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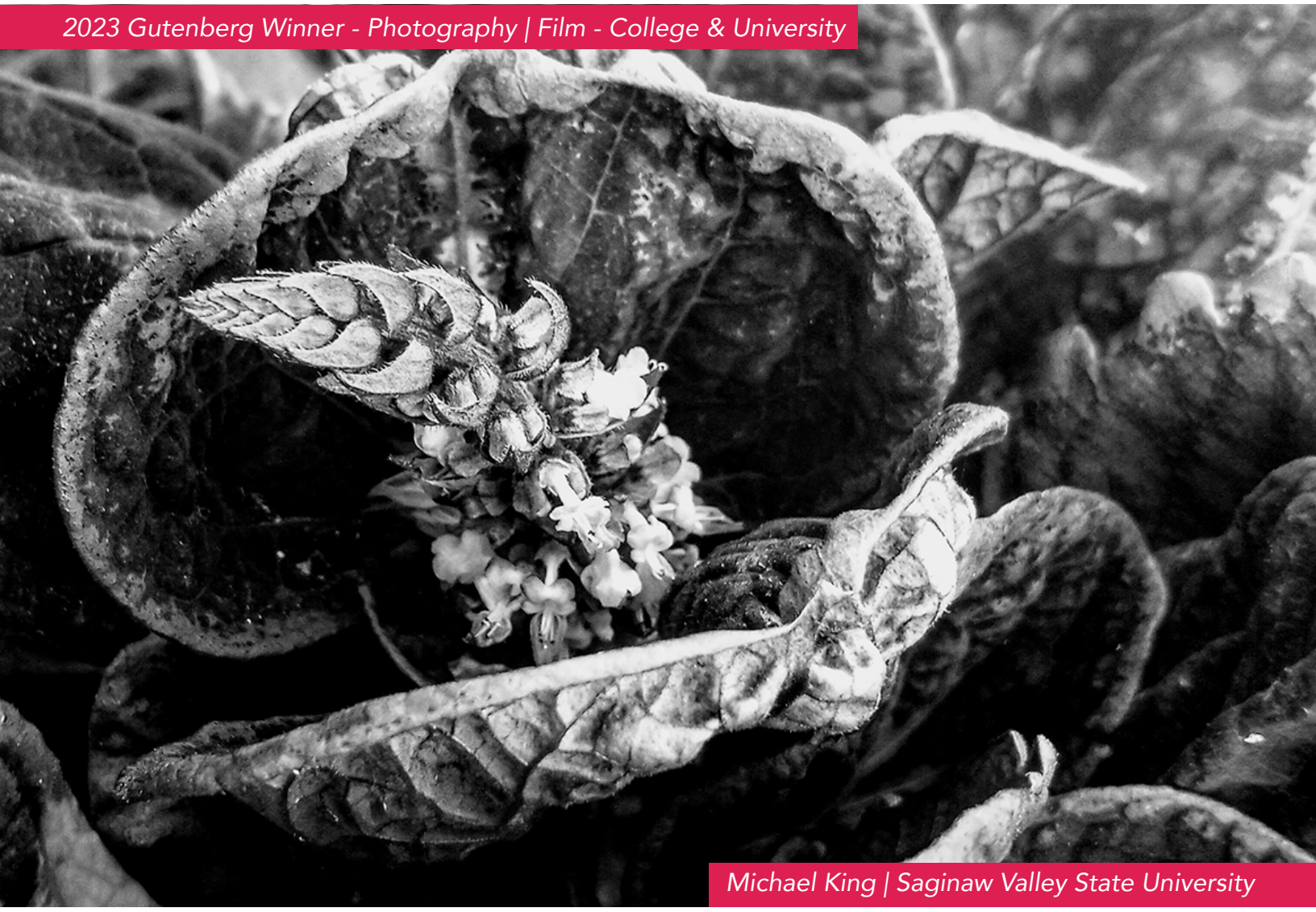

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Academic Graphic Communications: Revising the Taxonomy

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Abstract

The Classification of Instructional Programs (CIP) 2020 10.03 Graphic Communications taxonomy used by the National Center for Educational Statistics (NCES) has been unchanged for over 23 years and no longer describes current content within Graphic Communications (GC) associate and bachelor's degree programs. Because of these outdated CIP 10.03 terminologies and related occupational crosswalks, poor statistical and descriptive data is making its way into databases that are used by government entities, higher education institutions, career counselors, and more importantly prospective college students. This paper highlights the challenges we face and offers insight into a redevelopment to align federal reporting metrics with the industry.

Utilizing an updated content taxonomy, program definitions, and student learning objectives (SLO) developed through the Delphi technique by the Accrediting Council for Collegiate Graphic Communications (ACCGC), this study sought to understand how the taxonomy could be applied to the current state of the associate and bachelor's degree programs in North America. Through the development of a database of existing programs and the examination of the programs' coursework and SLOs, researchers were able to identify how programs fit within the updated taxonomy.

With the content taxonomy adopted by ACCGC as a foundation, this study recommends a revision of CIP 10.03 to include: Graphic Communications, General 10.0301, Graphic Communications Management 10.0302, Graphic Communications Design and Technology 10.0303, and Animation, Interactive Technology, Video Graphics and Special Effects 10.0304. In addition, this study recommends a revision to Standard Occupational Classification (SOC 2018) crosswalks from 10.03 Graphic Communications.

Key Words: Classification of Instructional Programs, Graphic Communications, National Center for Educational Statistics, Standard Occupational Classification

Introduction and Historical Perspective

The graphic communications industry includes a range of rapidly evolving technologies used in the design and manufacture of graphic information products, both in physical and digital form. Over the quarter century focused upon in this research, the academic discipline of graphic communications has expanded its scope of instructional content in sync with these industrial technological advancements. Unfortunately, current government definitions of this academic discipline were created 25 years ago and no longer accurately reflect the current state of this field of study. Further, data tracking systems used by the United States and Canadian governments are based on these old paradigms and provide inaccurate data on current programming and curricula. This paper explores these challenges and offers research-based solutions to align the federal data tracking systems with the current realities that exist in the graphic communications discipline.

The academic discipline of graphic communications has existed and continually evolved for over 100 years. Its roots date back to the early 20th century when the printing arts was introduced into high school curricula as a component of the manual arts. Prior to this time, training for careers in printing was carried out through apprenticeships and was not taught as part of school curricula. In mid-twentieth century, the use of the broad term Manual Arts to describe related school programming gave way to Industrial Arts. Around the same time, the subject of industrial arts was common in college teacher education curricula, with the sub discipline of graphic arts as a component (Hartman, 1962). In the 1970s, with industrial production de-emphasizing craft skills in the wake of increasingly more sophisticated automated machinery, the term industrial technology was adopted in place of industrial arts, encompassing four main areas of study: Communication (which included Graphic Arts), Transportation, Construction, and Manufacturing. In the 1960s and 1970s, industrial technology education at the college level began to move beyond just teacher training to also include preparation of management-oriented technical professionals. Curricula began to include business and management core courses to complement technical knowledge and to enhance the job readiness of graduating students.

In the 1990s, many degree programs in North America began renaming programs from Graphic Arts to Graphic Communications. There were three key reasons for this:

1. There was often confusion about the semantics of 'Art(s).' In the case of programs named Graphic Arts, Arts implied artisanship as it relates to craft skills in the context of a utilitarian trade. In the case of programs in Fine Arts, Arts implied purely creative and intellectual endeavors with curricular components in studio art, art history, and aesthetics.
2. The program term Graphic Communications fit more precisely under the academic departments in Industrial Technology (which included Communication as a subset).
3. The program name Graphic Communications better reflected the evolution of communication and information technology in the 1990s, which was evolving to embracing a mix of media beyond physical print, including the emerging technologies of data processing, computer-based media, digital workflows, and internet communication.

The CIP System and Graphic Communications

The CIP system is a taxonomy of instructional programs designed in 1980 by the National Center for Education Statistics (NCES) (a unit of the US Department of Education) as an aid for tracking, assessing, and reporting on data related to all programs of study (NCES, 2022). The earliest classification for the field of graphic communication appeared in the CIP 1985 version and called Graphic & Printing Communication. It was taxonomically categorized under Precision Production which was later removed. In 1999, members of the International Graphic Arts Education Association (IGAEA), now doing business as the Graphic Communications Education Association (GCEA), resolved to adopt an official definition of academic Graphic Communications that might better unify the dozens of educational programs that consisted of similar core curricula. In concert, a proposal was developed and presented to the NCES by the IGAEA leadership and Graphic Communications was adopted as an official program within the CIP 2000 taxonomy (CIP 10.03) (Personal communication with Past President of IGAEA, Lee Weir, February 2, 2023). This same taxonomy was also adopted by the Canadian Government in 2000. NCES and Statistics Canada work cooperatively to keep the system consistent for both countries (Canada, 2022; NCES, 2023). The original CIP 2000 and most recent, unchanged, CIP 2020 taxonomy of Graphic Communications 10.03 has the following subprograms:

(10.0301) Graphic Communications, General.

(10.0302) Printing Management.

(10.0303) Prepress/Desktop Publishing and Digital Imaging Design.

(10.0304) Animation, Interactive Technology, Video Graphics and Special Effects.

(10.0305) Graphic and Printing Equipment Operator, General Production.

(10.0306) Platemaker/Imager.

(10.0307) Printing Press Operator.

(10.0308) Computer Typography and Composition Equipment Operator

(10.0309) Graphic Communications, Other.

Despite the overall CIP taxonomy undergoing major revisions by the NCES in 2010 and again in 2020, no changes were made to CIP10.03 Graphic Communications. As of 2023 the CIP taxonomy definitions for code 10.03, originally designed in the late 1990s, are more historical than current. For example, some terminology within CIP 2020 is long out of use, such as Typography Composition Equipment, and some program titles are better suited to very narrow apprenticeship programs and on-the-job training, such as Printing Press Operator and Platemaker/Imager. These CIP 10.03 subprograms were introduced in the 1980s as part of CIP 48, Precision Production, but almost 40 years later remain in place today.

The Standard Occupational Classification (SOC 2018) system

The CIP system is a national standard used for reporting data on academic programs and fields of study by institutions, states, and the federal government (NCES, 2023). Operating parallel to the CIP system is the Bureau of Labor Statistics' Standard Occupational Classification (SOC) system. SOC 2018 endeavors to define the entire range of current occupations in North America in order to provide datasets for tracking, analyzing and reporting labor data through a variety of databases (BLS, 2023). The NCES (2022) maintains crosswalks between CIP and the SOC system, identifying matches between educational programs and the occupations to which they lead. Current NCES crosswalks from 10.03 Graphic Communications programs of study to the SOC occupations are shown in Table 1. Recommendations for modernizing crosswalks are presented later in this paper.

Table 1

Current CIP 10.03 Crosswalks to SOC Defined Jobs

CIP 2020	Title 2020	SOC 2018	Crosswalk Occupations
10.03	Graphic Communications		
10.0301	Graphic Communications, General.	51-5111	Prepress Technicians and Workers
10.0302	Printing Management	51-5111	Prepress Technicians and Workers
		51-5112	Printing Press Operators
10.0303	Prepress/Desktop Publishing and Digital Imaging Design	43-9031	Desktop Publishers
		51-5111	Prepress Technicians and Workers
10.0304	Animation, Interactive Technology, Video Graphics and Special Effects	27-1014	Special Effects Artists and Animators
10.0305	Graphic and Printing Equipment Operator	43-9021	Data Entry Keyers
		51-5111	Prepress Technicians and Workers
		51-5112	Printing Press Operators
10.0306	Platemaker/ Imager	51-5111	Prepress Technicians and Workers
10.0307	Printing Press Operator	51-5111	Prepress Technicians and Workers
		51-5112	Printing Press Operators

Table 1 (continued)

CIP 2020	Title 2020	SOC 2018	Crosswalk Occupations
10.0308	Computer Typography and Composition Equipment Operator	43-9031	Desktop Publishers
		51-5111	Prepress Technicians and Workers
10.0399	Graphic Communications, Other.	51-5111	Prepress Technicians and Workers
		51-5112	Printing Press Operators
		51-9194	Etchers and Engravers

The occupational titles Desktop Publishers, Etchers and Engravers, and Data Entry Keyers are outdated, while others like Printing Press Operator and Platemaker/Imager are rarely career goals for those pursuing college degrees. Due to these outdated and incomplete CIP 10.03 definitions and crosswalks to the SOC occupations, the current Bureau of Labor Statistics datasets incorrectly project the graphic communications industry as outdated and in decline. Further, this poor statistical and descriptive data is making its way into a range of databases used by government entities, institutions, career counselors, and prospective students.

These databases are many and their impacts far reaching. For example, all States require colleges to classify their programs of study in the CIP taxonomy and report to the US Department of Education. A search of the NCES's Institute for Educational Sciences database yielded 322 current degree programs classified by their institutions and states as subprograms within the 10.03 Graphic Communications taxonomy (College Navigator, 2023). Because SOC occupations are annually tracked for employment trends, CIP crosswalk data becomes the basis for databases used by publications reporting on the most valued college majors and occupations (Rapacon & Silvestrini, 2022). Additionally, State governments use these data sets for policy decisions. As an example, the State of Florida's Programs of Strategic Emphasis (PSE) policies use SOC occupational trends data to form the basis for college program funding decisions. In theory, any downward trend in the current crosswalk occupations such as Prepress Technicians and Workers, Etchers and Engravers, or Printing Press Operators might imperil funding for those Florida college degree programs that fall under CIP 10.03 (State University System of Florida, 2023).

The Department of Homeland Security maintains a list of STEM-classified CIP programs to determine if F–1 nonimmigrant students who earn STEM-classified degrees may be eligible to apply for a 24-month extension to work in the US beyond their graduation date (Federal Register, 2022). Only the Graphic Communications subprogram CIP 10.0304 Animation, Interactive Technology, Video Graphics and Special Effects is designated as a STEM program. Though not categorized as such by the NCES, all graphic communications curricula are prototypical STEM disciplines (Science, Technology, Engineering, and Math) (Riley, 2018). This is another example of how inaccurate CIP data may impact graphic communications degree programs. In this case, international students may be dissuaded from coming to the US to enroll in graphic communications degree programs, not being assured of extended work extensions under these dated definitions.

A New Content Taxonomy for Academic Graphic Communications

Given the limitations of the outdated CIP 2020 10.03 taxonomy, the Board of Directors for the Accrediting Council for Collegiate Graphic Communications (ACCGC) initiated the development of a current discipline-specific taxonomy to use internally for determining the suitability of degree program applicants for accreditation. At the same time, an update of Student Learning Outcomes (SLOs) used for accreditation standards was made (Accrediting Council for Collegiate Graphic Communications, 2023).

To develop the content taxonomy, ACCGC assembled an expert group comprised of content experts from the faculty of each of seven university graphic communications degree programs in North America. Six of the seven experts were from degree programs that were ACCGC-accredited. The rationale for preferring experts from ACCGC-accredited programs was to assure that their programs, (a) had been transparently verified as meeting the highest standards through peer review, (b) had up-to-date curricula informed by regular industry advisory council review, and (c) had curricula honed over time through a working system of outcomes assessment and revision.

To develop a new taxonomy, the ACCGC development committee used the Delphi method which is a process championed by the RAND corporation in the 1950s to predict how technology advancements would affect future warfare. Since that time, the method has been applied to a wide range of fields and topics but the basic structure of the technique remains the same: A moderator manages a group of subject matter experts and brings the group to a consensus regarding a topic under consideration. To achieve consensus, questions are posed to the group and responses are compiled without personal identification. Anonymity is crucial to ensure that personality-driven bias is kept to a minimum. Each member responds to the overall input anonymously through a series of rounds, with each round aiming to bring about closer agreement. The driving principle behind the Delphi technique is democratic distillation of complex subjects, with the assumption that group decisions tend to be more accurate and widely accepted than individual decisions (RAND, 2023). The ACCGC used the Delphi technique to bring about consensus on:

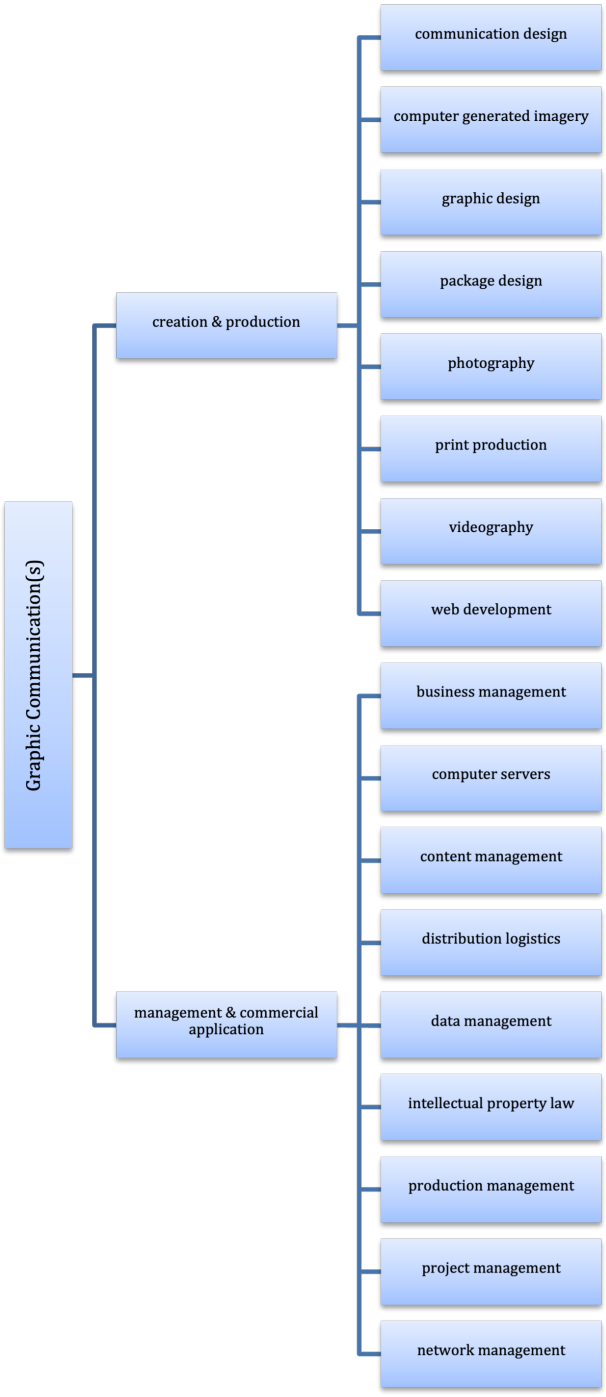
1. A four-level content taxonomy for graphic communications education.
2. Modern academic graphic communications degree program definitions.
3. A set of degree program SLOs that could be used for accreditation standards.

The process involved ten rounds of web-based surveys and took six months to complete, culminating in an ACCGC Board of Directors vote to adopt the content taxonomy, definitions, and SLOs for internal use. The three-level content taxonomy is shown in Figure 1 (the full four-level taxonomy can be found at www.accgc.org). The new definition of academic graphic communications was made using the 2nd- and 3rd-level content taxonomy terminology, resulting in the following broad description of the discipline and its curricular components:

A branch of technology with focus on the creation, production, management, and commercial application of visual products in digital and physical form. Study may include combinations of business management, computer-generated imagery, computer servers, content management, data management, distribution logistics, graphic design, intellectual property law, network management, package design, photography, print production, visual product design, production management, project management, videography, and web development.

Figure 1

Three-Level Content Taxonomy of Academic Graphic Communications



Student Learning Outcomes and Accreditation

The Accrediting Council for Collegiate Graphic Communications has defined these seven student learning outcomes (SLOs) for degree program accreditation:

- (Design and User Experience) Integrate design aesthetics, functionality, and relevancy into graphic communications products.
- (Production Skills) Impact production efficiency and product quality across a variety of media by applying knowledge of graphic communications materials, technologies, and practices.
- (Teamwork and Project Management) Contribute to graphic communications project teams for design, production, and management.
- (Legal and Ethical Considerations) Recognize and practice legal and ethical responsibilities concerning the creation, use, and distribution of graphic communications assets or products.
- (Communication) Communicate ideas through written, visual, and oral mediums to a wide range of audiences.
- (Research and Independent Learning) Research and apply new information to solve graphic communications design, production, and management problems.
- (Business and Management) Apply tools and principles in graphic communications business development and production management.

These discipline-specific student learning outcomes (SLOs) are defined to ensure that curriculum, facilities, and instruction support the learning deemed most critical to graduates entering the profession occupations in the graphic communications industry. In a system of outcomes assessment, course objectives within accredited degree programs should support these SLOs, and a system for measuring student performance related to the SLOs should demonstrate the effectiveness of curriculum and instruction. Even non-accredited college degrees are required by most institutions and State governments to establish, track and assess SLOs.

Scope of Impact: Identifying Current CIP 10.03 Degree Programs

Using the new ACCGC content taxonomy, program definitions, and SLOs, an effort was made to identify associate degree and bachelor's degree programs in North America that should be classified under the newly defined graphic communications framework. A three-step process was undertaken.

Step 1: *Develop a combined database.* Existing degree program databases were canvassed. These sources were cross-referenced and used to compile a master database of potential programs:

a. Institute of Education Sciences database, a unit of the U.S. Department of Education: nation-wide search of institutions that have a program categorized under one of the CIP 10.03 Graphic Communications sub-programs.
b. Findings from a 2022 publication identifying bachelor's degree graphic communications programs under the current CIP 10.03 2020 definition (Geisinger, 2022).
c. An ACCGC degree program database, last updated in 2010, that included both bachelor's degrees and associate's degrees in North America.
d. The Print & Graphics Scholarship Foundation (PGSF) Directory of Schools (Directory of Schools, 2023).

Step 2: *Verify each program in the database.* An internet search was made to verify each program's existence, review any changes to the program title, review of the required coursework, and review student learning outcomes (if available). While the researchers endeavored to be accurate, the results may be difficult to validate without ongoing verification; program title changes happen regularly, and program website information varies in recency and level of detail. It was found that most sites were current and included degree course requirements, as well as SLOs.

Step 3: *Eliminate programs from the database that fit more precisely under other areas within the CIP 2020 taxonomy.* A wide variety of program titles exist within the field of graphic communications. Further, many of the program titles used in the field of graphic communications can be confused with the academic disciplines of fine arts (particularly programs entitled 'Graphic Design') and mass communications/ journalism (particularly programs entitled 'Digital Media'). To make the distinction between fine arts-graphic design and graphic communications-graphic design, the researchers relied on established accreditation requirements within those disciplines. The National Association of Schools of Art and Design (NASAD, 2023) accredits fine arts-related graphic design programs, and requires these programs to include at least one course in art history and another course (or courses) in studio art (e.g. sculpture, painting, ceramics, etc.). The Accrediting Council on

Education in Journalism and Mass Communications (ACEJMC, 2023) accredits programs entitled Digital Media but the standards require SLOs focused on content composition, i.e., composing media for journalism, writing and producing documentaries, and communicating mass media. Both NASAD and ACEJMC standards are less focused than ACCGC with course depth in technical, business, and managerial aspects of media production. With these accreditation standards as qualitative parameters, the researchers were able to eliminate programs otherwise confused with the academic graphic communications discipline.

Table 2 provides a list of twenty bachelor's degrees with majors in the graphic communications discipline in North America. With some latitude for emphases, these programs meet the new content criteria defined by ACCGC for academic graphic communications programs. These 20 programs span 16 different states, plus one program in Ontario, Canada. States with bachelor's degree programs include Arizona, Arkansas, California, Connecticut, Illinois, Indiana, Iowa, Kansas, Kentucky, New York, Ohio, Pennsylvania, Michigan, North Carolina, South Carolina, and Texas. Note that no state has more than one program, and 34 States had no bachelor's degree program in the graphic communications discipline.

Table 2
Graphic Communications Bachelor's Degree Title Summary

Program title	Number of programs using the title
Graphic Technology(ies)	2
Graphic Communication(s)	2
Graphic Communications Management	1
Graphic Media Management	1
Graphic Arts Management	1
Graphic Communication Technology	1
Graphic Communications Media	1
Creative Media Production/Graphic Communication	1
Visual Communications Technology	1
Print and Graphic Media Technology	1
Graphic and Imaging Technologies	1
Digital Media Technology	1
Graphic Arts Design & Technology	1
Packaging Engineering Technology	1
Graphic Information Technology	1
Digital Media	1
Integrated Design	1

A total of 106 associate degree programs were classified under the graphic communications discipline, with the greatest number entitled Graphic Design. Graphic design programs were identified as not meeting the minimum requirements for NASAD accreditation since they all lacked art history or the studio arts requirements. With the majority of coursework focused on technical and production-oriented content, these programs fit well within the graphic communications content taxonomy and related SLOs. Note that though core curriculums among these associate degree programs were found to be quite similar, there are a surprisingly wide range of unique program titles. Aee Table 3 for Associate Degree Titles.

Table 3
Associate Degree Title Summary

Program title	Number of programs using the title
Graphic Design	17
Graphic Communications	7
Visual Communication(s)	7
Graphic Design Technology	5
Digital Media	4
Graphic & Web Design	4
Graphic Arts Technology	4
Graphic Arts and Imaging Technology	3
Graphic Communication Technology(ies)	3
Graphic Design & Communication(s)	3
Design and Media Production Technology	2
Graphic Imaging Technology	2

Table 3 (continued)

Program title	Number of programs using the title
Visual Communication – Design & Technology	2
Advertising & Graphic Design	1
Advertising and Graphic Design	1
Commercial Graphics Communications	1
Communications Arts Technology	1
Computer Graphics	1
Computer Graphics Technology	1
Design and Digital Marketing	1
Design and Digital Media	1
Design and Graphic Technology	1
Design Media Art - Graphic Design	1
Design, Interactivity and Media Arts	1
Digital Art & Design	1
Digital Arts	1
Digital Media Arts	1
Digital Media Design	1
Digital Media Technology	1
Graphic & Interactive Design	1
Graphic and Print Production	1
Graphic Art Communications	1
Graphic Arts Technology	1
Graphic Communications & Printing Technology	1
Graphic Communications Technology Management	1
Graphic Design & Production	1
Graphic Design and Printing	1
Graphic Design and Rich Media	1
Graphic Design Media	1
Graphic Design: Digital and Print Media	1
Graphic Imaging Management	1
Graphic Imaging Technology	1
Graphic Technologies	1

Table 3 (continued)

Program title	Number of programs using the title
Graphics and Printing	1
Interactive Design	1
Media & Communication Arts	1
Media Arts	1
Media Arts and Digital Technology	1
Media Technologies/Web & Print	1
Multimedia Arts & Technology	1
Multimedia Technology	1
Prepress and Printing Production	1
Printing Technology	1
Visual Communication & Design	1
Visual Media Design	1
Web Design	1

While core curriculum among programs was found to be quite similar, most of the 106 associate degree programs have additional divisions of emphasis titles available by student choice. The most common of these emphases' titles were compiled in Table 4, where tallies shown include Graphic Design (102 programs), Web Design/Development (49 programs), Print Production (48 programs), Photography (28 programs), Videography (17 programs), Package Design (seven programs), Computer-Generated Imagery (7 programs), Business Management (seven programs). Table 4 provides a full summary of the emphasis titles for associate degree programs in graphic communications.

Table 4

Frequency of Course Content Taught Within Associate Degree Programs

Covered in Curriculum	Number of Programs
Graphic Design	102
Web Development	49
Print Production	49
Photography	29
Videography	17
Package Design	7
Computer Generated Imagery	7

Table 4 (continued)

Covered in Curriculum	Number of Programs
Business Management	7
Campaign Product Design	4
Production Management	4
Project Management	3

Proposing a Modern CIP 10.03 Taxonomy for Graphic Communications

Using the content taxonomy and SLOs adopted by ACCGC as a foundation, the ACCGC Board of Directors approved a proposed revision of CIP 10.03 to act as a recommendation to NCES, CIP, and SOC. See Table 5 for the revised CIP definitions. Note that Graphic Communications, General 10.0301 remains unchanged as a program title. Current degree programs falling under this CIP 10.0301 have comprehensive curriculum foci. The Graphic Communications Management 10.0302 program title and definition provides coursework across most or all areas of the taxonomy, but with more depth and emphasis on business and management (including industry-specific business development, management information systems, project management, and quality control). Both the Graphic Communications,

Table 5
CIP 10.03 Revised

CIP Revised 2023	Title 2023
10.03	Graphic Communications
10.0301	Graphic Communications, General
	A branch of technology with focus on the history, creation, production, management, and commercial application of visual products in digital and physical form. Study may include combinations of audio editing, business management, computer generated imagery, computer servers, content management, data management, distribution logistics, graphic design, intellectual property law, network management, package design, photography, print production, communication design, production management, project management, videography, and web development.
10.0302	Graphic Communications Management
	A branch of technology with focus on the production, management, and commercial application of visual products in digital and physical form. Study may include combinations of business management, computer generated imagery, computer servers, content management, data management, distribution logistics, graphic design, intellectual property law, network management, package design, photography, print production, communication design, production management, project management, videography, and web development.
10.0303	Graphic Communications Design and Technology
	A branch of technology with focus on the creation and production of visual commercial products in digital and physical form. Study may include combinations of audio editing, computer generated imagery, content management, data management, graphic design, intellectual property law, package design, photography, print production, communication design, videography, and web development.
10.0304	Animation, Interactive Technology, Video Graphics and Special Effects
	A branch of technology with focus on the creation and production of visual commercial products in digital form. Study may include combinations of audio editing, computer generated imagery, content management, data management, graphic design, intellectual property law, photography, communication design, videography, and web development.

General and Graphic Communications Management 10.0302 program divisions align best with most current bachelor's degree programs. Graphic Communications Design and Technology 10.0303 programs are defined as those focused mostly on the design and technical production of commercial graphics and media products. They include programs most focused on the concepts, practices, and technology skill sets needed to produce the print and digital products sold by graphic communications businesses.

Finally, Animation, Interactive Technology, Video Graphics and Special Effects 10.0304 would remain unchanged. The title remains contemporary, is currently recognized as a STEM program area by the Department of Homeland Security and is inclusive of programs that focus curriculum outcomes mainly on digital media, with little or no content on print production, management, or graphic design.

In making these recommendations, and canvassing the current CIP 2020 programs, it is noted that academic graphic communications as defined by ACCGC has commonalities with other existing first, second, and third-level CIP programs, including CIP 11.0 Computer and Information Sciences and Support Services, and its second-level programs, CIP 11.0801 Web Page, Digital/Multimedia and Information Resources Design and CIP 11.0803 Computer Graphics. Another example is the first-level CIP 50.0 Visual and Performing Arts, and its sub-programs, 50.0409 Graphic Design and CIP 50.0408 Web Page and Multimedia Design. The following table identifies these overlaps. The proposed CIP taxonomy revision does not attempt to redefine other segments of the CIP 2020 system, but rather to point out potential similarities with some aspects of other programs within the taxonomy. (Table 6)

Table 6

CIP 2020 Programs That Overlap with The Proposed CIP 10.03

Revised CIP	Revised Title	CIP 2020	Crosswalk to CIP 2020 programs
10.03	Graphic Communications		
10.0301	Graphic Communications, General	09.0702	Digital Communication and Media/Multimedia
	A branch of technology with focus on the history, creation, production, management, and commercial application of visual products in digital and physical form. Study may include combinations of audio editing, business management, computer generated imagery, computer servers, content management, data management, distribution logistics, graphic design, intellectual property law, network management, package design, photography, print production, communication design, production management, project management, videography, and web development.	11.0105	Human-Centered Technology Design
		11.0801	Web Page, Digital/Multimedia and Information Resources Design
		11.0803	Computer Graphics
		11.0804	Modeling, Virtual Environments and Simulation
		11.0899	Computer Software and Media Applications, Other
		11.1004	Web/Multimedia Management and Webmaster
		15.1307	3-D Modeling and Design Technology/ Technician
		15-1255	Web and Digital Interface Designers

Table 6 (continued)

Revised CIP	Revised Title	CIP 2020	Crosswalk to CIP 2020 programs
		15.1503	Packaging Science
		50.0401	Design and Visual Communications, General
		50.0402	Commercial and Advertising Art
		50.0406	Commercial Photography
		50.0409	Graphic Design
		50.0411	Game and Interactive Media Design
		52.0205	Operations Management and Supervision
		52.0207	Customer Service Management
		52.0208	E-Commerce/Electronic Commerce
		52.0211	Project Management
		52.1801	Sales, Distribution, and Marketing Operations, General

Recommendations and Conclusion

The Career Information System (CIS, 2023) and the Institute for Educational Sciences (IES, 2023) were developed in partnership with the U.S. Department of Labor's Bureau of Labor Statistics and the Employment and Training Administration. As previously explained, NCES maintains a crosswalk that aims to match occupations with specific degree programs defined in the CIP taxonomy. This data enables data-driven institutional and government policy decisions on college programming, as well as student decisions on majors and careers. The outdated CIP 2020 definitions for 10.03 Graphic Communications likely negatively impacts enrollments in these programs of study. Most guidance counselors use or direct students to the Career Information System (CIS) for program exploration and degree selection (CIS, 2023). Note that within this system, Graphic Communications CIP 10.03 is not even included as a field of study, presumably due to the crosswalk careers being outdated. However, examples of related fields can be found, like those falling within the CIP taxonomy under 11.0 Computer and Information Sciences and Support Services.

To recommend updated crosswalks for CIP 2020 to SOC 2018, a list of job titles compiled from ACCGC accredited school's graduate survey data was cross-referenced with the full list of SOC 2018 occupations. Table 7 shows updated recommended crosswalks between proposed CIP 10.03 programs and existing occupations defined in the SOC 2018. Note that the crosswalks shown in the table are comprehensive to the Graphic Communications, General 10.0301, with the other 10.03 subprograms not included but likely to have more narrow subsets of these same crosswalks to SOC occupations.

Table 7

CIP Revised to SOC

Revised CIP	Revised Title	SOC 2018	Proposed Crosswalk Occupations
10.03	Graphic Communications		
10.0301	Graphic Communications, General	11-1021	General and Operations Managers

Table 7 (continued)

Revised CIP	Revised Title	SOC 2018	Proposed Crosswalk Occupations
	A branch of technology with focus on the history, creation, production, management, and commercial application of visual products in digital and physical form. Study may include combinations of audio editing, business management, computer generated imagery, computer servers, content management, data management, distribution logistics, graphic design, intellectual property law, network management, package design, photography, print production, communication design, production management, project management, videography, and web development.	11-2011	Advertising and Promotions Managers
		11-2021	Marketing Managers
		11-2022	Sales Managers
		11-3021	Computer and Information Systems Managers
		11-3051	Industrial Production Managers
		13-1051	Cost Estimators
		13-1082	Project Management Specialists
		15-1254	Web Developers
		15-1255	Web and Digital Interface Designers
		15-1299	Computer Occupations, All Other
		17-3013	Mechanical Drafters
		25-1194	Career/Technical Education Teachers, Postsecondary
		27-1014	Special Effects Artists and Animators
		27-1024	Graphic Designers
		27-3099	Media and Communication Workers, All Other
		27-4021	Photographers
		41-4011	Sales Representatives, Wholesale and Manufacturing, Technical and Scientific Products
		43-9031	Desktop Publishers
		43-9032	Prepress Technicians and Workers
		27-4011	Audio and Video Technicians
		27-4099	Media and Communication Equipment Workers, All Other

The current CIP 2020 10.03 Graphic Communications taxonomy used by the National Center for Education Statistics has been unchanged for nearly a quarter of a century and inaccurately describes current content within associate degree and bachelor's degree Graphic Communications programs. The ACCGC initiated an expert group process documenting and establishing that the modern academic graphic communications field has largely transformed since 2000, now covering a wide range of new content.

It is incumbent upon current academic and industry graphic communications organizations to act in unison to assure that US Department of Education-related datasets are current. The outdated CIP 2020 taxonomy and definitions largely misrepresent current college degree programs identified as CIP 10.03 Graphic Communications and the US Department of Labor-defined occupations to which these programs lead. Further, the current SOC 2018 crosswalks to CIP 10.03 represent only a narrow set of trade occupations, some of which are no longer considered viable. These inaccuracies are likely to reflect negatively on graphic communications-related majors for those researching career and degree program through existing databases. Additionally, institutional and government entities rely on these inaccurate datasets for policy decisions, which may lead to negative outcomes for those current programs classified under CIP 2020 10.03.

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Cyanotype: An Alternative Photographic Process for Graphic Communications Students

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Abstract

Graphic communications lab courses are primarily focused on hands-on learning to prepare students for careers in production, marketing, and content creation. With the increasing availability of "auto-everything" digital cameras, photography education has drastically changed from its film and darkroom roots (Macdonald, 2012). Much can be taught with modern automated tools but certain fundamentals like how lighting, camera settings, and chemistry interact have become increasingly more difficult to teach without experiencing the traditional process. This paper looks at cyanotype, an alternative photographic process that can bring back a simple hands-on analog experience while inspiring students to see photography at the intersection of science and art. Cyanotype does not require a film camera or a darkroom. The required chemistry is simple and non-toxic and development and fixing is done in tap water. The learning curve is simple enough for elementary school students to successfully participate yet can provide opportunities for more complex lessons in light, exposure, paper composition, and simple chemistry for older students.

Keywords: Cyanotype, Alternative processes, Photography, Graphic Communications, Teaching

Introduction

Almost two-hundred years after Sir John Herschel discovered the chemistry needed to create "blue prints," cyanotype is one of the most popularly practiced alternative photographic processes today (Anderson, 2019). Using a combination of only two chemicals, ferric ammonium citrate and potassium ferricyanide, cyanotype produces vibrant and instantly recognizable, blue and white images (Abrahamson, 2001; Anderson, 2019; Siegel, 2019). In fact, in 1843 Anna Atkins used the cyanotype process to create and publish the first photo-illustrated book, British Algae (Atkins, 1843). The process later became popular for documentation and duplication in cartography, postcards, and architectural drawings (Anderson, 2019; Ware, 1999). In the modern graphic communications classroom, the cyanotype process has several advantages over traditional silver gelatin processing. For example, cyanotype chemistry is simple and non-toxic, a light tight darkroom is not necessary, images are developed in tap water, and sunlight can be used for exposure.

Some may argue that exploring historic processes, no matter how "easy" they are to integrate, holds little value for modern students. However, there can be powerful lessons when computer-based tools are removed and learning is stripped down to manual tools and principles. In photography, this can emphasize a deeper understanding of how exposure, light, and composition work, which can then broaden student's skills and creativity when using modern, more capable tools (Walker, unpublished). Not only can analog processes aid in teaching fundamentals in a hands-on manner, they also are a compelling way to connect graphic communications to other general education content such as chemistry, physics, and math. One study showed that a lesson in cyanotype could be used as an interdisciplinary approach to teach natural science knowledge and visual arts to children from elementary school through high school age (Kmet' et al., 2023). Another study used cyanotype in a public health education forum to show the effectiveness of sunscreen application to protect from UV exposure while also demonstrating the difference in harmful exposure experienced in direct sun in contrast with shade (Turner et al., 2014).

This paper investigates how equipment and facilities already commonly found in graphic communications labs such as photo processing and layout software, transparency printers, UV exposure units, paper stock rooms, and sinks can be used to incorporate one analog process, cyanotype, back into the photography curriculum.

Chemistry and Substrate

There are two formulas commonly used in cyanotype today: the classic formula (ferric ammonium citrate and potassium ferricyanide) and the newer formula (ferric ammonium citrate is replaced with ferric ammonium oxalate) shortening exposure times (Anderson, 2019). In both cases, the dry chemicals are mixed with water and then stored separately until use. Prior to coating the substrate, the two chemicals are mixed in a 1:1 ratio in the quantity that will be used immediately for coating. The two solutions can be purchased commercially in bottles labeled formula A and formula B, ready to mix before use. There are also sheets of pre-coated paper available for purchase. All that is required to apply the sensitized liquid is a brush or solid glass rod. Foam or hake brushes that are at least 2.5" wide are inexpensive and work well for application. Once the chemicals are mixed, apply them to the substrate and leave it to dry for at least an hour in a "dimroom," away from sources of UV light. The drying step can be skipped and the sensitized paper used immediately if creating photograms.

A wide variety of papers are commonly available in graphic communications labs so this study focuses on paper as the primary substrate. However, cyanotype can also be printed on different substrates including textiles, wood, metal, glass, and canvas. Beginning students can print cyanotype on almost any paper but if picking a paper for high quality prints, several factors should be considered: type of fiber, additives, pH, color, and weight. Natural fiber papers work best such as 100% cotton or linen. Avoid paper with additives like optical brighteners, buffers, or bleach. For cyanotype, alkaline is detrimental to the archival quality of the print so avoid "acid-free" paper and seek out paper with a pH of 7 or less (Ware, 1999). Different colors of paper can be used but the "whites" in the monotone image will be paper-colored and the underlying color may impact the blue tones in the final print. Beginners tend to do better with heavier papers, 120-140 lb, but even very thin washi papers can be used if handled with care during the water wash. If appropriate paper is not found in the lab, high-end watercolor paper such as Arches, Hahnemühle, or Canmore can be purchased in bulk sheets or by the roll and trimmed down to size prior to coating.

Software and Negatives

Cyanotype prints can be divided into two categories: photograms and contact negative prints, as displayed

in Figures 1 and 2. These two techniques can also be combined to create unique visual effects. Photograms are created when a physical object is placed on top of the sensitized paper before exposure (Brown & Phillips, 2010). Early cyanotypes by Anna Atkins and others were made by aligning botanicals such as algae, leaves, and flowers on the paper. Atkins used photograms to document algae specimens in her early publications (Atkins, 1843). Photograms can also be made with inorganic objects such as lace, plastic figures, nuts and bolts, etc.

Figure 1
A set of three cyanotype photograms mixing botanicals and inorganic items.

Cyanotypes created using contact negatives are closer in resemblance to traditional photographs. But unlike using an enlarger in the darkroom, the resulting print will be created by placing the negative in direct contact with the photosensitive paper. This will produce an image the same size as the original negative. With this method, traditional 35mm silver gelatin negatives would produce very small cyanotypes. A larger format camera could be used, but today, it is more common to use an inkjet printer and transparency paper.

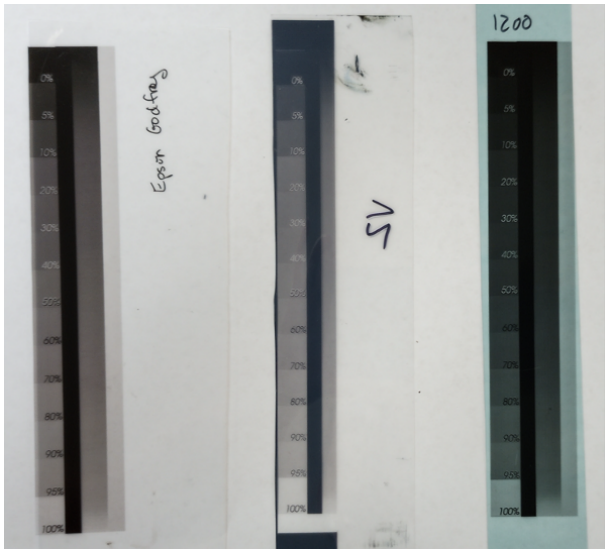
Adobe Photoshop or other similar photo editing software can be used to prepare the negative files from photographs captured with any digital camera. The cyanotype has a reputation of not capturing the full range of density seen in traditional silver gelatin prints but that can be controlled through three factors: quality of the substrate, exposure time, and properly preparing the transparency negative. Each substrate behaves differently with the synthesized iron process and will require testing to ascertain the best settings for baseline exposure and tonal range (Anderson, 2019; Ware, 1999). A step wedge can be used to ensure good exposure. Precise steps in the photo editing software will ensure good results when preparing the image to print the transparency film. In short, the post-production adjustments include: changing the mode to grayscale, applying a curve and a color profile, inverting to negative, and reducing ink density in the print settings window (Ware, 1999). Any touch-ups on the image such as cleaning up dust or burning and dodging elements in the frame should also be done prior to outputting the negative. Note that the resulting photograph will look rather overexposed on screen before inverting. This is intentional to ensure enough density in the shadows for contact printing.

For this study, we explored printers available currently in the Clemson University Department of Graphic Communications building. Going forward, what each piece of equipment is commonly used for in the lab,

Figure 2
A cyanotype made from a contact negative created from a photograph taken on a digital camera.

outside of how it was used for the cyanotype process, will be noted. Digital printers tested for this study included an Epson SureColor P7570 roll-fed printer (used for color separation proofs for screen printing), a Kodak Trendsetter NX Mid (used to create negatives for exposing screens and to etch metal lithography plates), and a sheet-fed Epson SureColor P800 (used for general printing as any standard sized paper can be used). All three of the printers tested produced usable tint scale transparencies as depicted in Figure 3.

Figure 3
Examples of the tint scale printed on the roll fed Epson, sheet fed Epson, and the Kodak Trendsetter, from left to right.

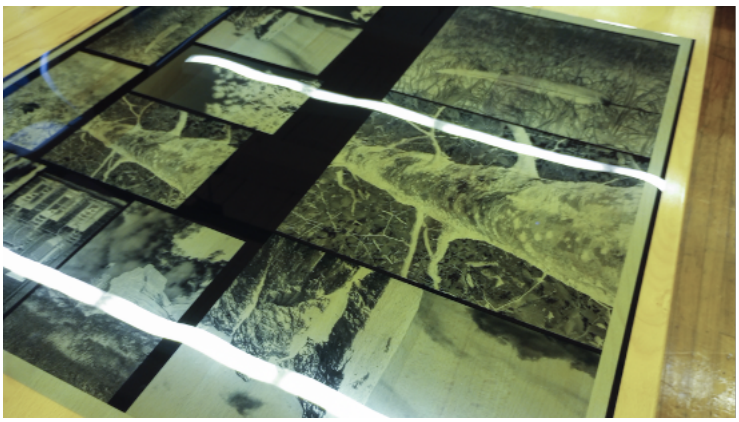


With Epson printers, the recommended ink set is Ultrachrome to ensure enough density to produce the full tonal range. The roll-fed printer was loaded with Epson CrystalClear film for color separation proofing. On this film, the resulting transparency negatives took a while to dry and were initially quite sticky. The resulting negative was susceptible to scratches and water damage, which melted the negative making it unusable. This was not the case with the sheet fed transparencies that were individually loaded into the other Epson printer. These sheets were specifically made for the cyanotype process (eg. Pictorico, Arista, Fixxons, etc., we used the Fixxons brand). The Kodak Trendsetter produced 30" x 30" negatives on Kodak DITR film. Figure 4 shows an example where multiple photographs were ganged together before printing and trimmed afterwards. The resulting negatives were very resistant to scratches and printed well with cyanotype. This is a good option for creating a batch of negatives as long as a large rotary trimmer is available.

Exposure

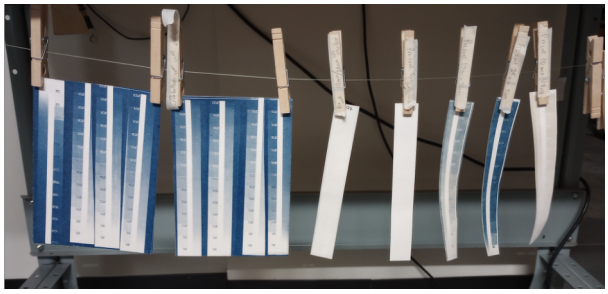
For exposure, we explored both natural sunlight and UV exposure units in the lab. Examples from these tests are depicted in Figure 5. Sunlight exposure is less consistent compared to using an exposure unit, but it is free to use when the weather cooperates. Times vary widely for outdoor exposures depending on weather, time of year, and latitude. For our location, exposure during a sunny, summer day ranged from 6-10 minutes. For either method of exposure, using a contact frame or "sandwiching" the paper and negative between two sheets of glass

Figure 4
A 30" x 30" file ganged for printing (before inverting) on the left and a printed sheet on the right.



will ensure consistent contact and a clean exposure. This is especially important outside where wind can disrupt your exposure by blowing away or shifting the negative or physical items in the photogram.

Figure 5
Sample of different exposures labeled and hanging to dry.



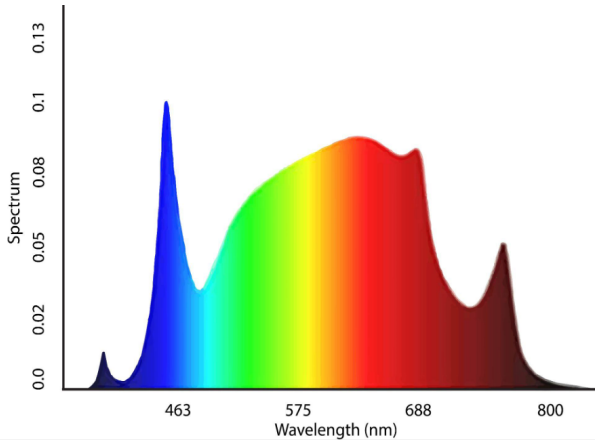
Cyanotype requires long-wave ultraviolet or UVA light for exposure, specifically a wavelength range of 320-400 nm or nanometers (Ware, 1999). Bulbs with this wavelength are commonly sold for other graphic communications applications. There were four devices that emit UV in the lab: a Lawson LED-5000 Screen Printing Exposure Unit (used to expose screens for screen printing applications), the X-Rite Judge QC Light Booth unit (used to demonstrate the effects of metamerism), a consumer-grade full spectrum light system (used to simulate the damage of sun exposure for research contexts), and the DuPont Cyrel 1000 ECLF flexo thermal plate processing unit (used to expose flexographic plates), as summarized in Table 1.

Table 1
Wavelength information provided by each manufacturer.

Unit	Wavelength
Lawson LED-5000 Screen Printing Exposure Unit	390-405 nm
X-Rite Judge QC Light Booth	350-400 nm
FECiDA Full Spectrum Grow Light	400-800 nm, see Figure 6
DuPont Cyrel 1000 ECLF flexo thermal plate processing unit	UV-A (360-380 nm) UV-C (254 nm)

Three of the devices tested did not work for cyanotype exposure. The Lawson LED-5000 Screen Printing Exposure Unit unit uses UV LED bulbs (390-405 nm) and these did not expose the cyanotype. The X-Rite Judge QC Light Booth has the ability to switch between bulbs to demonstrate different lighting situations (our unit had bulbs for D65, Tungsten A Halogen to represent lighting at home, a compact fluorescent bulb to mimic potential in-store lighting, a UV-A bulb, and an LED bulb L940) but the single UV-A blacklight bulb was not powerful enough to expose the cyanotype even with exposure times in excess of an hour. This unit might be functional if retrofitted with all UV-A bulbs but then it would not work for its current use. The consumer grade full spectrum light system did not provide enough in the UV-A part of the spectrum to effectively work for cyanotype. See Figure 6 for the manufacturer-provided wavelength produced by this grow light.

Figure 6
LED spectrum for the full spectrum light provided by the manufacturer. Recreated from manufacturer's original graph for clarity: https://www.fecida.com/product/cr600-1000w-led-grow-light/



Cyanotype exposure was successfully attained with the DuPont Cyrel exposure unit which has four different exposure options. The upper exposure tray is traditionally used to expose the front of a flexographic plate and has UV-A tube bulbs (360-380 nm). The lower unit is used to light finish the flexo plates and has three different settings: UV-A (360-380 nm) only, UV-C (254 nm) only, and one that engages both sets of bulbs. Three of the exposure options worked, excluding the UV-C only setting. The UV-A only in the light finish tray was the quickest and most efficient option with quality exposure in as fast as two minutes. Both trays have optional vacuum frames but to be consistent a glass "sandwich" frame was used on all the tests.

Development and Finishing

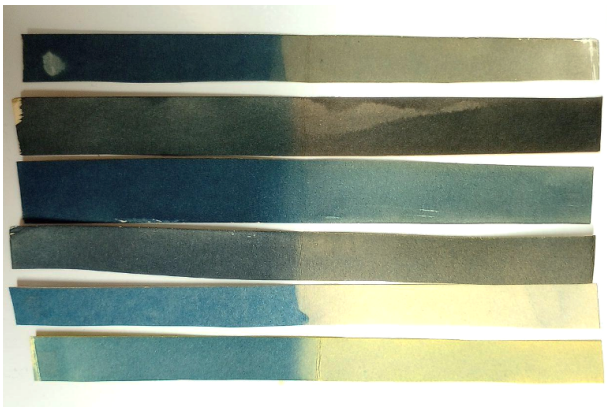
Development is very simple with cyanotype, all that is needed is tap water and a tray or a filled sink to rinse the exposed print. Rinsing takes around ten minutes and is finished when the water is no longer tinted by the unused chemistry washing off of the

paper. Full blue tones will develop during drying but for a preview of the finished image, a splash of hydrogen peroxide can be added to the final minute of the wash time. Prints can be dried flat on a screen or hung on a clothesline with wooden clothespins.

After drying, cyanotypes can also be bleached with diluted washing soda (sodium carbonate) and toned with common household supplies containing tannic acid (tannins) such as instant coffee, green or black tea, walnut husks, or herbs such as rosemary (Anderson, 2019). This process can take the recognizable Prussian blue tones and create yellows, purples, browns, and other blues as illustrated in Figure 7. It can even be used to create a multitone print although it can not replicate the full spectrum of colors we are used to seeing in photography (Alves, 2010).

Figure 7

Examples of colors achieved from bleach + toning (right) and toning only (left). From top to bottom: thyme, green tea, coffee (used grounds), coffee (instant), pecan shells, and tumeric.



Conclusions

Analog photography curriculum has been removed from the curriculum in many graphic communications departments. With a renewed push towards more interactive, hands-on lessons combined with the challenges presented when teaching photographic concepts with "auto-everything" cameras, cyanotype might be a good option to bridge the gap between traditional analog processes and modern photography. Unlike silver gelatin photography, cyanotype uses regular heavyweight papers, simple non-toxic chemicals, UV exposure from the sun or an exposure unit, and a "dimroom" instead of the traditional darkroom. Many people remember fondly the first time they saw a photograph "magically" emerging on paper during the development process and younger students are expressing an increased interest in using traditional processes or "retromedia" like film and polaroids (Magaudda & Minniti, 2019; Schneider, 2023). A memorable, hands-on learning experience can be reinstituted in the graphic communications classroom by using a simple, accessible process, cyanotype.

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» Line art should be in a vector format.

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