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Introduction

Graphic communications technology is a generic label that utilizes several techniques by which words, graphics, and designs are produced on paper, fabric, and metal or other suitable substrates with the use of inks or pigments. These techniques are also known as "graphic arts," or printing. In the United States, graphic communications has evolved into a major industry and has become more efficient through new technologies. Printing Industries of America (PIA) reports that the graphic communications industry is the third largest industry, employing over 1.2 million people in more than 46,000 establishments and selling over $160 billion of products to print product users (PIA, 2002).

Theoretical Background

Graphic communications education is one of the oldest fields, and its content is constantly changing due to rapid advancements and trends that are taking place in industry. Graphic communications has been a part of educational institutions since its invention in the 14th century, and it continues to meet the needs of a progressive industry (Daily, 2000). At present, graphic communications educational programs are part of several vocational- and technology-based educational programs and curriculums.

Marshall (2000) stated that two common goals of technology-based educational programs across the country are to increase enrollments and to offer a curriculum that is both current and relevant. Technological developments in the graphic communications industry are currently changing many of the job descriptions, thereby creating a greater need for a qualified and skilled workforce. Graphic communications companies and educators need to integrate technological and managerial changes into the curriculum to prepare the future production workforce and managers for industry. Wilson (2001) stated that the graphic communications industry is in a constant technological flux. He also stated that industry input is needed to make sound curricular decisions for technology-based educational programs to meet employers' expectations and to increase graduates' technical competency.

Childress & Gillispie (1999) stated that the graphic communications industry offers a host of career opportunities including management, sales, technical, art, customer service, and more. Graphic communications graduates from a technical or community college qualify for an entry-level or a technician position in industry. Similarly, graduates of a four-year or university-level graphic communications program qualify for entry-level supervisory management-trainee, or middle-management positions (Flecker & Groff, 1998).

A review of course catalogs from universities/technical colleges offering

graphic communications programs revealed that graphic communications curriculum covers both theoretical and practical content in the areas of print management, prepress, press/printing, and print finishing or bindery. Flecker & Groff (1998) indicated that the depth of course content taught to students may be different from institution to institution and program to program. This is due to the level of the programs and the status of the institutions. The Graphic Arts Technical Foundation (GATF) Directory of Schools (1999) revealed that the educational requirements differ significantly between technical and community colleges and the programs of undergraduate and graduate-level degrees. Denny & Harmon (2000) indicated that any type of education plays a critical role in society and allows an individual to develop the knowledge and skills necessary to capture economic opportunities and thus increase his or her income. Additionally, education plays a critical role in building a modern market-based economy and raising the standard of living (Denny & Harmon, 2000).

Lewis (1996) stated that, like other manufacturing industries, the graphic communications industry also requires trained and educated employees to keep the industry growing profitably. Currently, the United States printing industry is going through a radical reorganization of its workplace due to technological developments in every segment of the industry (Faiola, 1997). Due to these changes, there has been an increased demand for an educated and skilled workforce with up-to-date technical competencies. This demand is due to technological changes in digital prepress, management practices, color management, and digital printing areas of the industry (Lewis, 1996).

According to several published reports, the printing and publishing industry is in desperate need of qualified and skilled workers at every level. Dailey (2000) stated that jobs in the desktop publishing area of the industry were expected to grow 74 percent from 1996 to 2006. As the graphic communications industry begins to replace older technology with new, digitally- driven technologies for the purpose of efficiency in print production, profit gain, and to meet the demands of the various market segments, the type of employees' skills also needs to change.

New technology is often difficult for many older industry workers to adopt, especially with the rapid changes that have occurred over the past ten years in the industry. Modern graphic communications education can prepare an individual to cope with industry advancements (Faiola, 1999). Graduates with modern graphic communications education and skills are, and will be, in greater demand than ever before in one of the fastest growing industries in the United States.

Purpose of the Research

The purpose of this research was to determine the perceptions of the graphic communications industry and educators on the importance of technical competencies in the graphic communications technology curriculum. The following questions were investigated by the researcher.

1. What types of technical competencies are important for the print management area?
2. What types of technical competencies are important for the prepress area?
3. What types of technical competencies are important for the press and printing area?
4. What types of technical competencies are important for the binding and print finishing area?

Research Method

This research utilized a descriptive research method. There were two target populations for this study: mountain states (New Mexico, Colorado and Wyoming) printing companies and mountain states graphic communications educators. The lists of companies were identified from the Printing and Imaging Association of Mountain States (PIAMS) Print and Graphics Buyers Guide (2000) and PIAMS Membership Directory (2000). Survey instruments were addressed to the president and/or manager of each identified company in the study.

Educators included full-time and part-time instructors/educators who are teaching graphic communications and related subjects at secondary and post-secondary level institutions. They were identified from the Graphic Arts Technical Foundation (GATF) Directory of Schools (1999-2000), the PIAMS Membership Directory (2000), and the Colorado Community College and Occupational Educational System Directory (2000). In order to elicit information for this study, a three-page survey questionnaire was used to obtain the perceptions of the target population on the importance of the curriculum.

During the spring of 2001, 478 survey questionnaires were mailed to industry and 80 questionnaires were mailed to educators. Three weeks after the first mailing, the follow-up surveys were mailed to non-respondents. The following five part Likert-type scale was used throughout the survey questionnaire: 5 = very important, 4 = important, 3 = moderately important, 2 = little importance, and 1 = unimportant.

Survey questionnaire contents were validated by a panel of experts. The panel included four full-time university faculty members and the PIAMS. In validating the survey questionnaire, an initial draft was given to these panel members to check for errors and readability and to make suggestions for improvements in the survey questionnaire. All the required changes were made based on their recommendations and suggestions prior to mailing.

Data Analysis and Research Findings

Of the 478 survey questionnaires that were mailed to companies, a total of 64 were returned. This represents a 13.40% return rate. Of the 64 surveys returned, 8 were found to be incomplete. Of the 80 survey questionnaires that were mailed to educators, a total of 35 were returned. This represents a 43.75% return rate. Of the 35 surveys returned, 5 were found to be incomplete. Data was generated from the usable returned surveys. Descriptive and inferential statistics were the

statistical methods used to analyze the data. Analyzed results are presented in the following section.

Technical Competencies in Graphic Communications

This section presents the results of the descriptive and inferential statistics. An independent t-test was conducted to determine if any statistically significant differences exist between the mean scores of industry and educators opinions on the importance of technical competencies in the graphic communications curriculum in the areas of print management, prepress, press and printing, binding and finishing areas.

1. Print Management Area

The mean scores (maximum 5), standard deviations, and t-values associated with the 20 statements of technical competencies in the print management area of the graphic communications curriculum are compiled in Table 1. Significant differences were found in three of 20 technical competencies.

Graphic communications educators perceived a higher importance on the use of "graphic communications terminology" competency than industry. Graphic arts educators feel that it is important for students to know and use the correct terminologies that are used in their chosen areas. Additionally, educators perceived a higher importance on "identifying characteristics of digital communications" than did industry representatives. Educators feel that customers deliver more and more jobs that are to be printed via different types of communication channels. In addition, digital media is replacing print media. To cope with the rapid advancements of computers and digital technologies, educators believe it is important to focus the curriculum on digital communications technologies.

Industry representatives perceived a higher importance on "developing market plans and research" than educators. Industry tends to feel that workers with a graphic communications education can do a better job in developing market plans for their business. No significant differences were found in the remaining 17 of 20 competencies within the print management area. This indicates that educators and industry are in agreement (see Table 1).

2. Prepress Area

Statistically significant differences were found in two of 26 competencies in the prepress area of the graphic arts

Table 1. Comparison of Mean Scores (Educators and Industry) on the Importance of Print Management Competencies in the Graphic Communications Curriculum

	Educators N = 30		Industry N = 56		
Technical Competency Statement	M	SD	M	SD	t-value
Identify production requirements	4.39	0.63	4.09	0.98	1.493
Identify and provide customer needs	4.55	0.57	4.52	0.89	0.184
Select appropriate production materials	4.41	0.73	4.02	1.00	1.884
Analyze production problems	4.31	0.89	4.30	0.81	0.035
Communicate directly with the customers	4.21	0.90	4.46	0.83	1.315
Evaluate the capabilities of production equipment	3.93	0.94	3.64	1.02	1.244
Identify characteristics of digital communications	4.07	0.90	3.64	0.86	2.117*
Describe the relationships of tel./multimedia	3.43	0.96	3.09	1.03	1.453
Apply concepts of training and development	3.85	0.95	3.63	1.05	0.947
Demonstrate electronic document delivery	3.86	0.97	3.71	1.06	0.599
Apply production standards	4.32	0.77	4.07	0.91	1.243
Analyze and interpret data statistically	2.96	1.00	3.27	1.10	1.225
Prepare production costing and estimating	3.54	1.10	3.86	0.98	1.357
Develop marketing plans and research	2.86	0.93	3.45	1.01	2.589*
Use graphic communications terminology	4.46	0.64	3.88	1.05	2.734**
Shop floor management	3.32	1.16	3.61	1.04	1.144
Working well with others	4.62	0.62	4.59	0.78	0.187
Communicating effectively	4.66	0.61	4.66	0.75	0.034
Technical writing	3.69	0.85	3.57	1.13	0.496
Decision making skills	4.52	0.69	4.32	0.94	0.994

*$p \leq .05$, **$p \leq .01$

Table 2. Comparison of Mean Scores (Educators and Industry) on the Importance of Prepress Competencies in the Graphic Communications Curriculum

	Educators N = 30		Industry N = 56		
Technical Competency Statement	M	SD	M	SD	t-value
Understand different types of computing platforms	4.17	0.87	4.07	1.13	0.402
Basic programming skills	2.87	1.04	3.07	1.26	0.759
Access digital documents using CD-ROM/networking	4.31	0.85	3.95	1.23	1.427
Describe different types of screening technologies	3.72	0.92	3.39	1.19	1.311
Explain digital photography process	3.86	1.03	3.11	1.23	2.830**
Explain document and workflow management	3.66	0.97	3.55	1.17	0.399
Demonstrate graphic and imaging software	4.07	0.96	3.80	1.18	1.042
Explain digital graphic file formats: TIFF, PDF, EPS, DCS, and JPEG	4.17	1.00	4.00	1.14	0.686
Describe image setting technology	3.79	0.90	3.57	1.04	0.972
Explain desktop publishing system	4.00	1.07	3.61	1.15	1.524
Evaluate page makeup and graphic software	4.10	1.11	3.73	1.14	1.438
Prepare final design specifications	4.17	1.00	3.93	1.04	1.035
Apply design principles to printing process	4.17	0.97	4.04	1.06	0.580
Describe electronic/digital color separation	3.62	0.86	3.46	1.17	0.633
Identify computer network systems	3.28	0.88	3.27	1.04	0.035
Identify various digital storage devices	3.72	0.80	3.41	1.09	1.367
Evaluate desktop scanning technology	4.00	0.96	3.34	1.08	2.764**
Describe digital proofing system	3.72	0.92	3.48	1.06	1.040
Explain halftone photography	3.79	0.98	3.39	1.19	1.562
Explain color reproduction process	4.10	0.94	3.68	1.18	1.684
Explain color theory	3.79	0.98	3.63	1.21	0.644
Explain operations of color scanner	3.48	1.06	3.29	1.17	0.759
Differentiate between film assembly and imposition	3.52	0.95	3.52	1.27	0.002
Define electro-photography	3.07	0.844	2.77	1.06	1.325
Describe front-end platforms for digital printing	3.31	0.85	3.25	1.15	0.249
Describe prepress preflight process	3.79	0.94	3.79	1.14	0.030

*p ≤ .05, **p ≤ .01

curriculum. Graphic arts educators perceived a higher importance on "explaining digital photography process" and "evaluating desktop scanning technologies" competencies than industry. Digital photography process and desktop scanning technologies are the major source of image generation or image creation within the prepress area. As such, educators feel that emphasizing these two areas is very important within the prepress area of the curriculum. No significant differences were found in the remaining 24 of 26 competencies within the prepress area. This indicates that educators and industry are in agreement (see Table 2).

3. Press/Printing Area

There was a statistically significant difference in one of 11 competencies in the press and printing area of the graphic arts curriculum. Graphic arts educators perceived a higher importance on "explaining how printing processes affect the environment" than industry. No significant differences were found in the remaining 10 of 11 competencies within the press and printing area. This indicates that educators and industry are in agreement (see Table 3).

4. Binding and Print Finishing Area

There was a statistically significant difference in one of seven competencies in the binding and print finishing area of the graphic arts curriculum. Graphic arts educators perceived a higher importance on "identifying inkjet production operations" within the print finishing area of the curriculum than industry. No significant differences were found in the remaining six of seven competencies within the bindery and finishing area. This indicates that educators and industry are in agreement (see Table 4).

Conclusions

The conclusions of this study are based upon an analysis of the data and major findings. The research identified significant differences that exist among industry representatives and educators on the importance of technical competencies for the graphic communications curriculum. There were significant differences between educators and industry representatives in seven of the 64 competency statements. Graphic communications educators' perceived a higher importance on six of seven competencies than industry, while industry representatives perceived a higher importance than educators on one of seven competencies. There were no significant differences found in the remaining 57 technical competency statements between educators and industry. This indicates that industry and educators were in agreement.

Technological developments in the areas of electronics, computers, lasers, and computer integrated manufacturing techniques, science and engineering are radically changing the structure of the traditional printing industry. Due to these technological developments, significant changes are continuing in the printing industry, and thus demand a skilled workforce with up-to-date technical competencies.

Mountain States educators and companies can access the findings of this study through PIAMS. This study can be utilized as a "needs assessment tool" to make decisions on curriculum revisions and laboratory development initiatives. In addition, educators can compare the findings of this study with existing curriculum and identify strengths and weaknesses in the graphic communications curriculum. If needed, educators may implement or introduce new courses and topics in the graphic communications curriculum. For example, industry representatives perceived a higher importance on "developing market plans and research" competency than educators. As such, educators can integrate contents into the curriculum to meet the current expectations of industry.

Research studies on technical competencies are required to make sound curricular decisions for technology-based graphic arts educational programs. New developments in industry should be integrated into the curriculum so that both graduates and industry can benefit. Finally, industries and educators must work cooperatively to better promote education, as well as make efforts to enhance the current curriculums and educational programs. Without the cooperative effort of these groups, industry may face a serious workforce shortage.

Table 3. Comparison of Mean Scores (Educators and Industry) on the Importance of Press and Printing Competencies in the Graphic Communications Curriculum

	Educators N = 30		Industry N = 56		
Technical Competency Statement	M	SD	M	SD	t-value
Articulate print registration system	3.79	0.90	3.86	1.09	0.272
Describe difference between various printing processes	3.83	0.89	3.84	1.06	0.050
Describe different formats of web and sheetfed presses	3.59	1.02	3.25	1.05	1.414
Identify various characteristics of paper	4.10	0.86	4.07	1.01	0.145
Explain how the characteristics of paper affect print	4.14	0.79	4.14	1.00	0.023
Identify types and characteristics of printing inks	3.86	1.03	3.68	1.16	0.717
Apply standard printing trade customs	3.59	0.98	3.57	1.19	0.957
Describe how characteristics of paper affect the printing process	3.83	0.89	3.86	1.03	0.130
Describe the relationship between the printing and general economy	3.24	0.83	3.11	1.20	0.538
Explain how the printing process affects the environment	3.55	0.87	3.05	1.09	2.138*
Identify various print production processes	3.72	0.70	3.59	1.09	0.602

*p ≤ .05, **p ≤ .01

Table 4. Comparison of Mean Scores (Educators and Industry) on the Importance of Binding and Print Finishing Competencies in the Graphic Communications Curriculum

	Educators N = 30		Industry N = 56		
Technical Competency Statement	M	SD	M	SD	t-value
Utilize various binding methods	3.55	0.87	3.68	1.11	0.534
Evaluate postpress production operations	3.48	1.12	3.46	1.19	0.069
Identify inkjet production operations	3.45	0.87	2.93	1.19	2.081*
Recognize mail and distribution regulations	3.21	1.01	3.13	1.25	0.304
Identify mechanical binding methods	3.48	0.99	3.46	1.11	0.075
Name miscellaneous binding and finishing operations	3.41	0.98	3.43	1.16	0.058
Outline the opportunities for printer involvement in distribution of printed materials	3.07	1.03	3.38	1.21	1.156

*p ≤ .05, **p ≤ .01

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