used to emit or illuminate the colors in that image as well as the ambient light in the work area. The color of an emitted or illuminating light is given in degrees Kelvin (see Waite, Willis, and Oliver, 2005). SNAP, SWOP, GRACoL, and FIRST all specify the use of 5000˚K (also known as D50) lighting when viewing color proofs and prints. To improve the standardization of color as viewed on the screen as compared to that reflected from a substrate, it is important to set monitors to 5000˚K using monitor-calibration routines built into the Macintosh and Windows operating systems or by using external calibration devices (see Waite, Willis, and Oliver, 2005 for examples).

Work areas should be free from distracting colors so that images viewed on monitors are not adversely affected. For example, a colorful desktop pattern (wallpaper) can alter the designer's perception of an on-screen color image. To prevent color distortion, a neutral gray background should be chosen for all computer monitors used in the graphic design process. Gray absorbs and reflects equal amounts of all colors and, as a result, does not alter color perception. In addition, brightly colored walls, clothes, furniture, posters, and so on can reflect inappropriate light onto computer monitors and printed proofs. Therefore, work areas, furniture, and, yes, even the designer's clothing should be neutral gray. Specifically, wall paint should be flat (not glossy) and matched to Munsell N8 (standard gray). This paint is available from Sherwin Williams (specify #2129 Zircom flat paint) (Marin, 2005).

Recommended Instruction: Students of graphic design should be taught that PDF/X1a is the de facto file format in the printing industry and that PDF/X1a requires completed color images to be specified as either CMYK or spot color. Therefore, they must convert RGB images to CMYK before making PDF/X1a files. Students should first become familiar with Photoshop's Color Settings Dialog Box. Then, instructors should provide students with experience in separating colors using Photoshop's SWOP preset. Finally, students should be taught how to calibrate their monitors and work areas, load ICC profiles onto their computers, and utilize those profiles when converting RGB images to CMYK.

Image Resolution

Pixel-based images (i.e. non-vector photographic images) that will be placed into a page layout document and ultimately saved in a PDF/X1a file must have sufficient resolution to prevent pixelization (an ugly stair-step artifact) during print reproduction. Resolution is calculated using the Nyquist Theorem:

$$\text{photograph resolution (ppi)} = QC \times LPI \times \text{magnification} = 2 \times 150 \times 200\% = 600$$

In the Nyquist Theorem, "QC" stands for quality control factor and ranges from 1.5–2. In the above example, a factor of two is employed because it is the most common. "LPI" refers to "lines per inch" and is a measure of halftone resolution. Finally, "magnification" refers to the enlargement or reduction of an image. If an image is to be reproduced at same size, magnification is one. If the image were to be doubled in size, magnification would be two. Similarly, scaling a photo to half its size would require a magnification of .5. The resultant numeral is the photograph's resolution in pixels per inch (PPI).

To use the Nyquist Theorem, a graphic designer must know the LPI that the printing company will use when outputting photographs to film, plate, or press. The choice of LPI is affected by numerous variables including: aesthetics, end-use requirements, the printing process, the substrate on which the image will be printed, and the resolution of both the output device and the digital photograph. Fortunately, SWOP, SNAP, and GRACoL simplify the choice of LPI and provide specifications that vary only according to the substrate upon which the image will be printed (Table 1). If there is a range of LPIs, the designer would be wise to choose the higher number. In general it is better to have too much resolution than not enough. As always, it is better to find out the appropriate LPI from the printing company (if known) than use Table 1. However, if the printing company is unknown, Table 1 (below) may be safely used.

FIRST's LPI guidelines are more extensive that SWOP, SNAP, and GRACoL because flexography prints on a very wide array of substrates (films, papers, labels, and cardboards) and has three very different platemaking processes. Table 2 (right page) provides FIRST's guidelines.

Image resolution must be set in Photoshop. Once images of the proper resolution are placed on pages in a page layout program, they should never be scaled. Scaling images within page layout programs effectively alters the resolution of the image and may result in unsatisfactory results. Therefore, scaling

Guidebook	Substrate	LPI	PPI Resolution at Same Size
SWOP	All	133	266
SNAP	All	85	170
GRACoL	Grades 1 and 2 premium gloss/dull coated	175	350
	Grades 1 and 2 premium matte coated	150–175	300–350
	Premium text and cover (smooth)	150–175	300–350
	Grade #3 coated	150	300
	Grade #5 coated	133	266
	Supercal SCA+	133	266
	Supercal SCB	120	240
	Uncoated offset	110	220
	Newsprint (coldest)	85	170
	Newsprint (heatset)	100	200

TABLE 1: LPI guidelines for SWOP, SNAP, and GRACoL.

Substrate Category	Specific Substrate	Conventional Plate		Digitially-imaged Photopolymer Plate		Laser engraved rubber/cured polymer	
		LPI	PPI	LPI	PPI	LPI	PPI
Preprint Linerboard	SBS Board	110–133	220–266	110–175	220–350	110–120	220–240
	Uncoated	100–133	200–266	100–133	200–266	100–120	200–240
Combined Corrugated	Bleached White	55–100	110–200	55–100	110–200	55–100	110–200
	Coated	55–110	110–220	55–110	110–220	55–110	110–220
Folding Carton	SBS Board	120–150	240–300	120–175	240–350	110–120	220–240
	CRB Board	110–133	220–266	110–133	220–266	110–120	220–240
Multiwall Bag	Coated Paper	75–120	150–240	75–120	120–240	75–110	150–220
	Uncoated Paper	65–85	130–170	65–100	130–200	65–100	130–200
Film Products	All	110–133	220–266	110–150	220–300	85–120	170–240
Paper Products	Coated Paper	133–175	266–350	133–175	266–350	110–120	220–240
	Uncoated Paper	110–133	220–266	110–133	220–266	100–120	200–240

TABLE 2: LPI guidelines for FIRST.

should always be done in Photoshop before images are placed. In addition, images should never be upsampled (enlarged). Instead, they should be scanned or digitally captured with sufficient resolution to support the LPI to be used to print the job.

Fonts and Typefaces

Font Technologies: Three font technologies are in common use: PostScript, True Type, and OpenType. Of the three, PostScript is the most widely implemented and the least likely to cause output problems. True Type fonts often cause problems with image- and platesetters while OpenType fonts have yet to be fully integrated into the graphic arts workflow.

FIRST prohibits the use of True Type fonts. GRACoL, SNAP, and SWOP are silent on the issue. In addition, GRACoL, SNAP, and SWOP do not address OpenType fonts.

Perhaps the best advice is that given in GRACoL (IDEAlliance, 2002): "Talk with your prepress service provider and printer to determine if there are any potential problems with the fonts intended for use." In this way, specific information can be provided about the limitations of a particular service provider's workflow.

Size of Type: FIRST provides the most specific guidelines for type size in both positive and negative (reversed-out) form (see Table 3). GRACoL advises, "Beware of type smaller than 6 point, especially when using serif typefaces." Although the other guidebooks are not as specific, they do address the issue of color, reverse, and overprint type. In particular, SNAP indicates that sans serif type seven points or smaller and serif type 12 points or smaller must be reproduced in only one color. In addition, "Type smaller than 12 points should not be reversed on a four-color background and type smaller than 10 points should not even be reversed on a single-color background" (Newspaper Association of America, 2000). SWOP is even more restrictive: "Reverse type and line art should not be less then .007″ (1/2 point

Substrate Category	Specific Substrate	Positive		Reverse	
		Serif	Sans Serif	Serif	Sans Serif
Preprint Linerboard	SBS Board	8 pt.	6 pt	10 pt	8 pt
Combined Corrugated	Bleached White	8 pt	6 pt	10 pt	8 pt
	Coated Paper	6 pt	4 pt	8 pt	6 pt
Folding Carton	SBS Board	6 pt	4 pt	8 pt	6 pt
	CRB Board	6 pt	4 pt	8 pt	6 pt
Multiwall Bag	Coated Paper	8 pt	6 pt	12 pt	10 pt
	Uncoated Paper	10 pt	8 pt	18 pt	12 pt
Film Products	Polyester	8 pt	6 pt	12 pt	10 pt
	Polypropylene Clear	8 pt	6 pt	10 pt	8 pt
	Polypropylene Opaque White	8 pt	6 pt	10 pt	8 pt
	Polyethylene Clear	8 pt	6 pt	10 pt	8 pt
	Polyethylene Opaque White	8 pt	6 pt	10 pt	8 pt
	Metallized	8 pt	6 pt	10 pt	6 pt
	Narrow Web (all)	6 pt	4 pt	8 pt	6 pt
Paper Products	All	6 pt	4 pt	8 pt	6 pt

Table 3: FIRST Type Size Specifications

rule) at the thinnest part of a character or rule" (SWOP, 2005). See Table 3 on the following page.

Use of Type Within Vector Illustrations: Fonts embedded in vector graphics "placed" within page layout pages are often invisible to that program's font list. Therefore, if the font is not available on the output provider's computer, the embedded font(s) will be replaced with the system's default font. This, of course, results in unsatisfactory results when the job is saved as a PDF/X1a file or output to film, plate, or digital press. Therefore, GRACoL, SNAP, and FIRST all require—or strongly suggest—that the designer convert text included in vector graphics to outlines before placing that graphic in a page-layout document.

Embedding Fonts in PDF Files: One of the parameters of the PDF/X1a file format requires the embedding of all fonts in a compliant file. The default settings in Acrobat Distiller include "Embed All Fonts," and "When Embedding Fails Cancel Job." Therefore, it is extremely important that all fonts used by the graphic designer during the creation of a job and all its components are present on the machine used to create the final PDF/X1a file. It is also preferable to use

Acrobat Distiller rather than built-in export routines in page layout programs because Distiller is the more aggressive in finding attributes of a file that are not in compliance with the PDF/X1a format.

Other Type-Related Issues: Various guidebooks suggest other parameters regarding type. For example, the actual font should be used rather than choosing bold, italic, and so on from the "Styles" menu. In addition, outline and shadow text should be created in a vector graphics program using strokes rather than by choosing "Outline" or "Shadow" from the "Styles" menu.

Recommended Instruction: Students of graphic design should be taught the positive and negative attributes of PostScript, TrueType, and OpenType fonts. In addition, they should learn to check the appropriate guidebook when choosing sizes for positive and reverse types. When creating vector graphics, students should learn the process of—and repeatedly practice—converting typefaces to outlines before placing the art in a page layout file. Finally, students of design need to be taught to shun the "Styles" menu and use the actual font for bold, italic, or other versions of a given typeface.

Other Guidelines-Related Issues

Bar Codes: Perhaps due to the overwhelming popularity of the flexographic process for printing packaging, FIRST devotes a great deal of space to designer considerations for bar codes. These considerations include bar code specifications, type, substrate and color considerations, placement, orientation, size, and quiet zones. Since packaging is one of the fastest-growing segments in the printing industry (Tietz, 2005), and since virtually all packages, wrappers, and labels contain bar codes, it is extremely important the design students learn how to work with bar codes. FIRST is an excellent reference for students to use during the design process.

Trapping: PDF/X1a files allow the designer to include trapped images. "Image trapping is a technique in which abutting colors are slightly overlapped to minimize the effects of misregistration on the printing plates" (GRACoL, 2002). It is possible to trap images in the software in which they are created: pixel-based images can be trapped in Photoshop, vector images are trapped in the originating software (Illustrator, Freehand, Corel Draw), and page elements can be trapped in a page layout program. However, it is becoming more common for trapping to be done by printers to entire jobs rather than image-by-image, page-by-page. GRACoL (2002) recommends: "Do this (trapping) only if you understand the parameters of the job. The best advice is to consult the printer before you attempt to trap colors because the proper amount of trap varies from printer to printer and from press to press." FIRST (2003) treats trapping as a purely prepress function and does not mention the process in its design section. Thus, it is imperative for the graphic designer to ask the printer what to do about trapping. In most cases, printers prefer to do trapping themselves.

SWOP requires that all documents submitted as PDFs be properly trapped. Their recommentdation is that lighter colors
should be spread into darker colors by between .002″– .004″. Similarly, SNAP still considers trapping to be the designer's responsibility. Their recommendation is .005″ (or 0.36 pts).

Conclusion

The downsizing trend in prepress departments in printing companies has made it imperative that graphic designers prepare completed files as accurately as possible to avoid frustration and additional costs when jobs are entered into the production workflow. National and international associations have begun to standardize the variables inherent in various printing processes and have codified their recommendations into guidebooks such as SNAP (newspaper production), GRACoL (commercial printing), SWOP (publications printing), and FIRST (flexographic printing). If students of graphic design are to prepare files that will effectively pass through the print workflow, they must know and implement the appropriate guidebook. This article has reviewed a few of the more important recommendations of SNAP, GRACoL, SWOP, and FIRST that graphic design students must know. To be truly effective, students and practitioners should obtain each of these documents and review them carefully.

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