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Jeremy Dickerson, EdD & Joseph Winslow, PhD

Aaron C. Clark, EdD & Jeremy V. Ernst, EdD

Mitchell Henke, PhD, Elinor Blackwell, EdD, Cynthia Thompson, PhD, & Dave Dillon, EdD

Sonya R. Draper, PhD & Mitchell Henke, PhD

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Vincent W. Childress, PhD, Editor
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Guidelines

The *Technology Education Journal* is a refereed journal published by the North Carolina Council on Technology Teacher Education. The Journal is published on the World Wide Web by the Technology Education program at Appalachian State University in Boone, North Carolina, at <http://tec.appstate.edu/technology-education/professional-organizations>. The referee process is a blind, peer review process. The Journal is not an instructional technology journal. Its focus is primary and secondary school technology, design, and engineering teacher education and primary and secondary school technology, design, and engineering education. Submissions on topics related generally to technology, design, and engineering are welcome *as long as* they are linked to curriculum, instruction, and/or pedagogy *that will inform teacher education*. Manuscripts should follow APA format with the exception of line spacing; single spacing is requested, please. Submissions may be emailed to Vincent Childress at childres@ncat.edu.

Interactive Whiteboards in K-12 Classrooms: Tools for Teaching Technology

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Introduction

Interactive whiteboards (IW) are an emerging technology already in thousands of schools across the United States. These tools are often referred to by their name brands such as Smartboard© and/or Promethean Activeboard©. Smith, Higgins, Wall, and Miller (2005) describe IWs as large, electronic, touch-sensitive boards, which control a computer connected to a digital projector. Even though these technologies may already be available in many classrooms, they are often underutilized. Interactive whiteboards are bought by many school systems in an attempt to enable teachers and students to interact, discover, and learn with technology and to create an active and visually stimulating classroom. The acquisition of IWs provides teachers opportunities to move away from passive methods of technology integration such as the basic display of PowerPoint© presentations or the viewing of websites in the classroom.

If properly used, IWs can promote technology, design and engineering education in classrooms across various curricula and grade levels. In the limited budget climate in which most schools now operate, the integration of a single IW can be a cost effective technology purchase that can have a transformative effect on teaching and learning. Elementary grades in particular host a heavy concentration of these devices across the United States because of their simple touch interface. In fact, Horry County Schools in Myrtle Beach, South Carolina recently installed IWs in every elementary classroom.

This paper presents survey data on pre-service teacher education majors in reference to the use of IWs during their own K-12 education (N= 105). Additionally, this paper will provide examples of downloadable IW software applications that can be used to teach technology, design, and engineering so that readers who work in classrooms or prepare classroom teachers will have new tools and ideas for using IW technologies to promote technology education principles. These examples are aligned with the International Technology and Engineering Educators Association's (ITEEA) 2007 Standards for Technological Literacy, particularly standards 8, 9, and 11, which target design and engineering concepts for K-12 students.

Related Literature

Interactive whiteboards can be used to develop foundational skills such as problem solving, creativity, data collection, and innovation, which are core principles in science, math, technology and engineering. There is strong support for instructional tools, activities, and an integrated curriculum within the areas of mathematics, science, and technology (Wescott & Leduc, 1994). The scientific, technological, and academic communities have a vital role in supporting education reform efforts and encouraging young people to study and pursue careers in science, technology, engineering, and mathematics (Kesidou & Koppal, 2004). In today's workplace, knowledge of the inherent interrelatedness of math, science, technology and engineering is needed to solve many current and future problems. It helps students to realize the

connections between these disciplines when they engage in learning activities that cause them to apply their knowledge while seeking solutions to realistic problems (Park, 2006). Technologies like interactive whiteboards present opportunities for K-12 schools and universities to teach children and teachers about technology and its benefits by putting technology literally in their hands.

Research indicates that using an interdisciplinary or integrated curriculum provides opportunities for more relevant, less fragmented, and more stimulating experiences for learners in science, math, technology and other areas (Frykholm & Glasson, 2005; Koirala & Bowman, 2003; Jacobs, 1989). In a technology-rich society, it is critical to develop students who have a broad base of knowledge and skills so that they may be successful in dynamic and diverse workplaces. In an era dominated by mathematics, science, and technology, it is essential for classroom teachers to be equipped with the knowledge and skills to deliver meaningful instruction (Furner & Kumar, 2007). Technological, scientific, and mathematical literacy go hand in hand. Technologists use math and science, scientists use math and technology, and mathematicians use science and technology (Park, 2006). The acronyms —STEM” and —TIDE” have become popular terms in education today. STEM (Science, Technology, Engineering, and Mathematics) and TIDE (Technology, Innovation, Design, and Engineering) are commonly used acronyms to describe the collective set of similar and/or related areas of knowledge and skills. As teachers at all levels continue to prepare students to live and work in the 21st Century, it is vital to attempt and connect these disciplines with classroom activities.

Interactive Whiteboards in K-12 Classrooms

Kennewell, Tanner, Jones, and Beauchamp (2008) outline the use of IWs as a way to improve many aspects of classroom activity. They note key attributes of IWs as flexibility, versatility, multimedia use, multisensory presentation, efficiency in planning and document control, and interactivity and participation by students. The authors recently surveyed 105 traditional college students in teacher education programs and found that 69% had experience with IWs during their K-12 education. After further investigating the use of these technologies in local schools, the authors also discovered that the school district nearest their university had over 1100 IWs installed, and that 100% of the elementary classrooms in the district have IWs. This strengthens reports by Bell (2002), Kent (2004), Tanner and Jones (2007), and Hodge and Anderson (2007) that note widespread adoption by teachers and large-scale implementation across many school districts in the U.S. and other countries. In the United Kingdom, Kitchen, Mackenzie, Butt, and Finch (2006) reported that over two thirds (69%) of the primary school teachers surveyed used IWs in over half of their lessons. Such pronounced inclusion of these tools in so many schools merits continued research on meaningful, student-centered approaches to integration.

Aligning Interactive Whiteboard Lessons with ITEEA Standards

Teachers with IWs in their classrooms can utilize these tools to teach many STEM and TIDE concepts with visual, interactive lesson resources that are often free for download or for purchase at a reasonable price. Although interactive whiteboards have been installed in many classrooms over the last decade (Tanner & Jones, 2007), unfortunately, teachers often do not maximize their potential. Indeed, without proper training, adequate resources, and advanced planning, teachers tend to use these devices only as basic presentation screens. Teachers with IWs in their classrooms should instead leverage these opportunities to utilize creative and

specialized resources to teach TIDE skills, which are essential for students to develop as they prepare to live and work in the digital age.

Standards for Technological Literacy - Standards 8, 9, & 11 - Design & Engineering

This section focuses on specific uses of IWs for teaching concepts that are foundational to engineering and design education. The ITEEA Standards in the list below are followed by descriptions and URLs of downloadable IW software titles useful for teaching design and engineering concepts.

Standard 8. Students will develop an understanding of the attributes of design.

Standard 9. Students will develop an understanding of engineering design.

Standard 11. Students will develop the abilities to apply the design process.

As previously mentioned, two manufacturers currently dominate the IW market in public education—Smart (Smartboard©) and Promethean (Activboard©), and even though these devices provide similar functionalities, they are proprietary in terms of hardware and software. Once installed in a classroom, teachers can (under) utilize it as a touch-activated projection screen, or they can design customized lessons that integrate proprietary resources, many of which can be downloaded as “ActivLessons,” which are pre-packaged templates that promote engagement with technology while learning about technology. The online community for sharing or purchasing these interactive lessons is very large; there are two main sources: 1) <http://www.prometheanplanet.com> and 2) <http://exchange.smarttech.com>. The items in the bulleted list below are just a few examples of technology, engineering and design related lessons.

- Structures & Mechanisms & CAD/CAM lessons by Primary Engineer – Lesson packs use what the company calls a ‘_STEM by Stealth’ and ‘_thinking, designing and doing’ approach to design and technology by embedding practical math and science in ‘_design and make’ activities which incorporate meaningful design concepts and techniques.
- SSC Prototyping by Bloodhound – Allows students to interact with technology as they think through problems based on information and thematic instruction from a 1000+ MPH, land speed, world record-holding jet car.
- E-Gadget Factory - The e-gadget topic packs are designed to support the teaching of various technology topics across the curriculum. This is a series of lesson packs that provide teachers with interactive and engaging activities to support, explain, model and give practice to many engineering, technology, and design concepts, skills and processes.
- The Iron Bridge – A lesson that includes a showcase of the history and design of the world's first iron bridge in Shropshire, UK.
- Nuffield Primary Design & Technology – The Nuffield ActivLessons are units for teaching basic design and technology concepts to very young children. Each ActivLesson consists of a hands-on project with stepwise teaching guidance, vocabulary, resources and curriculum links to other subjects.

- Parallel and Series Circuits - Parallel and series circuits are defined and explained and examples and student activities are provided.
- Energy Efficiency – Students learn about energy as well as the relationship of work input and work output as they calculate efficiency in a simple machine. Students gain knowledge about greener thinking as they identify energy loss and ways to reduce it.

Conclusion

The materials listed above could be used to teach a variety of design and engineering principles across numerous age and grade levels. The authors encourage technology educators as well as teachers of other disciplines to seek ways to use IWs for more than a projection surface and to utilize the myriad online resources to enhance their classrooms with technology. Given that many students who are currently studying to be classroom teachers were exposed to IWs in K-12 and the fact that so many schools in the United States and abroad are purchasing these tools, it is vital that the technology education community take advantage of any opportunity to utilize them to promote the teaching and learning of design, engineering, and technology. Interactive whiteboards may thus be an effective vehicle for integrating STEM and TIDE beyond the walls of the technology education lab and into more traditional content classrooms.

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Functional Priorities of Students in an Introductory Engineering Design Graphics Course

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Introduction

Every academic year, students and faculty share the ritual of learning about each other. Faculty in particular hear all of the latest social aspects about the incoming freshman and how the generations differ. The current groups of students in the graphics classes are termed by sociologists as Millennials. These students are generally between the ages of 13 and 29, and bring the following to the authors' classrooms: First, they are the most ethnically and racially diverse cohort of youth in US history. These students are politically progressive and more inclined to trust in institutions than previous generations. Millennials are the first generation in human history to regard behaviors such as tweeting and texting, and using Facebook, YouTube, Google and Wikipedia, as everyday parts of their social lives, and in their search for truth and understanding (Keeter & Taylor, 2009). Considering this new group of students in their classes, and understanding that more students from all generations are coming back to school for a better life, the authors of this study wonder if these students are visually oriented, and if so, why and how do they see the use of visualization in their everyday lives. According to Justice and Dornan (2001), to be more effective in the classroom, teachers need to provide effective classroom instruction and appropriate learning assessments; but it is also important to understand the motivations, learning styles, and overall life strategies of the students. They come to teachers and advisors with academic stress and anxieties based on time management (or the lack thereof) and the need for leisure satisfaction (Misra & McKean, 2000). So, how do students function day-by-day; how do they spend their time as students? How would they prefer to spend their time? And, in terms of graphics, when asked to visually represent this information, how would they do it and why do they use a certain graphical form? Do students truly understand the role technology has in their ability to understand and use communications and seek information? These three major topics were surveyed within this research study, so that the professionals in technical graphics can begin the process of understanding what students know coming into classes, their biases, and how they view the information being taught. This is part of a continued thematic research that tries to identify teaching areas in graphics education and the best practices for doing so.

Background

This study was designed to continue the research efforts of the authors in graphics education and its need for further development. The authors strongly believe in students' abilities to represent all forms of visual communications but with particular emphasis on visual display of scientific and technical information. The authors are faculty within the newly established program in the College of Education at North Carolina State University called Technology, Engineering and Design Education. This new program has brought together both the teacher education and the engineering design graphics faculty in the Department of Science, Technology,

Engineering and Mathematics Education for a true STEM (science, technology, engineering, and mathematics) focus for both teaching and research. Partnered with this new program are faculty from both the College of Engineering and the College of Design. This new program facilitates the general education course for the university entitled "Foundations of Graphics (GC 120)." Although originally written for engineering students, this course is now re-developed into a general modeling and visual arts course for any major on campus. The course description is as follows: *"Introductory course providing orientation to language of graphics for students majoring in any field. Designed to help develop ability to use CAD within the context of a concurrent design process to understand how everyday objects are designed, analyzed and created. Emphasis placed on decision-making processes involved with creating geometry and development of modeling strategies that incorporate intentions of designer"*(North Carolina State University, 2010). The authors selected this course for this study for its easy access to a general student population and its general content and application that students learn while taking the GC 120 course.

Methodology

The survey was given to students taking an introductory engineering design graphics course at North Carolina State University during the 2009 fall semester. The instrument originally came from a university exercise that was used to determine faculty functional priorities and time allocations. The researchers for this study found that since the exercise required faculty to both list information and generate visual displays based on the listed information, it would be a good instrument to determine how students would visually show and present their information as well. This study is part of a continued thematic research that focuses on graphics education and the need to provide such understandings to students for success in the workplace. Also, this study continued research on how students spend time and energy, and their appreciation for using technology, graphics and visual communications. The university exercise instrument was combined with ten Likert scale questions that have been previously used to identify perceptions and use of graphics. Also, simple demographic information was added to the instrument for determining the general characteristics of the study sample (see Appendices for Example Instrument). This re-developed instrument was then reviewed by peers for usability and accuracy and edited based on reviews. Participants were selected from two course sections with the same instructor for consistency of implementation of the survey instrument, and engineering design graphics fundamentals that could affect the participant response. A total of 70 undergraduate students and one graduate student participated in this study.

Demographics

Four basic demographical variables were collected: 1) current academic program of participants, 2) age, 3) gender, and 4) current educational status (graduate or undergraduate). Frequency tables for the study sample were formed based on these four demographic variables. The single sample in this study is comprised of 71 university student participants. The sample represents a variety of majors ranging from engineering to zoology (see Table 1). The majority of students participating in this study were engineering majors. The engineering students are enrolled in a number of disciplines within the College of Engineering including aerospace, chemical, civil, electrical, mechanical, and textile engineering. The categorical breakdown is not specified in the frequency tables due to the item on the instrument being free-response. Many of the participants simply entered "engineering" without a designated discipline.

The majority of the students in the sample were ages 18-21, followed by ages 22-29 (see Table 2). The 18-21 demographic is typical of introductory undergraduate course offerings, as they are recommended to both entering undergraduate engineering and technology education students. The introductory graphics course serves as a prerequisite for many courses found in the secondary level of these majors. The prerequisite requirement paired with the high proportion of traditional students at North Carolina State University results in a common distribution of age.

Table 1. Frequency Table Results for Major

Age	Frequency	Relative Frequency
Engineering	57	0.80
Technology Ed.	4	0.055
Comp. Science	3	0.04
Physics	1	0.015
Biochemistry	1	0.015
Math Ed.	1	0.015
Zoology	1	0.015
Ind. Design	1	0.015
1 st Year College	1	0.015
No Answer	1	0.015

Table 2. Frequency Table Results for Age

Age	Frequency	Relative Frequency
18-21	62	0.87
22-29	9	0.13

The 71 participants were predominately male. The study sample consisted of only 11 female participants (see Table 3). Considering that 57 of the 71 participants were engineering majors, a relative frequency of 0.16 is reflective of North Carolina State University's College of Engineering female majors of 16.7% (North Carolina State University, 2009).

Table 3. Frequency Table Results for Gender

Gender	Frequency	Relative Frequency
Male	60	0.84
Female	11	0.16

The educational status demographic is typical for a similar primary reason as the age demographic of the participants (see Table 4). The introductory engineering graphics course is recommended and predominately taken by entering undergraduate engineering and technology education students. However, the course is available to education graduate students pursuing initial Technology, Engineering, and Design Education licensure or any other graduate student on an audit basis.

Table 4. Frequency Table Results for Educational Status

Status	Frequency	Relative Frequency
Graduate	1	0.01
Undergraduate	70	0.99

Findings

The average, variance, standard deviation, standard error, median, and range of the 10 Likert scale items on the Functional Priorities agreement scores for the 71 engineering/technical graphics student participants is found in Table 5 (See Appendices for Example Instrument). Most notably, Item 3: “Learning technology is too difficult for me” has the lowest comparative mean of the 10 Likert scale items. The variance and standard deviation of Item 9: “I would like to learn more about using technology to design graphics” is large in comparison to the variance and standard deviation of the other nine items. This indicates a larger spread of the engineering/technical graphics student participant agreement for this particular item. Additionally, the standard error of Item 9 is greater than the standard error of the other Likert scale items. This uncovers a larger fluctuation in agreement from participant to participant for the item. The medians of the 10 items exhibit minimal deviance from the means suggesting a somewhat symmetrical participant agreement distribution. The range is calculated based on the minimum and maximum ratings on the 10 Likert scale items. The sizable range for Item 9 iterates the degree of difference in variability of engineering/technical graphics student participants’ assessment of this item.

Supplemental qualitative questions were asked to student participants. The first supplemental question asked participants “Where do you spend your time and energy and what percentage of time do you spend on each task?” Several themes emerged from the qualitative review. Students tend to spend high proportions of time studying, attending class, and sleeping, while lesser proportions of time noted are spent with friends and exercising.

The second supplemental question asked participants, “How you’re CURRENTLY spending your time and energy. (Show in a visual display).” The same themes identified in the first supplemental question emerged. Students tend to spend higher portions of time studying, attending class, and sleeping. However, activities identified with lesser proportions in the first supplemental question were not specifically identified in the participant’s visual display created for the second supplemental question.

The third supplemental question asked, “How WOULD YOU LIKE (or do you need) to be spending your time and energy. (Show in a visual display).” Again, studying, attending class, and sleeping were themes in the participant visual displays. The qualitative review of the third supplemental question also identified social activities as a category in which students would like to or feel a need to participate.

Participants were then asked, in the fourth supplemental question, “Why did you choose the visualization you did for representing current time spent?” Followed by the fifth supplemental question that asked, “Why did you choose the visualization you did for representing how you would like to spend time?” These are paired together in the qualitative review because they have identical continuing themes. Students largely used pie charts to represent their current time spent and how they would like to spend their time. They identified that pie charts were selected for two primary reasons: 1) Pie charts are a simple way to represent something for which the sum is 100, and 2) Pie charts are easy to develop and comprehend.

Table 5. Functional Priorities Summary Statistics*

Column	n	Mean	Variance	Std. Dev.	Std. Err.	Median	Range
Q#1	71	4.41	0.35	0.59	0.07	4	2
Q#2	71	4.41	0.50	0.70	0.08	5	3
Q#3	71	1.674	0.76	0.87	0.10	2	4
Q#4	70	4.58	0.24	0.49	0.05	5	1
Q#5	71	4.22	0.37	0.61	0.07	4	2
Q#6	71	3.77	0.77	0.88	0.10	4	4
Q#7	71	4.07	0.52	0.72	0.08	4	3
Q#8	71	4.08	0.59	0.76	0.09	4	3
Q#9	71	3.70	1.06	1.03	0.12	4	4
Q#10	71	4.04	0.58	0.76	0.09	4	4

*(See Appendices for Example Instrument)

Conclusions

This study was designed to identify the functional priorities of student daily life, while simultaneously asking for graphical representation preferences for time display information. Overall, the researchers of this study identified through Likert scale statements that students tend to be in positive agreement concerning technological abilities, graphical representations and visual communication effectiveness. This finding could be attributed to the type of course the

students were taking while given the survey instrument. Further study is needed with students not taking a graphics course and those who have completed graphical training at some point in their lives. Also, students are not capturing all of their information when asked to place the information in a graphical form. Students were more descriptive when asked to give functional priorities in listing form. Overall, no thematic difference existed between what students' current time priorities were, as compared to what they would like to be doing, other than having more social activities. Finally, the qualitative review indicates that students identify a preference toward and use representative graphics that are direct, easily interpretable, and appropriate given designated tasks.

As graphic communications becomes more a part of everyday life for students and professionals, more understanding is needed in ways to better serve students by helping them develop skill sets in all forms of technical communications related to visualization, as they prepare for the 21st Century workforce. If pedagogy is to be improved upon and student learning gains increased, graphics educators must first identify and analyze what students bring into the classroom from other disciplines as well as their personal lives in order to better facilitate learning in the graphics education classroom.

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Appendices

Student Functional Priorities Survey

006

Age: 18-21 22-29 30-39 40-49 50-69

Gender: male female

Current Education Enrollment: graduate undergraduate

Which academic program are you currently enrolled in at the university? *mechanical engineering*

Why did you choose this academic program? *Interest in how things work*

Please tell us how much you agree or disagree with the following statements by circling the number that matches your choice.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I have a good understanding of the ways in which technology can be used in the real world.	1	2	3	4	5
I would enjoy a job that involved technology.	1	2	3	4	5
Learning technology is too difficult for me.	1	2	3	4	5
It is important to know about technology.	1	2	3	4	5
I have a good understanding of the ways in which graphics are used to communicate technical and scientific information in the real world. (Some examples of graphics are graphs, charts, pictures, maps, and symbols).	1	2	3	4	5
I think that it is interesting to study how to use graphics to communicate technical and scientific information.	1	2	3	4	5
I think that I could get a good grade in a class that focused on using technology to design graphics that communicate information.	1	2	3	4	5
It is important for students to study how to design graphics to communicate technical and scientific information.	1	2	3	4	5
I would like to learn more about using technology to design graphics.	1	2	3	4	5
I have a good understanding of how to use a computer program to design graphics that communicate technical and scientific information.	1	2	3	4	5

Functional Priorities

Where do you spend your time and energy and what % of time do you spend on each task?

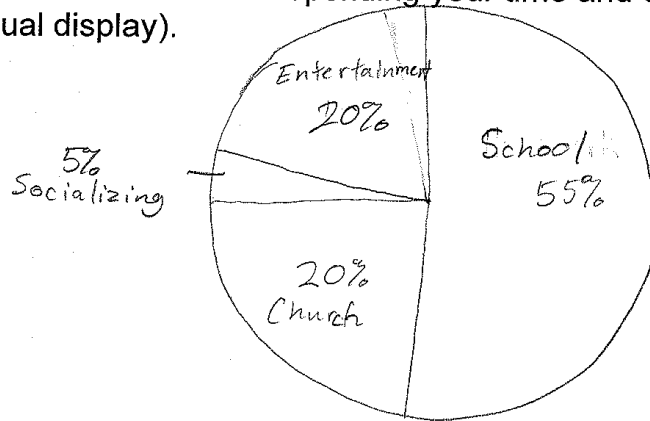
Example-Study

1. Homework/School 55%
2. Church 20%
3. Entertainment 20%
4. Socializing 5%
- 5.
- 6.
- 7.
- 8.
- 9.
- 10.

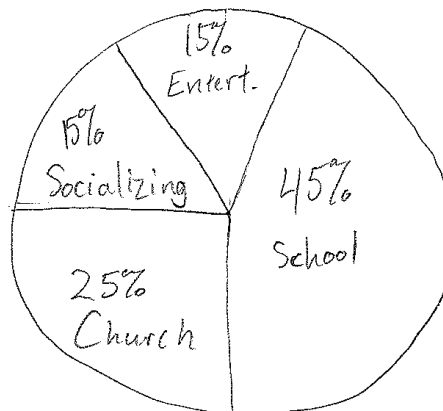
100 %= 100 (your last item can be listed as 'other' for small tasks)

Your Priority

How you're CURRENTLY spending your time and energy. (Show in a visual display).



How WOULD YOU LIKE (or do you need) to be spending your time and energy. (Show in a visual display).



Why did you choose the visualization you did for representing current time spent?

To easily convey the amount / quantity of time spent.

SAMPLE

Why did you choose the visualization you did for representing how you would like to spend your time? (Same as above)

Also, to more easily compare differences between the two visuals.

The Use of ArtiosCAD Software in Corrugated Packaging Design Courses

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Elinor Blackwell, EdD
Cynthia Thompson, PhD
&
Dave Dillon, EdD

North Carolina A&T State University
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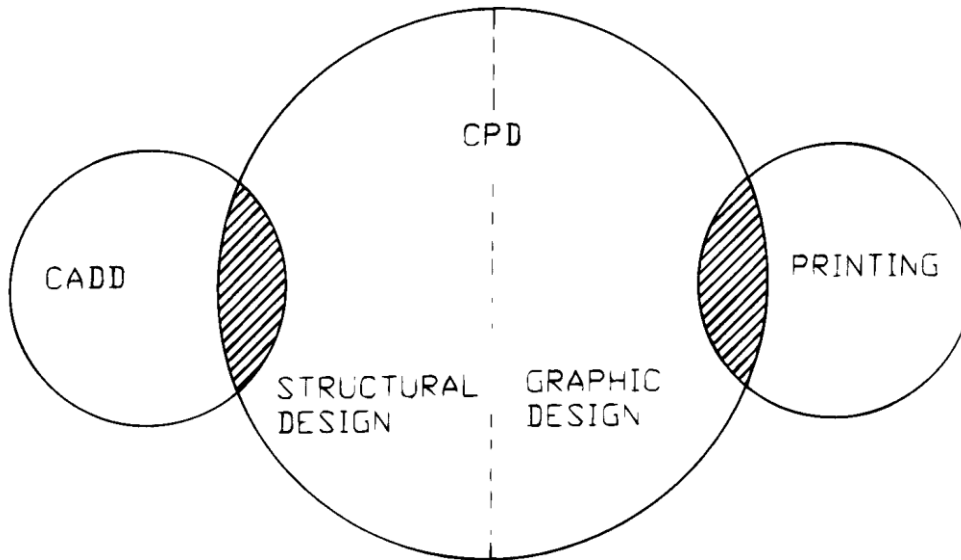
Introduction

Computer Aided Design and Drafting (CADD) software is now commonly used in community colleges and universities to produce technical graphics (Bradney, 1998). In some situations, it is merely being used to replace some of the content found in traditional manual drafting courses, but in others it is being used to deal with various applications (Dillon, Kapur & Brock, 1996). One of these applications is in the evolving field of carton and packaging design (CPD). This is a specialized field that is often linked closely with flexographic printing, however, the use and structure of the software related to CPD is similar to that of a general CADD package. Particularly within the areas of flat pattern design, intersections and developments there is a considerable common ground between CPD and CADD software packages. Since instruction in the field of CPD is not as common as for general CADD classes, the techniques and strategies for courses in CPD are not as developed. A brief survey of the carton and packaging industries indicates a great need for such courses.

Overview of an Introductory CPD Course

A CPD course involves units of instruction in carton and packaging design, structural design and integrity, printing considerations, die making, bar code applications and other related manufacturing processes (Bessen, 1990). The term “converting” is often used in association with this field, in that it refers to the changes (cutting, folding and creasing) that are made to container board or corrugated stock as it is converted into a package or display. It is essential that students understand the interrelationship among the aforementioned topics of instruction, as illustrated in Figure 1. In particular, the relationship between the printing processes and the design and production of the container must be covered in detail (Eldred, 1993). It is in this unit of instruction that students must consider issues such as the location of graphics to structural elements including a cut or fold and whether the graphics will be printed prior to converting or vice versa.

Figure 1. Interrelationship of CPD with CADD and Printing



A thorough understanding of workflow and production must be introduced. Issues such as the creation and use of job tickets and the overall concepts of project management should also be stressed. It is the combining of all of these elements into a cohesive unit of instruction, along with hands-on laboratory exercises that will produce a student who has a basic understanding of how this industry functions.

Description of ArtiosCAD Software Appropriate for Courses

ArtiosCAD available through ESKO Artwork, is multifaceted and multi-use design software for professionals working in the package and structure design industries. The software has an extensive array of tools, organized into modules, which are helpful for both the designer and the die maker. The package employs the standard Microsoft Windows user interface and provides corrugated and container board standard designs and allows the use of parametric design. It also is fully compatible when using DDES, CFF2 and DXF file formats. This software adds to the design and visualization process allowing the user to virtually fold 2D flat designs into 3D representations of the design. One advantage of this function is to allow the designer to check the fold sequence and fit. These resulting 3D files can then be used to display artwork and create assemblies and displays, even viewing those items in the intended product environment. Manufacturing applications involving CAD/CAM are also possible with ArtiosCAD. Other useful functions include the automatic creation of job tickets to communicate design and production information and the availability of standard import and export translators, such as DDES, CFF2, DXF, HP-GL, TIFF and EPS.

One of the world's most popular structural packaging systems is ArtiosCAD. ArtiosCAD can increase productivity throughout the companies which produce point of purchase (POP) displays and corrugated or folding packages, by offering tools designed specifically for packaging professionals. The design and drafting tools for ArtiosCAD include functions which provide structural designers all the tools they need to accomplish their goals. Some of the capabilities of the software include provision for complete 3D integration, which provides fast

access to design presentations and prototypes. An added bonus for utilizing 3D integration is a decrease in errors associated with communication and time needed for review of design cycles. Additionally, the snapping and tool alignment features of ArtiosCAD allow for graphical feedback to designers. The advantage of graphical feedback is that designers with varying levels of expertise can interpret this information quickly, make any needed revisions, and then finally increase productivity. ArtiosCAD also includes an Adobe Illustrator plug in, which further augments workflow for graphic and structural designers (EskoArtwork, 2011).

The NSK website states that the global standard for the packaging industry is ArtiosCAD. The system's producer engages in continuous product improvement to maintain its position on the cutting edge of technology. The ArtiosCAD system has become the focal point of manufacturing processes related to a packaging product's supply chain (NSK, 2007a).

Benefits to Users to Include in Courses

According to the NSK website in the segment on Design, Manufacturing and Communication for Packaging, some of the advantages for utilizing ArtiosCAD include the provision of smooth workflows within the cycle of package production from initial design through product completion. Effective tooling and layout design applications help minimize the cost of production. Productivity for product designers is increased by the software's excellent design and drafting tools. Globally, ArtiosCAD provides customers with faster turnaround times than other structural design tools. The ArtiosCAD Designer feature has effective drafting tools which aid die makers and designers by providing detailed visual input or feedback, such as dimensions of entire objects. The Builder feature gives ArtiosCAD the capability to create POP displays and folding cartons in seconds. The Style Maker function allows the software to automatically resize designs potentially creating thousands of parametric designs while also making new reusable standards from custom designs.

Additional customer benefits from ArtiosCAD 3D allow designers to quickly provide customers with realistic models, which could even include bends and creases. Assembly drawings can also be created with speed. The 3D animation feature, which can be output as QuickTime or AVI movie files, provides the capability of demonstrating how packages will actually be assembled or folded. These demonstrations can be utilized for customer presentations which reveal product features and capabilities. ArtiosCAD also has the ability to import models and industry standards from external sources into the program. Some of the 3D formats which can interface with ArtiosCAD include CATIA, Pro Engineer, Inventor and Solid Works. ArtiosCAD can also integrate current designs with previous work via its relational database. This feature makes searching for related projects easy and reliable. Reports can be automatically formatted and thumbnail sketches can be created using this feature. One example of these reports is the entire bills of materials, which can be created in 3D with Database Reports and then saved in HTML or Excel formats, allowing even more interactivity between ArtiosCAD and other systems.

Other benefits of using this software include the ability to create virtual prototypes for products which are so realistic there is a decreased need to create proofs and samples. ArtiosCAD is also capable of incorporating cross sectional views which give customers a view of the internal components of products. Three dimensional models can be produced for a number of items such as boxes, bottles, cans, glasses and bags. Other products which can be made with this software include products made of foam, plastic and cardboard. The sheet layout feature for ArtiosCAD allows for quick graphical representations of various phases of a product.

The Cost/Estimating feature also provides designers the opportunity to choose the most cost effective components for desired products. These features represent some of the benefits garnered from using ArtiosCAD which have helped this software gain worldwide recognition. A workflow which is “round trip” can be achieved when there is seamless interactivity between files created in ArtiosCAD and imported into Illustrator while maintaining the integrity of the ArtiosCAD data (NSK, 2007a).

Uses for ArtiosCAD for Your Students

ArtiosCAD helps consumer package company (CPC) managers control the supply chain to bring the best products to market as quickly as possible. There is a lot of competition among CPCs to gain visibility on supermarket shelves, with roughly 22,000 items on these shelves, which are joined by approximately 1,500 new products yearly. The cost for introducing new products can approach 10 million dollars with close to 60% of the cost associated with packaging, development and market assessment. Consequently, it is critical for brand owners to get the product packaging right the first time, and ArtiosCAD makes effective collaboration easier. The art director must design the package to accommodate the shape of the product; additionally, the safe delivery of the product must be assured, and structural designers must satisfy supply chain demands. Externally, ArtiosCAD is designed to optimize supply chain efficiency by facilitating product design, development and access to markets. The NSK website points out some other benefits of using the software including allowing managers comprehensive control over designing and drafting, creation of layouts of products, progression to prepress and provision of die board data needed for production. ArtiosCAD also provides designers with user-friendly access to specification sheets, cost analysis, 3D mock-ups and excellent corporate presentation capabilities (NSK, 2007a).

Features Students Need to Understand

ArtiosCAD has dedicated tools which help product designers and structural engineers increase productivity and get products to market with maximum speed. The 3D Designer feature also allows packaging personnel to import images of 3D supermarket shelves, to get realistic views of how the product will appear on shelves. Additionally, corporate logos can be imported to provide visual images which make excellent and realistic presentations. ArtiosCAD allows 3D designs to be exported as static images (PNG or JPEG file formats) or as animations (VRML files), and either file type can be integrated with PowerPoint or Word files. ArtiosCAD can also be integrated with shipping logistics with palletizing software applications which help designers visualize how the package will be oriented when it is shipped, stored and transported to market. The NSK website also states that designing in ArtiosCAD is as easy as creating paper and pencil drawings by hand with the convenience of thousands of standards readily available (NSK, 2007b).

Industry Outlook and Your Students

Some jobs which could utilize ArtiosCAD are in popular demand and should be brought to the attention of students. The Juju Job Search Engine reported that there is quite a demand for industry professionals who are proficient in the use of ArtiosCAD. According to the Job Fox website, one of the current positions related to ArtiosCAD is a Structural Designer (SD). SDs may use ArtiosCAD in conjunction with other software packages to create prototypes for product presentations to customers. Another type of position advertised was for Point of Sales Designer,

who could utilize ArtiosCAD with POP and POS designs for packages which appeal to customers. Other job functions include making recommendations regarding design specifications, materials and display interactivity. Another ad for a SD was looking for someone to facilitate the POP designs for customers. This person would design packages according to customer specifications based on package appearance, serviceability, materials and production methods. The salary for these careers ranges from 55 to 60 thousand dollars per year. Students need to know that these jobs are merely a representative sample of current positions available for professionals in this industry which continues to grow despite the negative down turn in the economy (Juju Job Search Engine, 2010).

The strong job outlook was confirmed by a recent report published by Market Research.com in *Datamonitor Industry Profile for the Container & Packaging Industry (CPI) in the United States*. This report reveals a strong job market for this industry. This report predicts that the market will increase from \$120 billion in 2009 to \$126 billion by 2014. The most lucrative segment of the container and packaging industry was paper, which produced 50.6 billion dollars in total revenue or 42% of the total market value. This data may be used in recruitment approaches for courses and programs in this field. Although the overall market growth is anticipated to slowdown, this report goes on to say that the greatest consumer for this market is Europe, which accounted for 32.9% of total sales. The United States (28.6%) is virtually tied for second place with Asian Pacific (28.3%) countries for market shares of containers and packages. The report also points out that the largest share of this industry in the United States is owned by The International Paper Company, the United States' front runner in the industry since it cornered 8.4% of the market (Market Research.com, 2010).

Students Can Study Production of Models, Samples and Prototypes

The design of a structure such as a container or display is generally considered separately from the graphic design, even though these two areas are interrelated and affect each other with regard to layout and production. Students must understand this relationship. Generally, the structural design phase begins with the development of a set of production drawings. These drawings will most likely be produced at full scale and have an accuracy of about $\pm 1/32$ inch. (Lamit & Kitto, 1997). It is from this set of drawings that a full size prototype of the structure will be developed. This prototype can be produced manually by hand or by the use of a cutting table. These prototypes allow both the graphic and structural designers to test the sample for form/shape and strength, and if necessary allow for adjustments in the structure design before it is manufactured. The creation of scale and, when feasible, full size models is an essential part of a course that deals with CPD structural and orthographic design. A sound understanding of intersections and developments, generally found in the design/drafting sequence, will greatly benefit the student during this portion of the course (Fiber Box Association, 1997). There are several techniques for creating these classroom samples without the use of a cutting table. One approach is to have the students use manual drafting techniques to draw directly onto a card stock material, and then cut, fold and glue the box into the desired shape. Another is to print or plot the design on paper, transfer the design to the stock and then cut, fold and glue the box. Either method will work in the absence of a cutting table, and this helps the student better understand this part of the design process.

Course Content in the Printing Area

Most corrugated boxes are printed using the flexographic process and use water based inks (Foundation of Flexographic Technical Association, 1997). Since the box material is often very porous, and the inks are water based, the capability of the flexographic method for printing very fine line work is limited when printing directly on corrugated substrate. This information is important course content. This is occasionally a problem in that finely detailed graphics and font types can spread and fill in, becoming blurred and unreadable. Tolerances for traps tend to increase with the caliper of corrugated substrate. If increased detail is required for a structure, the graphics can be printed using lithography and then laminated to the corrugated substrate. The printing processes and the order of operation must be considered when deciding if the box is to be printed first or die cut first. This will effect whether an image can be allowed to bleed outside of the box outline. This is also important when allowing for score lines. Care must be taken to avoid printing too near to a score line. Slits and slots must be treated in the same manner as score lines with regard to printing. Students must be taught all of these techniques. Boxes are often printed using the offset lithography method, although it is usually limited to the printing of spot labels. Screen process printing is, however, frequently used for both boxes and corrugated display units. Students need to know that each of these printing methods has its advantages and disadvantages as well as its unique equipment and processes.

Students who gain practical experience with ArtiosCAD through design and prototype creation gain a distinct advantage. Skill development in using the application provides students with experience with one of, if not *the*, industry standard software application for package and structure design. Combined with outputting prototypes to a cutting table, students are able to better make the connection between design and the actual product. Experience with those aspects of the process allows students to make better decisions, and understand - why, during the design stage.

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Saturday Technology Academy: Youth Learning in STEM Fields of Study

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Introduction

Traditionally, females have majored in science, technology, engineering, and math (STEM) fields in lower numbers compared to males. As a result of low enrollments, many colleges and universities have created and developed different programs to increase the number of females and minorities in these careers. For example, summer camps and Saturday academies are models utilized to recruit this population of students into technology fields.

Two complementary documents already have set the standard for developing a technologically literate population. The first, *Technology for All Americans: A Rationale and Structure for the Study of Technology* (International Technology Education Association, 1996), provides major tenets to assist educators in helping students become technologically literate and sets the foundation for the second document, *Standards for Technological Literacy* (International Technology Education Association, 2000), which defines what students should know and be able to do in order to be considered technologically literate. The 20 Standards that are the focus of the second work delineate proposed outcomes of a technology curriculum in grades K-12; they provide a consistent guide for educators and a framework they can use to develop individualized curricula and programs.

To help students learn technology, many programs have been developed at institutions of higher learning. For example, two youth technology summer camps were offered at North Carolina A&T State University (NC A&T SU) in the School of Technology in the summer of 2008 to increase the number of female students who pursue and succeed in careers related to STEM (Draper & Blackwell, 2009). The enrichment programs were geared to attract nontraditional students into technology fields in grades six through eight. The need to increase the number of nontraditional students in fields related to STEM is based on data that documents the underrepresentation of women and minorities among professionals in these careers.

Another technology camp conducted exposed students, especially females, to the field of technology (Dailey, 1998). Students were introduced to technical fields and career opportunities by working in a team and learning environment. Participants in the Technology Day Camp were middle and high school students who were involved in computer-assisted-drafting, graphic arts, and manufacturing. A STEM camp conducted in 2008 and 2009 targeted females entering ninth and tenth grade to the field of math (Dave, Blasko, Holliday-Darr, Kremer, Edwards, Lenhardt, & Hido, 2010). The Math Options Summer Camp utilized hands-on, lab-based modules to focus on the use of technology. Workshop evaluations revealed that students enjoyed using technology and gained a broader understanding of STEM careers.

Agricultural education programs are also incorporating innovative technology into their middle school programs. For instance, the Miami-Dade Public School System in South Florida uses computer-based modular instructional technology in its traditional vocational agricultural education program (Alonge, 2001). This emerging trend helps schools adjust to the dynamic

agricultural industry environment and attract the best students into their education programs. Another agricultural camp that integrated technological content into its institute was the Food and Agribusiness Industries Summer Program (FAISP), which was offered in the summer of 2009 at NC A&T SU in the Department of Agribusiness (Draper & Jefferson-Moore, 2010). This project educated future agribusiness leaders on the logistical transformation of raw agricultural commodities through to the end consumer. It was the first of three cycles funded by the United States Department of Agriculture to provide underrepresented populations of high school students with an opportunity to learn about careers within the food and agribusiness industry. Ultimately, the program's goal was to develop the next generation of students in agribusiness.

Innovation

Besides summer camps, other technology institutes are being offered during the school year. One such program is the Saturday Technology Academy (STA) which was offered in the fall of 2010 at NC A&T SU in the Department of Graphic Communication Systems and Technological Studies. The STA was offered for underrepresented populations of high school students in Guilford County, North Carolina who had an interest and/or curiosity in technology. The STA program was designed to increase the number of students who pursue and succeed in careers related to STEM by offering a program to students in grades nine through 12. The academy attempted to recruit more females than males into the program. Ultimately, the STA's goal was to provide a pipeline of diverse students participating in STEM school programs. Based on the goals of recruitment, major points of the project were to:

- Promote interest in technology programs through the development of a Saturday academy by educating high school students about technology careers.
- Help high school students understand technology by engaging them in challenging technology activities to develop their problem solving and manipulative skills through hands-on activities.
- Improve high school students' awareness of technology and the role of technology in their lives.
- Develop high school students' ability to communicate effectively in a technological world.
- Create a marketing strategy in order to promote the project and technology programs as vital sources of education, research, and service within the profession of technology.

Participants

The STA consisted of high school students ($n = 7$; 2 females and 5 males; ages, 2 fourteen, 4 fifteen, and 1 seventeen; class levels, 4 sophomores, 2 juniors, and 1 senior). Participants were recruited through an email listing of Career and Technical Education (CTE) teachers, technology education teachers and guidance counselors. All participants lived in Guilford County.

Workshops

The STA provided students an overview of technology principles, engaged them in technology activities, and improved their awareness of technology and the role of technology in their lives. Participants visited laboratories and learned about the many technology programs at NC A&T SU. Faculty coordinated lectures in classroom and laboratory settings which allowed

participants to improve their problem solving and manipulative skills through hands-on activities. Students met six Saturday mornings between September and November. On the first day, participants were given an introduction to technology. In addition, students were introduced to electronic components. They drew schematic symbols (battery, transistor, switch, resistor, lamp, inductor, capacitor, etc.), and completed an electronics lab activity by assembling “The Bug” kit from TeacherGeek.com. Students followed the instruction guide’s step-by-step wiring to complete the simple circuit “bug” activity. During the second session, participants completed a video communication activity. They designed and produced a video to advertise their bug to teachers or students. In addition, the students brainstormed video ideas, developed the storyboard, wrote the scripts, planned the shots for the scenes, rehearsed the script, and shot and edited the video.

The STA also provided a unique opportunity to introduce students to a variety of technology related theory and applications. The graphics portion of the technology academy introduced participants to a creative problem solving strategy useful when designing solutions for graphics related projects. In this case, students were tasked to develop a two-color logo for the technology institute. The first session involved lecture and discussion pertaining to the use of creative problem solving strategies as well as visual and verbal brainstorming techniques. Active participation from the students kept them engaged and resulted in the generation of many unique and creative solutions. The students were then asked to further develop their own ideas and provide an email copy before the next session.

The resulting design (see Figure 1) was to be screen process printed by the participants onto t-shirts. Ready to print screens were produced before the session. During the session, the process to create an image carrier from a film positive for screen process printing was demonstrated. Prepping, coating, exposing, washing out, taping, and registering for print were covered. While each step of the process was covered, time restrictions mainly involved with drying the screen between steps prohibited the use of the demonstration screens. Providing an opportunity for students to learn theories related to graphics technology and then experience first-hand the production techniques allowed them to develop a deeper understanding of the relationship between theory and practice.

On the last day of the program, students were asked to rank order the sessions they liked - best to least (i.e., 1 = best, 2 = second best, 3 = third best, and 4 = least liked session). Results were as follows:

1. Screen printing
2. Print logos
3. Electronics
4. Video communication

Throughout the program, students learned about careers within the field of technology. During the closing ceremony which was held on the last day of the academy, students provided an overview of their Saturday experiences. Participants will be tracked to determine if they



Figure 1. Final two-color logo created by STA students.

pursue STEM programs. Saturday technology academies, summer programs, and other innovative projects can be devices to promote the field of technology well into the 21st Century.

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