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Where Will They Come From?

by David W. Dailey Ed.D. • Lora L. Hopper M.S. • Eastern Kentucky University

A question may come to the mind of the Graphic Communications educator about to retire: who will replace me and will my departure mean the demise of the program? Where will future educators, particularly at the college and university level come from? Many programs are closing due to low enrollment, lack of opportunities for graduates, and/or a poor pool of qualified faculty replacements. The purpose of this study was to determine whether such a pool exists and if so, do the educators possess the technical qualifications to move into the college classroom.

An examination of the literature

Due to a limited number of graphic communications programs at all educational levels, few articles have been published which have examined future education needs in this field. There have been a few general articles written which have surveyed needs for educators at all levels. In 2001, Colb stated:

> Schools throughout the United States are in the early stages of a serious, deepening teacher shortage, the result of three major forces quietly working their way across the nation. First, a generation of experienced teachers is approaching retirement age. Second, many younger teachers, tired of poor pay and difficult working conditions, are leaving the profession well before retirement. And third, the status of the teaching profession is so low that new recruits are not being attracted in nearly the numbers required to replace those who are leaving. In short, the need for teachers, projected to reach a total of more than two million by 2010, is beginning to increase dramatically.

Aaronson and Meckel (2009) lamented the loss of public school teachers due to retirements and estimated a need for 2.3 to 4.5 million new teachers between 2009 and 2020. Based on U.S. census data, the authors projected more retirements between 2010 and 2020 than in any decade since the end of World War II. School-age population growth is projected to decline which means the need for new teachers is within historical norms.

Several authors have examined faculty trends at the university level and found multiple facets of the educator shortage issue. Dorfman (2009) found that many professors have continued to remain in the classroom/laboratory even beyond the age of 70. Most of those in her study did not continue working out of financial necessity, but listed enjoyment of their work or the feeling that it was important that they continue. She quotes one professor who stated, "Well, I enjoy doing research and I enjoy teaching. And both of those are very satisfying experiences." (p. 1036). Faculty members who indicated that they continued in the classroom said they enjoyed teaching, research or other creative work. When questioned about collegiality within the departments where they worked, survey respondents replied that attitudes of younger faculty and students were generally positive. Student attitudes toward older faculty ranged from positive, to "it depends on the student" (p. 1041), to the need "to be careful around students." (p. 1043).

Professors "actually like their jobs and often do not want to leave" according to June, et.al. (2008). The authors reported on a survey of faculty at four-year institutions conducted by TIAA-CREF in late in 2007, which found that "53 percent of professors were "very satisfied" with their jobs, compared with 42 percent of all workers." Retirement among the general population was reported to be age 62, but many faculty members retire at 66, with an upward drift. One-third of those responding to a telephone survey expected to retire at age 70 or later. "The ability of colleges to enforce a mandatory retirement age of 70 ended in 1994, when an academic exemption for a federal age-discrimination law expired." Leslie and Janson (2005) stated that colleges and universities previously had been able to require faculty retirements between the ages of 65 and 67. When the federal government amended the Age Discrimination in Employment Act in 1986 to ban mandatory retirement, colleges and universities received a temporary reprieve that lasted until 1994.

Of 640 professors at the University of Rhode Island, June, et.al. reported that almost one-third were 50 or older, and 105 were 65 and above, and "A few were rapidly approaching 80." According to the survey, 23% indicated they would like to retire before age 65, while only 14% indicated 65 as the age at which they thought they would retire. On the upper end, 28% stated they would like to retire at 70 or older, while 37% indicated they realistically thought they would retire at 70 or above.

Leslie (2005) reported that most faculty planned to retire in their mid-sixties following the relaxation of the man-

datory retirement age, and only a few planned to retire beyond the age of 70. Without a definite age for faculty retirement, colleges and universities have faced an increasing need for greater management in both academic and financial areas. These needs have led many institutions to begin phased retirement programs which include financial incentives along with reduced workloads. By 1999, about half of all four-year colleges and universities had begun to offer some variation of phased retirement according to the National Survey of Postsecondary Faculty data. The programs vary greatly, with some that are very restrictive by requiring advance notice, long service at a single institution, and waiver of tenure rights with less-than-attractive financial benefits. Other plans are considerably more generous, making phased retirement a virtual right and providing attractive financial packages. These programs have only been readily accepted when they have been financially generous.

Although phased retirements may benefit the financial standing of the institution, the department has to contend with a part-time faculty member leaving a class load partially uncovered until the member fully retires and a new faculty position becomes available. And with many colleges and universities facing financial difficulties and budget cuts, the department has no guarantee that the retiring faculty member will be replaced.

Following World War II, the major concern of colleges and universities was finding enough qualified faculty in the growing educational system. The opposite is facing institutions today, as many faculty members are in their late fifties and early sixties. With the aging of their faculty, many institutions are turning to "temporary and part-time faculty as ways to put off making long-term financial commitments," according to Leslie (2005). Funding at both the state and federal levels and increased tuition "have limited institutions' ability to attract and hold newer Ph.Ds." "Younger faculty appear to come and go in a far less permanent relationship to their institutions, while the tenured ranks age further without replacements." Phased retirement programs have been shown to aid both the institutions and faculty who accept reduced pay during the early retirement phase. "But those who have taken advantage of them report that easing into retirement has helped them through one of life's most difficult adjustments: leaving a career and entering a new life stage." (Leslie and Janson, 2005)

Clark and d'Ambrosio (2005), report that when a faculty member retires, the college or university faces funding issues and long-term staffing decisions of whether to hire full-time tenure track faculty, or fill the vacancy with part-time lecturers. The authors state the recent trend toward part-time staffing and non-tenure-track faculty. The decline in compensation of non-tenure-track faculty as compared to tenure-track faculty has been a major factor in adding faculty to institutions. "As these instructors became relatively less expensive, colleges and universities decreased their reliance on tenure-track faculty. (p. 391).

> Budgetary restrictions clearly influence employment choices. New graduates seeking employment ultimately must decide whether to remain in academe as contract employees, postdocs, or part-time instructors or choose some other career. Recent trends suggest that colleges and universities will have fewer full-time tenure-track faculty in the future than in the past. (Clark and d'Ambrosio, 2005, p. 392).

On the other hand, many institutions are finding a shortage of qualified faculty. Business faculty, particularly at the doctoral level, are in demand according to Mangan (2007), Chafkin (2005), Alsop (2007), and Crespi (2010). Fine (2002) predicts shortages in the social science and special education areas, and Jones (2009) states faculty with a doctoral degree in music education are in need. To overcome the lack of qualified faculty, Omiecinski (2003), reports on an increasing use of part-time faculty at Canadian universities.

To profile one institution, Eastern Kentucky University (EKU), as of May 1, 2014, had 629 full-time faculty and 455 part-time faculty. Of faculty between 65 and 69 years of age, there were 48 full-time and 53 part-time. There were twelve full-time and 22 part-time faculty members who were 70 or older. In 2014, the university offered an enhanced early retirement plan as part of a budget-cutting plan. In 2014, there were 21 faculty members in some type of early retirement plan (either the enhanced plan or the plan prior to the enhanced plan, (P. Sallee, personal communication, May 20, 2014).

Research Problem

There are fewer graphic communications programs at institutions of higher learning than those in other disciplines, such as the social sciences. Consequently, with fewer programs, there are fewer faculty to examine for employment needs, retirements and projecting program futures. By way of example, with two faculty members at Eastern Kentucky University approaching retirement, this

writer is concerned about the future of graphic communications that started at this institution in the 1960s.

Graphic communications is a discipline that must be explained to lay people. This is an industry that ranks third in the number of facilities, with national employment at just under one million. Yet few people have even a cursory knowledge of the industry. Consequently, graphic communications is not a high demand major. As a result, some programs have closed, and closure may be in the future for others.

When faculty retire, universities look at the strengths and weaknesses of existing programs, the number enrolled in a program, degree completion rates and job placement rates. If program continuation is an option, new qualified faculty must be hired: educators with the required educational background and laboratory experiences ready to transition into the college and university setting.

Methodology

This study was undertaken with the goal of understanding the makeup of the current graphic communications education workforce. The sample for the study consisted of the membership of the International Graphic Arts Education Association (IGAEA), plus a few other educators. An initial survey was sent in November of 2013 by email to 457 educators using an on-line survey tool (2013). A follow-up survey was resent in December, 2013. The total response rate was a 37.6%.

There were 172 responses to the survey, with various response rates to a number of survey questions. Five respondents did not complete the survey. Of 169 responses, 48 (24%) responded that they had retired. If survey respondents chose 'retired,' the survey closed immediately since none of the other questions would apply to retired educators.

Discussion of Results

Of the 121 who responded that they were still teaching, 55 (46%) indicated that they planned to teach ten to nineteen or more years. Eighty-seven percent of respondents selected that they were intending to teach (a) 20 or more, (b) 10 to 19, or (c) five to nine years. Thirty-two (27%) of the respondents indicated that they planned to retire in less than five years. In cross referencing this number instituional level, nine (28%) were teaching at the college or university level. Twelve (37%) of community college and/or technical college faculty expect to retire in less than five years. Nine of the 32 at four-year institutions expect to retire in less than five years.

When survey responses of faculty expecting to retire in less than five years are examined in terms of highest degree held, six hold a doctorate, six a master's plus 30, and eight hold the master's degree for a total of 63% of 32 respondents planning to retire in the near future.

Many colleges and universities require applicants for tenure-track positions to possess a doctoral degree or at the very minimum ABD (all but dissertation) in the ranks of higher education. Some universities consider a master's as a terminal degree for particular fields, such as aviation and fine arts. For this survey, 19 (16%) of the respondents indicated that they hold the doctoral degree, with two ABD.

When responses to the highest degree held and current teaching level were cross tabulated, all of those holding a doctorate (19) or ABD (2) taught at the four-year level. Two respondents at the college level had completed some doctoral work (as well as one high school teacher). Of those with a master's plus 30 hours, five each were at the college or community college level while twelve were high school teachers. Twenty-eight respondents held a master's degree, including 8 at four-year institutions, 9 at the community college, 5 at the technical college and 12 at the high school level.

Forty-eight (47%) of all respondents held either a master's degree or a master's plus 30, which is sometimes referred to as a Specialist Degree or Rank One. When asked "Do you have aspirations of moving to a higher level of teaching?" (either (a) high school to community college or technical college or four-year college, or (b) community college or technical college to four-year college), 71 (66%) planned to stay at the same level, while 34% aspired to move to a higher level. Seventeen (16%) of respondents at community or technical colleges aspire to the four-year college.

This is a good sign for four-year colleges needing to replace those who are planning retirement in the near future. A drawback for this later group is that only five respondents indicated that they are either ABD or have some doctoral coursework completed. As shown in Table 1, which is a cross tabulation of highest degree held with current teaching level, 52 educators (46%) of the 115 responding hold a master's degree or higher. This means they are not far from achieving a doctoral degree and thus eligible to apply to a college or university where they meet requirements.

When considering a move to an institution of higher learning, one often needs to take into consideration that that institution may not be in the immediate vicinity, thus requiring a move. Those willing to move versus those unwilling were just about evenly split, with 61 (52%) willing to move, and 48% preferring to remain at their present location. Moving may need to be considered to work on an advanced degree, although there are now opportunities for further education in an on-line format.

One encouraging sign for graphic communications education is that of 116 responding to the question regarding continuing in the classroom, 109 (94%) plan to teach until retirement. Two plan to leave teaching for an industry job, and five plan to leave the field of education completely.

Another area of study included graphic communications competencies possessed by educators. At four-year college programs with larger faculties, there may be more individual specialization, with faculty members teaching courses only in electronic publishing, screen or flexo printing, or web applications. In smaller programs, only one or two faculty members might cover a wide range of separate courses spanning topics such as electronic prepress, digital photography, web publishing, screen, flexo, finishing and packaging, and estimating. With this range of courses, an incoming faculty member replacing a retiring member would need to be well versed in many areas, with hands-on skills on a variety of software and equipment.

When answering questions on technical competencies, respondents were told to select all items that applied. Ninety-six felt competent in the electronic prepress area, and 98 in the printing processes. Only 24 felt competent in teaching web publishing, and 44 in the packaging area. Seventy-seven expressed that they would be able to teach finishing and binding courses. When areas were broken into components, 93 responded that they felt competent to teach electronic prepress using the *Adobe Creative Suite* software. Thirty-seven were familiar with some aspect of using imposition software. When asked about other areas in prepress, comments included "imposition; file creation; preflighting; PDF editing; trapping; advertising design; photography and signage; cross-media/multi-channel marketing; eBooks; XML; data management; email blasting; variable data printing; mobile integration (QR codes, augmented reality, image recognition); *Prinergy* software; *Pitstop* software; and color management. One respondent mentioned the cross media environment, which includes a linkage between print and digital/web publications.

In terms of competencies in the printing processes, of 98 responding to this item, 94 (96%) indicated the ability to teach offset press. Further breaking down the size of presses, 55 were competent with duplicator size presses and 44 with larger size sheetfed presses. Fewer faculty members responded that they had strengths in the web offset area. Screen printing was the next highest area of competence in the printing processes, with 82 of 98 responding positively for this process, followed by flexo with 32 and gravure with 14. When asked for comments on other competencies in the printing processes, respondents mentioned digital or digitalography; wide format inkjet; dye sublimation; vinyl graphics; variable data digital printing; and pad printing.

Table 1: Cross tabulation between highest degree held and current teaching level.

		I am currently teaching at the following level					
		College or University	Community College	Technical College	High School	Middle School	Total
The highest degree that I hold is…	Doctorate	19	0	0	0	0	19
	ABD (All but Dissertation)	2	0	0	0	0	2
	Some doctoral courses	2	0	0	1	0	3
	Masters plus 30	5	5	0	12	0	19
	Masters	8	9	5	12	1	28
	Bachelors	0	9	5	18	0	30
	Certificate	0	2	1	9	0	11
	Other	0	1	1	2	0	4
	Total	36	25	12	54	1	115

Only 76 responded to the item on competencies in the binding and finishing area, with an equal number of 75 indicating an ability to teach cutting and folding. Due to the expense of equipment, it was interesting to note that of this group of respondents, 51 felt competent to teach such binding equipment as saddle and/or perfect lines or case binding. The survey did not seek to differenciate between competence to teach actual bindery equipment or to just provide information. Comments provided under the other category of this question included die cutting; foil stamping; laminating; CAD table; prototyping; coating; quality control; and embossing.

Eighty-one responded to the item on screen printing with the majority, 71, indicating using manual presses. Only 22 indicated using automatic presses. For other options, rotary screen; embroidery; wide format inkjet including substrate options and considerations was indicated.

By cross tabulating processes faculty feel competent to teach with the academic level at which they teach, offset press and screen printing clearly rank higher among all levels of faculty. Flexo ranked a distant third, with only 31 faculty, and only 14 felt competent to teach gravure. Again, there is no distinction on hands-on competence vs. ability to teach through just lecture (See Table 2).

Conclusions

Among the educators surveyed, it appears there were an adequate number who have a number of years of teaching before their planned retirement. Fifty-five of 121 respondents who were currently teaching indicated ten or more years until retirement. Sixty of 97 respondents indicated that they have considered further education.

The majority of educators responding prefer to stay at the same level they are currently teaching. Only 37 of 107 who responded to this survey question indicated they would like to move to a higher level of education. There were 61 of 117 responses that indicated they would be willing to relocate depending on opportunities for advancement.

Only three respondents have completed any coursework toward the doctoral degree and only two are at the ABD level. As previously stated, most colleges and universities require an applicant to come into a position with at least an ABD if not a completed doctoral degree. Years ago, a master's degree plus and teaching experience was adequate preparation. That is no longer true, and several four-year college institutions have recently experienced failed graphic communications faculty searches.

In terms of technical preparation, the survey has shown that respondents have an adequate background to transfer into the four-year academic environment. There did seem to be a heavier emphasis in teaching courses in electronic prepress over press courses. This is perhaps due to the fact that many programs have cut back on traditional courses due to changes in the industry, cost of equipment, or qualified applicants.

Recommendations

A major recommendation for those who aspire to teach at a four-year institution is to begin to prepare academically. There are programs in need of qualified doctoral degreed faculty to replace those who are approaching retirement. One might think he/she would like to move up to the next level, but factors such as age, family circumstances, or income need consideration.

Several interesting comments were forwarded as part of the data collection for this study:

> "We are searching for a new Department Chair and I looked up all the graphic programs I could find and found there were only 33 people with a terminal degree and a graphics background right now. I think

Table 2: Cross tabulation between process competent to teach and teaching level.

		I am currently teaching at the following level					
		College or University	Community College	Technical College	High School	Middle School	Total
Which printing processes do you feel competent to teach?	Offset Press	27	16	9	48	1	92
	Screen Printing	27	14	7	40	1	80
	Flexography	18	3	2	8	1	31
	Gravure	9	3	0	2	1	14
	Other	14	6	3	16	1	35
	Total	30	17	9	49	1	96

the problem is really significant, there is one young faculty member here working on her doctorate, but her emphasis is in web design.

I think we need to think about delivery and using some of the new instructional tools.

There are great HS teachers that need to be encouraged to work on a degree and take the jump to college teaching". (Leininger, J., 2014, Jan.)

Murphy (2014, Feb.) put forth an interesting challenge when she stated:

> "I do believe the students of today are the best source for the teachers of tomorrow. If we all, whether at 2-yr or 4-yr institutions, prepare our students in a practical way for the profession they've chosen, they are tomorrow's teachers".

In an on-line discussion group, educator Harvey Levenson (2014, Jan.) posed several questions that might be examined by researchers:

- What type of scholars do we need to best prepare students for viable careers in graphic communication?
- To what extent should such scholars have been prepared in traditional graphic communication disciplines or in other disciplines?
- To what extent should future graphic communication professors have industry experience prior to entering the academy?
- If previous industry experience is desired, what industries would make sense that reflect the interests of graphic communication today and in the future? What terminal degrees should future graphic communication educators have?
- What role should laboratories play in graphic communication education, and to what extent should professors have industry relations that will help support laboratories through donations and overall software, hardware, supply, and equipment installations?
- To what extent should future graphic communication professors be resources for industry as opposed to relying on industry being a resource for them?

These are questions that should be considered when examining the future of graphic communications programs, particularly as many phases of the industry are moving away from heavy iron presses to an increased concentration on digital output. No matter which direction the industry takes in terms of output, every printed piece requires creation at the electronic prepress stage.

Wherever they come from or how they get there is not a matter of great concern. The concern is that many graphic communications educators are retiring and leaving a void in the classroom. Perhaps as Levenson has said, we need to look at the needs of our curricula for the future and modify it according to industry needs. That is a topic for a future study.

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An Application of the Technology Acceptance Model to Intended Adoption of Digital Printing Technology in the Label Industry

by Bruce Leigh Myers, Ph.D. • Trevor Schroeder, M.S. • Rochester Institute of Technology

Production-level digital printing technologies have made significant inroads into many segments of the commercial printing industry. One particular segment which is especially well-suited for the adoption of digital printing is label printing. Despite this apparent fit, digital printing technologies have not been universally adopted by label printers.

The present study examines the intention to adopt digital printing through Davis' Technology Acceptance Model (TAM). Using a cross-sectional, quantitative survey, managers at label printing organizations were asked about their intention to adopt digital printing, as well as questions relevant to the constructs which comprise the TAM, namely, *Attitude*, *Perceived Usefulness*, and *Perceived Ease of Use*. The resulting data indicate a relative indifference regarding the constructs on the part of those label printers that do not intend to adopt digital printing, whereas intended adopters view the technology as easier to implement and befitting of a business model based on an expanded customer base.

Introduction

Digital printing technologies have made significant inroads into many segments of the traditional printing market. As technologies continue to mature, benefits such as faster turnaround time, personalization and more cost-effective short runs have combined to make digital printing an integral part of many printing operations (Myers, B., 2014).

One segment especially well-suited for digital printing technology is the label business. (McLoone, 2010). Digital printing technologies, however, have not been universally adopted by all label printers. While some plan on adopting digital printing for labels in the near future, others do not foresee digital printing in their immediate plans. Using the constructs of Davis' Technology Adoption Model (TAM) as a framework, this study examined the salient factors that separate intended adopters from those label printers that do not intend to adopt digital printing technology in the near future, including a discussion on the potential implications of these findings.

Need for the Study

Examining the adoption of innovations has been the primary focus of studies for over 100 years (Brown, 1981). This study attempted to build on this rich history while providing relevant information for both industry and researchers. From a practical standpoint, the research examines the factors that underlie the intention of label printers to adopt or to not adopt production-level digital printing technologies. The information is likely useful for those with a vested interest, including the vendor community, standards bodies, educators, buyers, and printers. In addition, the present research utilizes the TAM as a framework, and as such adds to prior research that focuses on an attitude/behavior perspective, which has proven to represent an especially powerful, yet simple, manner in which to predict user intentions (Gallion, 2000).

Literature Review: The Technology Acceptance Model (TAM)

The TAM was developed by Davis (1980), with the goal of explaining information technology usage behavior. An adaptation of Fishbein and Ajzen's Theory of Reasoned Action, the TAM utilizes three key constructs, namely *Attitude, Perceived Usefulness* and *Perceived Ease of Use*, which are theorized to influence Intention to Adopt, as illustrated in Figure 1.

Attitude toward adopting is defined as the prospective adopter's positive or negative feeling about the company's adopting industry specifications (Ajzen, 2012, Fishbein & Ajzen, 1975, 2010). As used in the present study, Attitude is an important component of the TAM, and is measured using a semantic differential scaling technique based on

The Technology Acceptance Model, adapted from Davis, 1980, 1989.

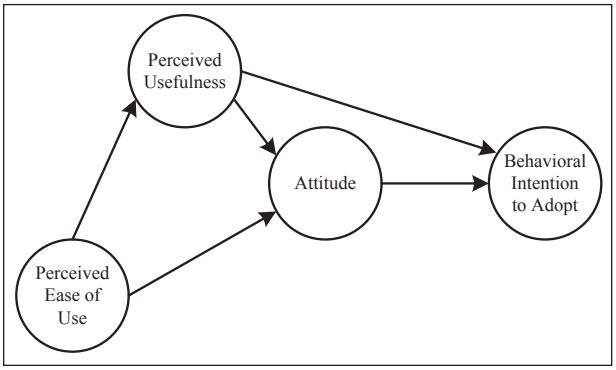

Figure 1

seminal work developed by Osgood, Suci and Tannenbaum in the 1950's, as cited in Fontaine, Scherer, and Soriano (2013) and Crano and Prislin (2010).

Perceived Ease of Use is defined as the degree to which the prospective adopter expects the adoption of industry specifications to be free of effort regarding its transfer and utilization (Davis, 1989, 1992). It is theorized to influence both *Attitude* and *Perceived Usefulness*, as instrumental improvements in ease of use may result in the increased performance of a respective innovation. *Perceived Usefulness* is defined as the prospective adopter's subjective probability that applying industry specifications will be beneficial to the adopting companies' wellbeing (Davis, 1989, 1992). *Perceived Usefulness* is theorized to influence both *Attitude* and *User Intention to Adopt*. Further, Davis, Bagozzi and Warshaw (1989) contend that there is a relationship between the constructs perceived ease of use and perceived usefulness, as illustrated in Figure 1.

One key criterion for selecting a theory to examine a phenomenon such as innovation adoption is parsimony: social researchers tend to prefer theories that utilize a minimum number of constructs (Dobbins, 1999). The TAM represents one such parsimonious model; it is generally regarded as simpler, easier to employ and less costly to apply than other such models (Myers, B.L., 2004).

Research Design and Methodology

In order to address the research question, a cross-sectional survey instrument was developed based upon previous studies utilizing the TAM. The questionnaire instrument was developed specifically for measuring the constructs which comprise the TAM, namely, Perceived Usefulness, Perceived Ease of Use, the direct Attitude measure, as well as Intention to Adopt. The survey was pilot tested among industry professionals and academics prior to administration. The goal of the survey process was to seek responses from label printers in the United States who were non-adopters of production-level digital printing technology. As no list of such companies was readily available to utilize as a sampling frame, the following procedure was employed to obtain the list of potential respondents:

A current *Hoover's* database was searched for "Commercial Printing" (except Screen and Books), "Located in the United States", and several relevant keywords. If the company in the resultant search had a website available, it was examined to ascertain if that particular organization was an appropriate candidate for the study. This process resulted in 160 companies. Companies identified by the *Hoover's* search that did not have available websites were placed in a separate category. One hundred of these companies without a found website were randomly selected to receive the questionnaire instrument.

There were 260 questionnaires mailed. Fifty-one were returned, resulting in a response rate of nearly 19%. Of these, 31 qualified for data analysis. Ten of the 31 indicated neither an intention to adopt or to not adopt digital printing technology in the next twelve months, eight respondents reported that they did intend to adopt, and 13 indicated that they did not intend to adopt within this time period.

Demographic information with regard to the size of the companies responding is presented in Table 1. Over 85% of the respondents indicated that their companies had fewer than 50 employees. Companies with 100 employees or more represented just fewer than 11% of the respondents.

Table 1: Respondent Demographics: Number of Employees (n=31)

Number of Employees	Percentage of Respondents
1 - 9	35.7%
10 – 49	50.0%
50 – 99	3.6%
100 – 199	7.1%
200 – 499	3.6%
500 or more	0.0%

Results

The direct measure of the *Attitude* construct consisted of four separate items, as shown in Table 2. Mean results indicated a generally positive outlook with regard to the adoption of digital printing technologies among intended adopters, whereas non-adopters were somewhat indifferent, with average values close to zero on the semantic differential scale. For example, the semantic differential portion of the questionnaire instrument asked respondents to rate the adoption of digital printing technology on a scale from negative three to three, with the negative three value associated with "Bad" and the positive three value associated with "Good." The mean value for respondents that did not intend to adopt digital printing technology was -0.25, indicating a relative indifference. The

Table 2: Direct Attitude Measure: Mean Values Semantic Differential Scale –3.0 to 3.0

	Adoption Intention	
	No ($n = 13$)	Yes ($n = 8$)
Bad / Good	-.25	1.88
Disadvantageous / Advantageous	0.42	2.50
Harmful / Beneficial	0.25	2.25
Reckless / Well-Judged	0.08	2.43

mean value from intended adopters on the "Bad" to "Good" semantic differential resulted in 1.88, indicating a generally positive outlook about the technology adoption.

Turning to the Perceived Usefulness and Perceived Ease of Use constructs, respondents were asked to respond to a Likert-like question for the theorized factors which comprise the usefulness/ease of use constructs, as detailed in Tables 3 and 4. Overall, intended adopters believe that digital printing could be more easily integrated into their current work operations, and that adoption would enhance their business operations, whereas those that did not intend to adopt are more indifferent about the ease of use and usefulness dimensions.

In terms of *Perceived Ease of Use*, of particular note were the beliefs of the respondents about the amount of training required. Clearly those that did not intent to adopt reported that significant training would be required for digital printing, where responses from the intended adopters were more neutral, as illustrated in Table 3. Examining the *Perceived Usefulness* construct, intended adopters generally believed that capturing more business was an especially relevant factor, as such this differentiated them from their counterparts: this and the other components of the *Perceived Usefulness* construct are illustrated in Table 4.

Table 3: Perceived Usefulness — Mean Values Likert-like scale: extremely unlikely (-3.0) to extremely likely (3.0)

	Adoption Intention	
	No ($n = 13$)	Yes ($n = 8$)
Integrating digital printing for labels would be easy for our company.	0.15	2.25
Adopting digital printing for labels would be frustrating for our employees.	0.15	-0.88
It would be easy for the employees in our company to become adept with digital printing technology.	0.77	1.88
Using digital printing would require significant training for our employees.	1.46	0.13
Digital printing for labels would make label production at our facility more difficult.	0.23	-2.00
Adopting digital printing for label production would disrupt our company.	0.08	-1.88
Overall, our company would find adopting digital printing for labels easy.	0.00	1.63

Findings

Due to the limited number of usable responses from the survey instrument, the results should be viewed as informational rather than of statistical inference. Nonetheless, several implications of note can be concluded from the data obtained here. First, although the label printing market segment seems to be a natural fit for production level digital printing technology, this view is not universal across all aspects of this segment. Some businesses simply do not view digital printing as viable for their particular operation at this time. This is reflected by the relative indifference in terms of *Attitude*, *Perceived Usefulness*, and

Table 4: Perceived Ease of Use - Mean Values Likert-like scale: extremely unlikely (-3.0) to extremely likely (3.0)

	Adoption Intention	
	No ($n = 13$)	Yes ($n = 8$)
Utilizing digital printing for labels would give our company greater control over our work.	0.00	1.50
Digital printing for labels would improve productivity in our company..	0.00	2.13
Digital printing for labels supports critical aspects of the jobs of the employees of our company.	-0.58	1.13
Utilizing digital printing for labels would allow our company to accomplish critical tasks more quickly.	-0.17	1.75
Digital printing for labels would enhance our firm's effectiveness in the marketplace.	0.08	2.13
Adopting digital printing for labels would improve the quality of work produced by our company.	-0.67	1.13
The ability to offer digitally printed labels produced in-house would allow our company to capture more business.	0.33	2.50
Overall, the ability to produce labels that were digitally printed would be useful for our company.	0.17	2.50

Perceived Ease of Use in those label organizations that do not intend to adopt digital printing. In examining these constructs more closely, it is noteworthy to recognize that employee training and integration are viewed as a particularly significant obstacle separating those that do not intend to adopt from those that indicate an adoption intention. Further, the data revealed that differences noted between intended adopters and those that did not intend to adopt was most significant in terms of the perceived business case required to support adoption. In short, when it comes to capturing more customers, intended adopters clearly believe that digital printing technologies equate to more potential business, while this is less likely the case for their counterparts.

Conclusions

Using the structure of Davis' TAM to view potential adoption in this particular context shows promise as a manner in which to parsimoniously elicit salient factors germane to the adoption of innovation. *Attitude*, together with *Perceived Usefulness* and *Perceived Ease of Use* represent a framework where notable differences between intended adopters and those that do not intend to adopt a particular technology are reported, and offer implications for relevant stakeholders. For example, the realization that those label printers that do not intend to adopt digital printing technologies view employee training as an impediment could be significant to those that market such technologies. This could result in a focus on training, support, and a transition plan to help to assuage such concerns.

Based on the results of this survey, it is also important to recognize that the business case required for the adoption of new technologies is paramount. This realization has potential implications for not only vendors, but also educators as it suggests that for today's students to excel as tomorrow's business leaders they need to be well-versed in the business planning aspects of industry, whether their career is in the production or vendor sides of the business.

Future Research

Future researchers may choose to apply Davis' TAM to other research contexts: the *Perceived Ease of Use* and *Perceived Usefulness* constructs represent a succinct manner to gauge and measure potential adopters. It is likely that within domains where a more comprehensive sampling frame is available, larger response rates can be obtained that will allow enhanced statistical inferences to be drawn.

Furthermore, building on the cross-sectional, quantitative results here, future qualitative researchers can possibly reveal more in-depth knowledge of the nuances inherent in this particular innovation adoption context by using open-ended questions and case study methodologies.

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Multi-Shot Digital Imaging

by Chris Lantz, Ph.D. • Western Illinois University

Introduction

Multi-shot digital imaging refers to several exposures that are automatically blended into one image in capture software for the purpose of increasing resolution or separating color into red green and blue components. *Sinar, Hasselblad* and *Megavision* currently sell new multi-shot digital camera backs for medium and large format cameras.

Micro-scanning and macro-scanning are multi-shot techniques used to increase resolution. RGB tricolor imaging is used to increase color fidelity and to properly render fine detail with regular patterns or eliminate moiré. Micro-scanning is done with piezo motors on the sensor in the back. The tricolor or color separation technique is done with a monochrome sensor and a RGB filter wheel with three overlapping exposures. The chief disadvantage of both micro/macro-scanning and tricolor RGB is that a still life subject must be used. All micro-scan backs also have a one-shot mode where instantaneous exposures of moving subjects can be made at a lower resolution. Tricolor backs have a one-shot mode but only in black and white. Live preview of focus and composition on the computer monitor in capture software is also a feature of all of these high-end backs.

Making multiple exposures of the same scene to increase resolution was a compelling feature in the past because sensors were lower in resolution. From today's standpoint it is just as important because a less expensive back with a low pixel count and low price can produce high resolutions. All but one *Sinarback* (*Sinarback 22L*) have multi-shot capability. Together with the *Sinarcam-2* and macro-scan motorized mount they form an automated color live view system for the *Sinar* P or P2 large format camera. It can also be used in stand-alone mode or on a medium format camera.

Most educators would not consider these top-of-the-line multi-shot digital backs as possible systems for their programs because of the high cost of new equipment (same as the price of an average new car). Many would even consider the new lowest cost single-shot backs without live view as beyond their budget (same as the price of an average used car). Instead of these new expensive options, second hand surplus equipment from *Sinar* and *Leaf* will be detailed in this paper as low cost alternatives. These were the top-of-the-line systems of their time (1998–2004) with multi-shot, live view, motorized back mount and computer controlled shutter and aperture automation. The *Sinarback 23* and *Sinarcam-2* is a micro/macroscan camera that was awarded the 2000 GATF InterTech Technology Award (figure 1). *Sinar* was one of eight award receipents in 2000 (GATF, 2000). The *Leaf Volare* and *Sinarcam-1* is a slightly older tricolor version presented in this paper (figure 2). This paper will give the technical details necessary to put together such systems from surplus components. Those reading this paper for general information may want to pass over some of the technical details but they are necessary for assembling the *Volare* and *Sinarback* systems.

Multi-Spectral Imaging and Leaf Volare

The principle of tricolor photography is as old as the first color processes in photography and graphic arts. The

Side and front view of Sinarback digital back system on a Sinar P film camera.

Figure 1

Side and front view of Leaf Volare digital back system on a Sinar P film camera.

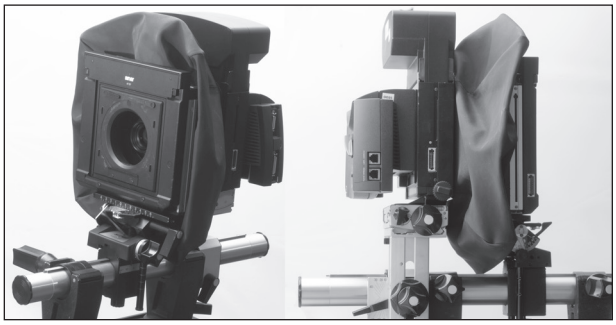

Figure 2

advantage of tricolor digital photography is that color separation is not done with a bayer RGB pattern matrix filter on top of the imaging chip with one exposure. It is done within software with three separate exposures through red, green and blue filters to a single black and white sensor. *Megavision* is the maker of a current monochrome back used with an RGB filter wheel. The advantage of tricolor is that fine pattern and detail such as in a fabric or brush strokes in a painting will not interfere with the bayer matrix pattern of RGB points on top of the chip (figure 3). There is no bayer filter on a monochrome sensor . The clarity of color in tricolor photography is also better than that produced by the bayer pattern chip in a typical DSLR.

A *Leaf, Sinar, Scitex*, and *Creo* partnership produced the *Volare* 6MP (6 megapixels) tricolor large format camera system in 1998 and sold it until 2001. It is a fully automated RGB tricolor wheel system for a large format camera. Many printers will remember the first and second generations of this system from print shows such as Gutenberg. The early *Leaf DCB* (referred to as the brick because of its shape) and *Leaf DBC II* were not included in this paper because they produce less than 6MP. The *Sinarcam-1* is an electronic shutter, liveview LCD, and an automatic software controlled RGB color wheel. It has a separate motor to control the aperture (figure 4).

The *Volare* monochrome back is put on the rear standard of the large format camera along with the *Sinarcam-1*. An aperture control motor is put on the front standard along with the *Sinar* digital DB lens. Each *Sinar* digital DB lens has a control plate that identifies the lens type and aperture scale in *Leafcapture* software. When a new lens is installed on the camera the relevant scale is looked up in software and displayed. The shutter speeds are also selected in software via a sliding scale.

When a live view button is pushed in *Leafcapture,* the shutter and lens is automatically opened and a live view LCD is moved into place in the *Sinarcam-1*. The LCD is then retracted when the live view button is pushed again. The depth of field can be previewed with live view. The display on the computer monitor brightens automatically to compensate for stopped-down apertures. The *Volare* has monochrome live view. Live view is useful in previewing view camera movements on screen with *Leafcapture.*

Live view on a large format camera was a groundbreaking feature in 1998. Only recently has live view become available with camera tethering software for a DSLR. From a teaching standpoint, live view on a large format camera is the most important capability of the system. The instructor can use live view on a projector to display live camera movement corrections in a demonstration. The inability to display camera movements to students on the big screen was a major limitation in teaching large format in the past. It is not possible for the instructor to observe the effect of camera movements with students on the small 4×5 inch ground glass focusing screen. Live view projected via projector makes demonstrations possible. It is true that *Polaroids* could be used in the past to demonstrate camera movements. However, with *Polaroid* prints students can't visualize the work-flow of adjusting camera movements. *Polaroid* prints do not show the real time gradation of movement and focus effects (such as in the plane of focus). For more information on camera movements see the Spring 2009 *Visual Communication Journal* (Lantz, 2009).

When ready to take a photo on the *Volare,* the shutter fires three times while the RGB motorized filters are positioned by the computer. As stated earlier, the biggest disadvantage to this system is that the color mode is only

Fine texture in wallpaper (enlarged view on right) is one example where the bayer pattern can cause moiré.

Figure 3

Sinarcam-1 (left) and aperture control motor (right) used with the Leaf Volare.

Figure 4

for still life photography. A black and white single shot mode is available and the photographer can pick what filter to use. RGB filters lighten their own color and can be useful in controlling the tonal range in a monochrome image. Another back from the same time period as *Volare,* but with a bayer pattern, is the *Leaf Cantare.* The *Leaf Cantare* shares many components with *Volare* but is a color single shot back with an early multi-shot capability to increase resolution. It has no RGB filters *(Sinarcam-3*). *Cantare* does not have the anti-moiré advantages of the tricolor system. Both the *Volare* (with different filter wheel) and *Cantare* can also be used on medium format cameras.

The *Volare* and *Cantare* use dedicated *Leaf* Taxi PCI boards that fit into a *Mac G4* Tower. They can also work with the *Leaf* PC Cardbus PCMCIA card and a *G4* laptop. *Volare/Cantare* use several interface cords and a dedicated power supply. Complete systems sold together with all the necessary components are rare and usually command a higher price than sourcing surplus components separately.

Micro and Macro-scanning With Sinarback

Microscan digital backs have sensors that are shifted in pixel length amounts in order to increase the one-shot resolution of the digital back. This shifting or micro-scanning is done with small piezoelectric motors. Four or 16 separate shots are taken with one pixel shifts and then blended into one file with increased resolution in software. Macro-scanning is different than micro-scanning. Macro-scanning is shifting the whole back in large movements automatically. Captures are slightly overlapped and stitched together in software. This increases the surface area of image capture. Micro and macro-scanning can be done in conjunction to achieve the highest resolution possible for a given sensor size. For example, 16 shots for each of four positions on the back of a large format camera can be taken automatically for a total of 64 pictures blended together in software to make one large file. The size of this file is dependent on the native or one-shot resolution of the camera back. For example, a *Sinarback 23* with a one-shot native resolution of 6MP is a 25MP back in multi-shot mode. The *Sinarback 23* would be a 75MP back in multi-shot mode when used in conjunction with the macro-scan motorized mount. Not bad for a used $250 *Sinarback 23* digital back (this is the cost of the back itself in 2014, and not the whole system).

The *Sinarbacks* used in this study include the *Sinarback* 22 (4MP), *Sinarback* 23HR (6MP), *Sinarback* 44 (16MP) and *Sinarback* 54 (22mp). Resolutions were given in single-shot mode and are higher in 4-shot or 16-shot multi-shot modes for each of the backs. The *Sinarback 23* and *44* use *Dalsa* sensors and the Sinar 54 uses a *Kodak* sensor.

Three of the backs are actively cooled to lower noise levels in the images, with the fan speed controlled in *Sinar Captureshop* software. All four of these backs can be used with the *Sinarcam-2* for enhanced live view and automated shutter and aperture control via *Sinar Captureshop* software. The *Sinarback 22, 23* and *44* fit on a motorized sliding mount called the macro-scan that is installed on the back of the large format camera (figure 5). The *Sinarbacks* can be installed on the back of the camera without the macro-scan by using a mount plate. The 22MP *Sinarback 54* does not work on the macro-scan motorized mount because of the default frame spacing in *Captureshop* software.

The *Sinarcam-2* fits on the front standard of the large format camera along with the same Digital DB lenses that are used on the *Volare* and *Cantare* systems detailed in the last section. Live view is native with all of these backs and can work without the *Sinarcam-2* on medium format cameras but with a reduced frame rate. The live view frame rate is enhanced with the LCD panel used within

Macroscan camera mount with Sinarback removed (top).

Figure 5

the *Sinarcam-2.* The *Sinarcam-2* contains a built in aperture control motor and an electronic shutter (figure 6). The same lens code plates used on the *Volare Sinarcam-1* system also work on the *Sinarcam-2.* One set of digital DB lenses can be used on all three systems (*Volare*, *Cantare* and *Sinarback)*. These lenses can also be used on the older mechanical *Sinar Autoshutter*. This is important if the *Sinarback* is used in the field on a large format camera with a portable solution. The mechanical *Autoshutter* does not need a power source. The portable solution consists of a battery that powers a PCI card and *Sinarback,* but not the *Sinarcam*. When including a teathered laptop computer, the portable solution is big and bulky but works well with a long battery life (about one hour).

A mount plate and trigger cable is necessary when *Sinarbacks* are used with medium format cameras. *Sinar* made mount plates and trigger cables for *Hasselblad, Mamiya, Bronica, Fuji and Contax* cameras (figure 7). Many backs do not have removable mount plates and can work with only one model of medium format camera. Eight different mount plate kits were made for *Sinarback 22/23* backs.

Sinar Captureshop

Sinar Catureshop is the image capture software used with the *Sinarback*s and *Sinarcam-2*. It is free to download from *Sinar* and works only with *Mac OSX* and *OS9*. Upon starting *Captureshop,* the camera type is selected for the camera and shutter combination. There is a long list of possible combinations. One example is "*Sinarcam*-2," which when selected, a menu will appear listing the lens detected from the lens code plate.

Live view is activated by clicking the closed eye button in *Captureshop* software. Live view is active with an open eye icon and inactive with a closed eye. When live view is active an aperture button appears. When the aperture is pushed, the depth of field can be previewed in live view. The camera movement effects are confirmed with the color live view image on the computer monitor. A smaller magnified image is provided to assist focus. A still preview image can be taken with the exposure mode set on "P." The color balance can be corrected with a eye-dropper tool on a neutral white or gray area in the subject, such as an 18 percent gray card.

The final exposure mode has two or three choices depending on the back model. All *Sinarbacks* have one-shot or 4-shot mode except the *Sinarback 22* light. Some models have one-shot, 4- shot and 16-shot selections like the *Sinarback 23HR*. When selecting 4-shot or 16-shot

Sinarcam-2 shutter and aperture control.

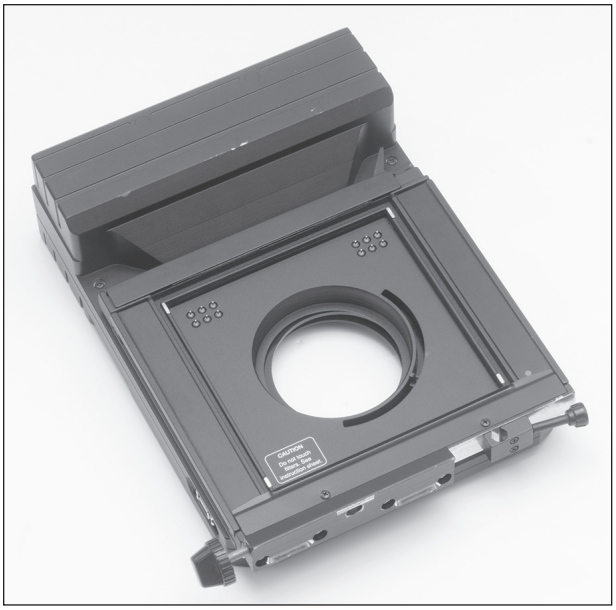

Figure 6

A Sinarback 22 with a Fuji GX680 medium format mount plate.

Figure 7

modes, a slight noise is heard from the piezo motors in the back confirming the mode change. The final shot is taken with a red bolt button. If 4-shot or 16-shot mode was selected, the shots are taken automatically and then compiled and light equalized.

The macro-scan panel in *Captureshop* software is active if the macro-scan motorized back mount is being used. The macro-scan is a mount for a *Sinarback* which moves it into different positions with servo motors. A rectangular image is made from four positions on the macro-scan mount. A two-shot portrait selection is made from two vertical positions on the macro-scan mount. The landscape option is made from two horizontal positions on the micro-scan mount. Once one of these three options is selected the back can be put into live view to preview the cropping. The different positions on the macro-scan mount can be seen only one at a time by pushing the position squares in the control panel. The *Sinarback* is moved on the macro-scan mount by motors when the position squares in software are activated (figure 8).

The whole area of the macro-scan can be previewed manually by sliding a ground glass into position where the three options are marked out on the ground glass (figure 9). Once the cropping is achieved, the "scan" button in the macro-scan menu is used to automatically shoot the photos at the required positioning and with the selected capture mode of one-shot, 4-shot or 16-shot at each position. The camera back is physically moved with loud servo motors in two different directions while the shots are taken. The cords on the back must be properly positioned so they don't get caught on the macro-scan mount itself. After the shots are taken, the "process" tab is selected in *Captureshop*. The resulting two or four individual photos are stitched together in the "microstitch" control panel with the "stitch" button. The final photo can then be gray-balanced and output to disk.

Assembling the Sinarcam Systems

The most difficult parts to find for the *Sinarback/ Sinarcam*-2 and *Leaf Volare/Sinarcam*-1 systems are the necessary PCI interface cards. Some of the cables are also difficult to find but can possibly be custom made because they use standard connectors. The firewire backs are more expensive because propriety PCI cards, which only work in older *Macs,* are not necessary. Firewire *Sinarbacks* can be used on more modern *Intel*-based *Macs.* The file transfer speeds with these old PCI cards do not feel slower in operation than the newer firewire backs.

Surplus computer dealers sell pulled cards from old towers and laptop computers. A *Sinar* PCI card is a field programmable PCI card. They are not standard fibreoptic network cards. They are not labeled *"Sinar"* but can be

The macro-scan camera mount at rest (top) and in motion (bottom)

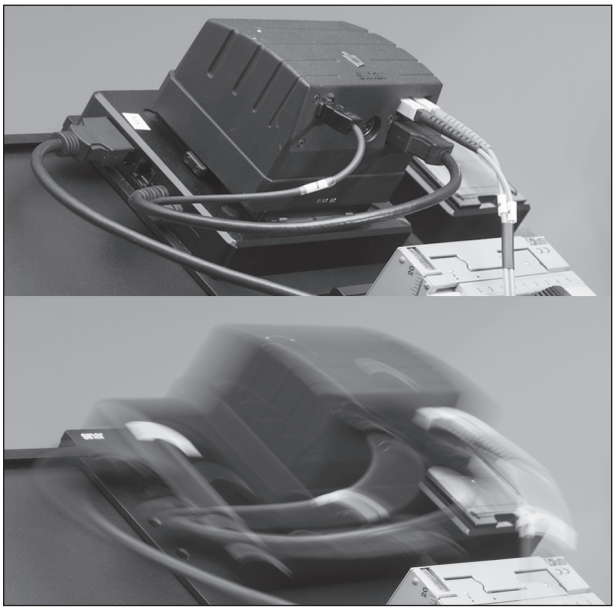

Figure 8

Ground glass mask on macro-scan to indicate cropping for two shot landscape mode.

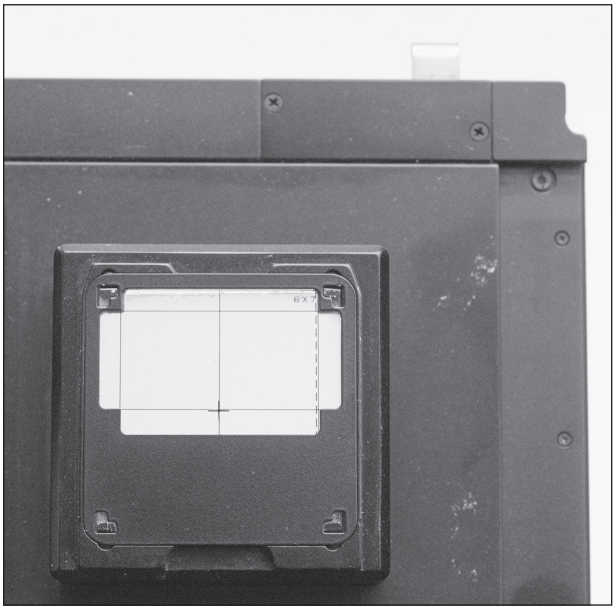

Figure 9

identified with a *Sinar* code/part number on the back of the card. The fibreoptic PCI cards fit in a *G4* tower. The *Sinarback* PCI cards can not be used on a newer *Intel Macintosh* or PC. *Captureshop* 4.1.2 runs well on *Mac0S 10.5X* or earlier. The *Volare Scitex* PCI Taxi cards are clearly labeled, which can make them easier to find. *Leaf* PCI cards use a 9-pin RS-232 cable to connect their power supply to the PCI card. This is not a serial connection but uses a 9-pin serial cable (the kind found on an old modem). *Leafcapture* can run on *Mac OS9* (V7) and *Mac OS-10.4* (V8.4.6). but not on *Windows*. Only *OS9* will work with *Leafcapture* 7 on a laptop with the *Leaf* Cardbus PCMCIA card. *Volare* with a PCI Taxi card will only work in *Mac OSX* if the sensor "blemish" files are available from the original CD with which it was shipped. *Phase One* owns *Leaf* and will provide a download link to *Leafcapture* 8.4.6 for *OSX* if you email their support team.

A single PCI slot Magma breakout box (Sinar fibreoptic card installed) with a cardbus laptop host card (bottom) for a Powerbook G4.

Figure 10

The *Leaf* support team division of *Phase One* may have the original blemish files for a *Leaf Volare* if you provide a serial number for the back.

PCI Breakout Boxes

The *Sinar* PCI card can also be used on a faster *PowerMac G5* tower or on a *G4 Titanium* or *Aluminum Powerbook* if a *Magma* breakout box and a *Magma* host card is used (figure 10). The *Magma* box is a PCI expansion system used by the audio recording industry to house the many soundcards used in a recording studio, for example. Low cost surplus *Magma* boxes (*Digidesign are Magmas*) have one to 13 or more PCI slots. The *Sinarback* card is an older PCI card that doses not fit in a newer *PowerMac G5*. The newer *Magma* PCI card (PCIHIF68) fits in the *PowerMac G5* 1.6ghz (PCI models only). This host card is connected to the *Magma* breakout box with the older PCI card in it. This is connected with a standard 68 pin SCSI VHDCI cable (less than 6 feet). *Magma* is not a SCSI interface but uses a SCSI cable.

A cardbus *Magma* PCMCIA card can also be used with a *G4* laptop. The 17inch *Powerbook G4* is the fastest laptop (1.6ghz) that will work with the *Magma* system and *Sinarback* PCI card. A PCI-X *Magma* host card is compatible with the PCI-X slots in another newer model *G5*.

A bi-directional fibre optic patch cord (two bottom plugs) with a broken connector on top where the break off plastic protected the fibre optic port on a digital back.

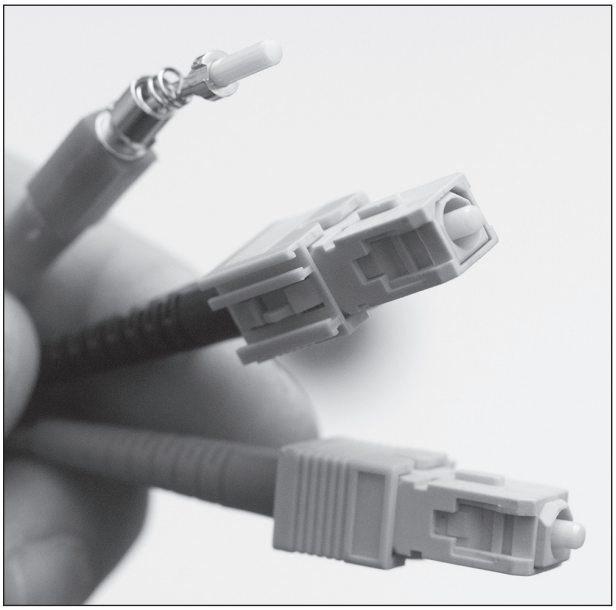

Figure 11

The last PCIe slot *PowerMac G5's* can be used but the most expensive *Magma* PCIe host card is necessary. Some less expensive generic PCIe to PCI breakout systems are available that are not made by *Magma.* Pick the least expensive host card out first and then select the *G5* tower with the correct expansion slots to match the card. *Magma* is the brand that is used by *Sinar* in their portable solution kit.

The *Leaf Taxi* PCI card used by the *Volare* does not work in a *Magma* system (this was tested). *Leaf* sold their own PCMCIA cardbus solution for laptops and a newer *Taxi* card that worked in a *PowerMac G5*-PCI. The *Leaf* PCMCIA Card uses its own custom cable to connect to the nine-pin port of the *Leaf Volare* power supply.

One advantage of the fibre optic backs is that they are less fragile. More modern backs have firewire ports that can wear out quickly or be damaged easily. The fibre optic port on a *Sinarback* use a standard patch cord common in the networking industry (figure 11). This fibre optic patch cord is very well designed to resist damage to the fibre optic port. They have plastic that is designed to break away and not damage the equipment they are plugged into. The "duplex multimode fibre patch cable sc/sc bi-directional" is $35 and is a compatible replacement (*Tripp Lite*). Replacing a fibre optic patch cable is less expensive than an OEM replacing a firewire port on a digital back (about $1000).

The *Sinarcam*-2 uses a propriety power supply with a USB or serial nine–pin RS-232 plug on it. This controls the aperture motor built into the *Sinarcam*-2. The older RS-232 model is more common than the newer USB model. A nine-pin serial to USB converter can be used to convert the serial port to USB. Older *Macs* such as the beige G3's use a round serial plug and do not need a USB adaptor. A Gold-X serial to USB adaptor ($16) is recommended for *Mac OS10.5*× or lower and *G4* or *G5* computers. For *Mac OS9* the *Keyspan* adaptors such as the USA28-X work well.

Sinarcam Stand-Alone

Another advantage of the *Sinarcam*-2 system caries over from the *Volare Sinarcam*-1 system. This is the stand-alone *Sinarcam* configuration without the large format camera (figure 12) (such a system could be used in one-shot mode for portraits). A *Nikon, Olympus* or *Hasselblad* mount lens board is used along with the *Sinarback* or *Volare* on the other end of the *Sinarcam*. Old non-AI lenses work on the *Nikon* lens board. A mount plate is used for the *Sinarback* because the macro-scan mount does not work for *Sinarback* in stand-alone mode. There is no macro-scan mount on the *Volare* so it also needs a mount plate. A rotating mount plate (vertical and horizontal format) is available for the rectangular sensor backs (*Sinar* 23). A non-rotating plate is used for a square

Sinarback/Sinarcam-2 (left) and Leaf Volare/Sinarcam-1 (right) in stand alone configurations with Nikon lens board and non-AI lens.

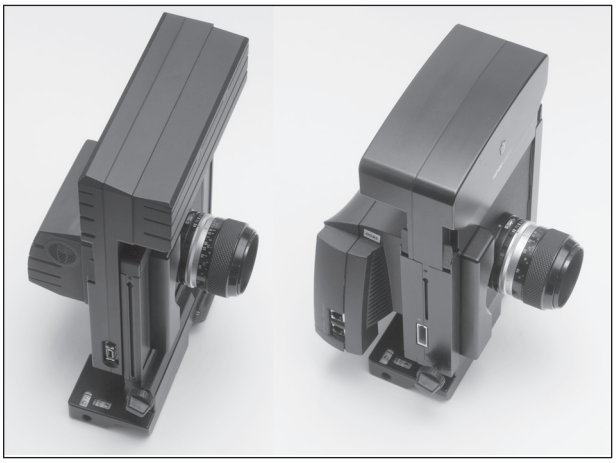

Figure 12

Sensor rotating lever on a Leaf Volare back.

Figure 13

format sensor (*Sinar* 22). The *Volare* has this rotation built into the back itself with a sliding blue plastic lever that physically rotates the sensor (figure 13).

The automatic version of the lens board has a solenoid in it that stops the lens down to taking aperture when an exposure is made. The manual lens board has a lever that moves manually to stop the lens down to the taking aperture when ready to make an exposure. The lens boards for the *Volare Sinarcam*-1 and *Sinarback Sinarcam*-2 are interchangeable. The *Sinarcam*-2 and *Sinarback* fits on a frame that attaches to a tripod mounting block. The *Volare* does not need this mounting frame because it is built into the *Sinarcam*-1. Both the *Volare Sinarcam*-1 and *Sinarback Sinarcam*-2 use the same tripod mounting block.

Once a *Volare* or *Sinarback Sinarcam* configuration is set up it is easier in operation than a manual mechanical shutter system in a medium format camera, such as a *Hasselblad*. This is because shutter and aperture can be operated from the computer. The lens does not need to be opened on bulb to use live view. Jewelry and small product macro photographers especially like the *Sinarcam* configuration because it is difficult to operate the traditional large format lens controls when the camera is at short focus distances from the subject.

Sinar P film camera with a Sinar X front standard and an Autoshutter with an older DB lens.

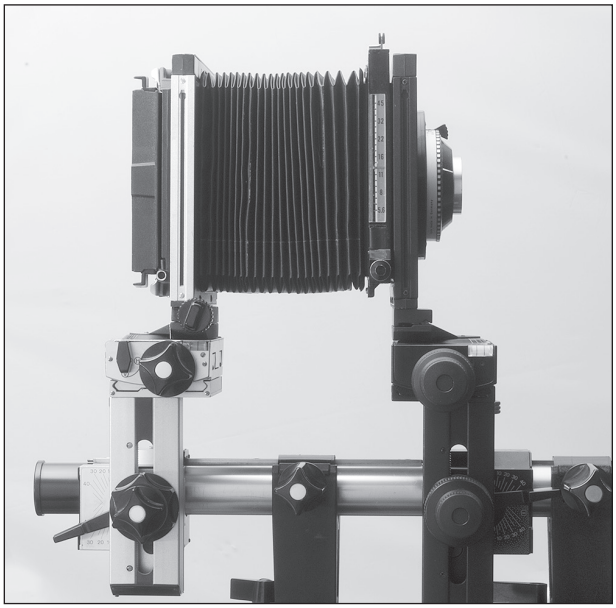

Figure 14

Compatible 4x5 Sinar Cameras

Only *Sinar* large format cameras work with *Sinarback* and *Volare.* Both *Volare* and *Sinarback* systems work best on the *Sinar* P or P2 film cameras (figure 14). The less expensive *Sinar* P is a camera from 1973 and it works with both the *Volare* and *Sinarback* based systems. The older *Sinar* cameras with rail clamp-1 will need to use two rail clamps to support the increased weight of the digital back (figure 14). One rail clamp-1 tends to slip and rotate with a load it was not designed to support. The newer rail camp-2 could work, but two older rail clamp-1 clamps are less expensive and work better. A mount plate for two clamps would be necessary. This can be made easily, or aftermarket dual camera mounts could be used. The *Sinar* dual rail mount plate is usually expensive. It is good practice to avoid picking up or moving one of these cameras on a tripod. Better to use a wheeled tripod dolly/studio stand or remove the camera for transport.

In the past photographers would not compromise and use a less expensive camera than the P or P2 for the *Sinarback* or *Volare.* This is because the digital back system was several times more expensive then the camera and they did not want to risk breaking the components. Now the cameras are worth more than the backs. Bits and pieces from different less expensive *Sinar* cameras can work with *Sinarback* and *Volare*. The *Volare* and macro-scan mount on a *Sinarback* system requires a removable bellows frame on the rear standard. The *Sinarback* without the micro-scan does not need a removable frame and a *Sinar X* would work well. Only the P and P2 rear standards have

Back view (left) and front view (right) of two types of Digital DB lenses. The top lens is a digital converted film DB lens and the bottom lens is a newer Digital DB design.

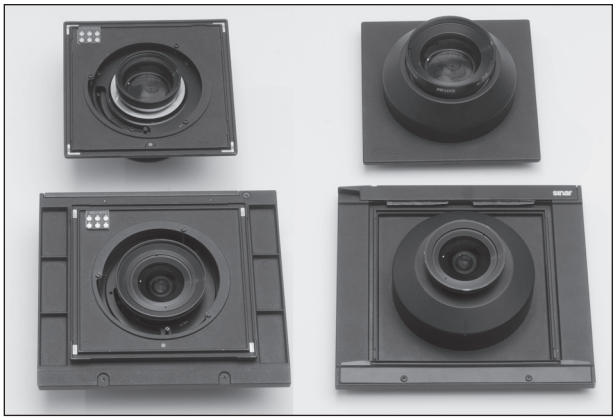

Figure 15

removable frames. The F rear standard could work on a *Volare* as a front standard with a small lens because the heavy *Sinarcam*-1 is on the other end of the camera. The F front standard breaks too easily and is not recommended. The newer F2 front standard could work on a *Volare* with a small lens.

The most common bellows on the *Sinar* cameras for *Volare* and Sinarcam is a Bag bellows as in figure 2. A special bag bellows made for digital lenses is necessary only with lenses such as 35mm. A regular bellows as in figure 1 is still necessary for longer lenses such as 210mm.

Sinar DB Lenses

The older *Sinar* digital DB lens designed for the original DCB and DCB2 can be used on *Sinarbacks* and *Volare*. A red sticker on them indicates "*Expolux* Tricolor Shutter Only." The *Sinarcam-1* and *Sinarcam-2* did not exist at the time these lenses were made, but work fine. In many cases these older digital lenses are of the same design (same lenses as far as the tests done for this article) as current German digital lenses sold today by *Rodenstock*.

The newer *Sinar P3* camera has a smaller bellows design with electric contacts and ribbon cable in it. No exterior trigger cable is required. The *Sinarcam-1* and *Sinarcam*-2 do not fit on a P3 camera. The *Sinar P3* camera uses a newer electronic shutter within the lens. The P and P2 can be converted to the smaller P3 frame size with an expensive kit. The *Sinar* digital DB lenses do not work on the P3. This is why digital DB's are obtainable at much lower prices. The digital DB lenses work on *Sinar's* old mechanical *Autoshutter* (figure 16). Film based DB lenses can be converted to Digital DB by adding a code plate.

Some digital DB's were designed to solve the "close focus" problem that digital large format photographers have with shorter focal length large format lenses. The lenses are mounted backwards on the front standard of the camera (see figure 2). This eliminates the need for a recessed lens board. Longer focal length lenses that do not need a recessed lens board use the standard film-based DB's with the addition of a code plate. This code plate is a ½-inch square green circuit board with gold shorting contacts (figure 17). It communicates the lens type and aperture scale to the *Sinacam* though the configuration of the shorting pads.

These plates exist on many DB lenses because they are backwards compatible with the *Expolux* electronic shutter system that predated the *Sinarcam.* Make sure these plates stay in position. They can move because they are attached with double stick tape only. If they loose contact with the *Sinarcam* the whole system stops working. The wrong code plates can be used with a given lens if you are aware of the actual aperture scale and make allowances for it when setting the f-stop in software. The first-generation code plate system for the original *Sinar* Digital Shutter (1978) use a silver metal plate that is not compatible with *Sinarcams*.

All the *Sinar* DB's have the same aperture control arms that stop the lens down to taking aperture. This DB system can be used as a universal lens system. The *Volare, Sinrcam* and *Autoshutter* can all be used with the same

A Sinar mechanical Autoshutter can be used with digital DB lenses and a Sinarback, as well as film DB lenses. There is a camera mode for the Autoshutter in Captureshop software.

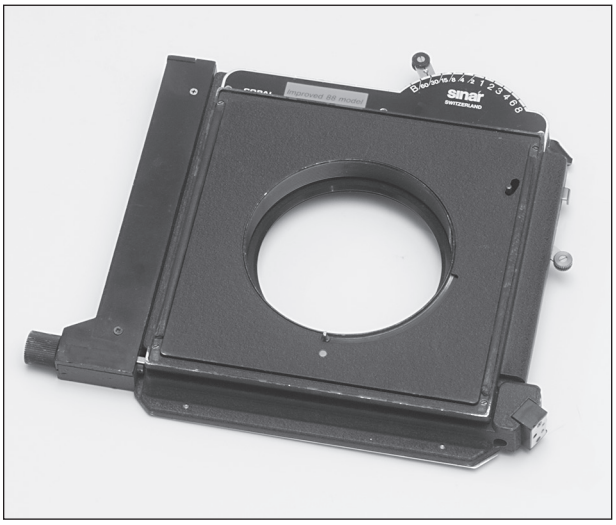

Figure 16

Sinar digital DB code plate.

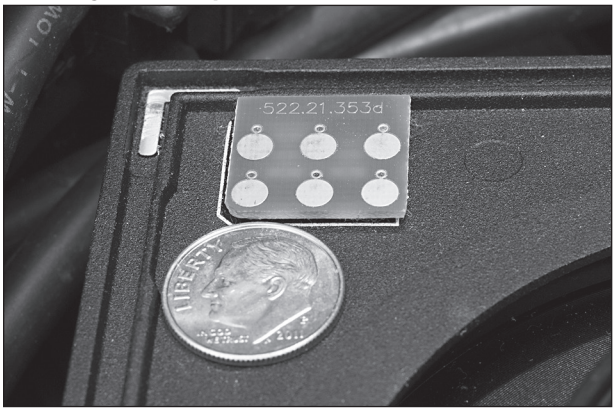

Figure 17

lenses. The problem with this system is if the *Sinarcam* is broken a large collection of DB lenses are not useable. This is why a spare *Sinarcam* is important. *Sinar DB* lenses can also be used with virtually all other digital backs and the mechanical *Autoshutter* or older *Expolux* electronic shutter. DB lenses are the most affordable medium and large format lenses on the market (because the older *Sinar* shutters are no longer made). Most DB lenses can be converted to standard mechanical between-the-lens large format *Copal* shutters that are still made today.

Conclusion

Some features of these older systems are unique and not duplicated in the newer backs. The *Sinarcam* stand-alone options are not available with the new backs. Older *Sinarback*s work on discontinued medium-format cameras such as *Bronica* and *Contax*. Macro-scan is also not available with newer backs. Macro-scan may be revisited in the future when the resolution density limits have been reached on imaging chips. Macro-scan just increases the size of the capture area and not the density of the sensor. One could argue that newer backs don't need the additional resolution of macro-scan. The case could be made that most don't need the increased resolution capability of new backs in general, but they are still being made in increasing resolutions nevertheless. There are other factors to consider such as dynamic range and light gathering capability, but the megapixel war is still going on for medium-format sensors. For example, applications such as aerial photography will absorb as much resolution that manufactures can create.

Setting up these cameras is time consuming, but in operation they are easier to use than traditional large format cameras. *Sinar* made a serious effort to transform the traditional large format camera workflow into a more efficient and convenient user experience. This is why the *Sinar* system won the GATF Intertech award (GATF, 2000). The basic multi-shot principles have not changed in current products. Students can learn about the advanced features of new high-end backs by using the older systems presented in this article.

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360° Product Photography

by Martin Wiser, M.S. • Illinois State University

Introduction

Over the past decade, there have been increases in demand in the private sector for three-dimensional imagery, such as 360° object photography that can allow the viewer to rotate an object in a circular view. A business can use 3D rendering of products, allowing a customer to see a very realistic 3D object (like a shoe on a clothing website) from any angle, before making a purchase. These 360° object images can be converted into computer-assisted design files to drive 3D printers as well. There has also been overlap between 360° photography, 3D rendering and 3D printing. For example, *Top Show 3d* and *Autodesk 123d Catch* has been utilizing 360° photography that is transferred into a 3D rendering of an object as a CAD drawing, which can then be replicated using a 3D printer.

Other processes include spatial 360° photo stitching (also known as panoramic photography) that has been made popular by *Google Maps* and allows a viewer to be in a virtual space to get a circular view of his/her location. Realtors are using this process to provide customers virtual tours of the inside of homes.

This article provides practical guidelines for instructors who may wish to add 360° photography to their curriculums. It includes step-by-step procedures and an explanation of all the tools needed to create 360° product photography. The outcome of this instruction will be a functional 360° product displayed on a website.

The need for 360° product photography

In eCommerce, consumers spend millions of dollars on products that they have never physically seen or held. Their only exposure to the product is a two-dimensional picture on websites selling the product. Anecdotally, it is not unusual to see negative reviews from an array of two-dimensional representations of products with the feedback "not what I was expecting." One can assume that either the product was not the right size, or the images did not portray the product to the customer's expectations. One way that a consumer product company can help assure a better understanding of a product or reduce misrepresentation of the product is by utilizing 360° product photography. In an intuitive way, the customer can rotate the view of an object to be seen from all sides with command of a mouse or touch screen. This not only allows a person to rotate an object, but when set up on the website with the right code, a customer can zoom in to see the object details.

Some studies have looked into the benefits of being able to visually rotate an image of a product. A study by E-consultancy.com suggested that there is "always an angle that a customer wants to see products from that hasn't been displayed" (Moth, 2012). The study goes on to state that websites that utilize 360° photography to display products have an increased view time from the visitors—a key aspect of increasing not just sales but ad revenue. In fact, 360° product photos have "led to a 20% increase in conversion rate for these product pages (compared to static photos), as well as a drop in return rates" (Moth, 2012). *Spinlab*, a company that has created an automated process for 360° product photography, corroborates this data (Spinlab360). A drop in return rates equates to a decrease in logistics costs for businesses and ultimately customers. This might logically also translate to increased customer satisfaction and repeat business. It could also mean that businesses selling from websites that utilize 360° product photography are setting themselves apart from competitors and possibly drawing business away from competing websites that use static photos only. There is added cost associated with the creation of 360° photographs, but these costs may be easier to justify when calculating the benefit in increased sales.

Options for 360° photography

There are a number of companies that sell the hardware and software needed to create 360° photography. Some of the options are fully automated, and all the photographer has to do is place the product on a rotating surface and in a few minutes have the desired output. As of 2014, an automated system costs from $2,400 to as high as $20,000, depending on a variety of desired options. The automated process is a fantastic option for imaging companies that want to generate high volumes of 360° photographs.

For smaller companies, educational institutions, or individuals that want to photograph a limited number of products, there are ad hoc options for creating the images. A step-by-step guide for creating and trouble-

shooting using a camera, tripod, turntable, lighting, editing software and web development code is presented here.

Creating your own 360° product photography

There are three main phases to creating 360° product photography. First is the set-up phase, second is the capturing and editing phase, and third is the coding phase. Below are the tools needed:

1. A camera with manual settings.
2. A tripod.
3. A method to rotate the object (this will be explained in greater detail).
4. A method to light the object.
5. Image editing software (*Adobe Lightroom*, *Photoshop*, or *Photoshop Elements*, *pixlr.com*, or possibly the software that came with your camera).
6. HTML and JavaScript code.

Preparation

Some set-up and preparation work is needed before you begin. The first step is to determine how you will rotate the object that will be photographed. The rotation method depends on the size of the object. For small objects, a low profile cake-decorating turntable works adequately (in 2014, this costs between $7–$25). For larger objects, a custom turntable can be made with some plywood and lazy susan bearings (in 2014, this can be made for as little as $30 or could run several hundred dollars depending on the choices of materials and bearings that are used).

Set up the rotational method

On the rotation device, you need to make reference marks to identify where to rotate the object for each exposure. This can be done with a sewing tape measure and placing indication marks on the rotation device. Once indication marks are made, number each mark. This will provide a reference point where to start your exposures once you begin shooting (figure 1).

Determine where to make marks with this formula: Indication marks distance = circumference of the turntable divided by the number of exposures desired. *Snap360.com* recommends 24 images, but there is no standard for the correct number of exposures to rotate an object. However, the fewer pictures that are taken, the more "jumpy" the animated spin will be when viewing the final output. After experimenting with shooting between 16 and 40 exposures, it was found that the optimal number of exposures is between 24 and 36 images. There is a tradeoff: the higher the number of exposures taken, the smoother the animation, but this will result in a larger size file and increased load time for viewers.

You also need to make a stable reference indicator of where to stop the rotation for each shot. This can be done a number of different ways. Figure 2 is an example of a reference indicator.

Setup the camera and studio arrangement

The next step includes setting up the camera and studio setting. Manual setting on the camera should be used to assure control of the aperture and shutter speed. A tripod should be used to ensure stability. It is also advisable to

Making reference marks to identify where to rotate the object for each exposure

Figure 1

Reference indicator

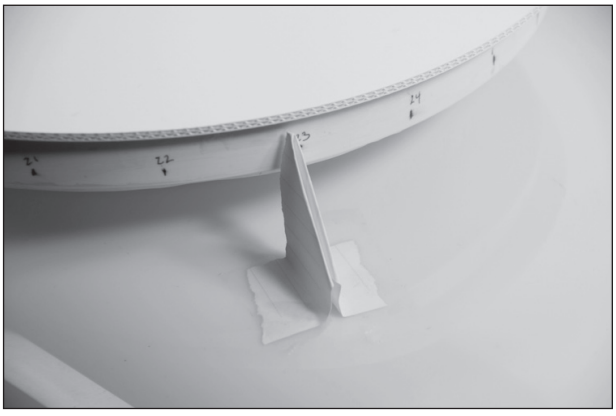

Figure 2

take a few test exposures to verify that the desired results are achieved before beginning the 360° exposures.

Lighting of the object and background will need to be arranged. Lighting the object well will decrease editing time later. By making sure that there is a continuous white background and foreground around the object (which is done with the lighting), the attention is placed only on the 360° object. In 360° photography, most of the final editing done is to make the space around the object white. That is why spending time lighting the object can cut down on editing time later.

Some cameras and software options enable the photographer to tether the camera directly to a computer. This is not mandatory but can help save considerable time by allowing the photographer to review the image on the computer to assure the settings are adjusted properly before beginning to shoot the 360° sequence.

Assembling the sequence

Although any digital camera that can mount on a tripod can be used to shoot products in 360° photography, an SLR (single lens reflex) camera with manual settings and the option of RAW file output shooting is ideal. One reason for this is that you can edit all of the images at once. Another consideration is to turn off the image stabilizer, as it is not necessary since you are using a tripod. The autofocus may also be turned off or stay on depending on the desired outcome. If the autofocus is left on, then the focal point will change throughout the rotation of the object. Also, if the photographer wants to increase the depth of field and keep the entire object in focus, then it is better to turn off the autofocus option and increase the aperture to f16 or higher. Increasing the aperture number will also increase the depth of field range, which will result in more of the object being in focus. When ready to start shooting, keep aperture and shutter settings consistent throughout the entire shoot. The same holds true for editing. It is important remember a simple rule: when editing 360° photographs, what applies to one needs to apply to all. If this rule is not followed, the images will look inconsistent when viewing the final rotation on the website.

Before shooting, remember the number on the turntable where the first exposure was made. Shoot the first image, then rotate the turntable to the second mark, then shoot the second image and rotate the turntable to the third mark, etc., until the final shot, one number prior to the starting number on the turntable.

When framing the object in the viewfinder, the photographer should be aware of the size of the object in relation to the background. Poor results may follow if the object can barely be seen in relation to the background. Be certain to fill the frame. Once all 24 or 36 images have been captured, move on to editing.

Image Editing

Consistent editing across all images is essential. When editing the white or black point, color temperature, contrast, vibrancy, or when making any other adjustments, apply these adjustments to all images in exactly the same manner. If not, as the finished object rotates the lighting, contrast, or color may shift and be very obvious and distracting. Using the actions function in *Photoshop* may be a good practice for both efficiency and for assuring exactly the same adjustments. From here, it is important to change the images to the appropriate size and resolution. Because this is going to be viewed on the web, some advanced planning regarding the pixel dimensions will need to be done. As a rule, it may be best to make all edits to high resolution images, and then make a final edit to a copy of the images, reducing them to the final resolution as needed for the web page.

Save the set of images as jpeg files at medium compression quality. The final step in image editing is to name the files for the script that will be used on the website. The files are numbered starting at 0 (this can be automated as a batch process in *Photoshop*, or done manually). For this application, name the files IMG_0.jpg, IMG_1.jpg, etc. (see note 4 below). Be sure to number the images in the order that they were shot. If the images become out of order, it can take some time and troubleshooting to get the images back in the correct order.

Deploying using HTML

The final part of this process is displaying the 360° object in a web browser using HTML. There are three primary components. The first is the JavaScript code that composites the images to an animation. While there are a variety of solutions for this, the jquery plug-in called *jquery.threesixty.js* will be used with permission from author Nick Jonas (N. Jonas, personal communication, December 10, 2013). The second requirement is a folder containing a set of edited images, numbered and saved correctly. The final component is the HTML page code

with a few custom adjustments to make everything work. At the time of this publication, the *jquery.threesixty.js* plugin and the HTML file will be placed on the GCEA website for downloading. Create a folder and copy all three of these components: (the *jquery.threesixty.js* file, the folder of edited images, and the *index.html* file).

Next, custom edit the HTML to the image names. Shown in Figure 5 is the HTML code; bold text are all of the areas that are necessary to change to customize to a particular 360° product. Use an HTML editor or text editor to edit the code.

After making all the edits to the HTML, save the document. Close the document then open the HTML in a web browser. This will display the interactive 360° photographed product rotation and can be controlled by a mouse.

HTML Note 1: RENAME the title; HTML Note 2: Rename the Head title tag to describe the object

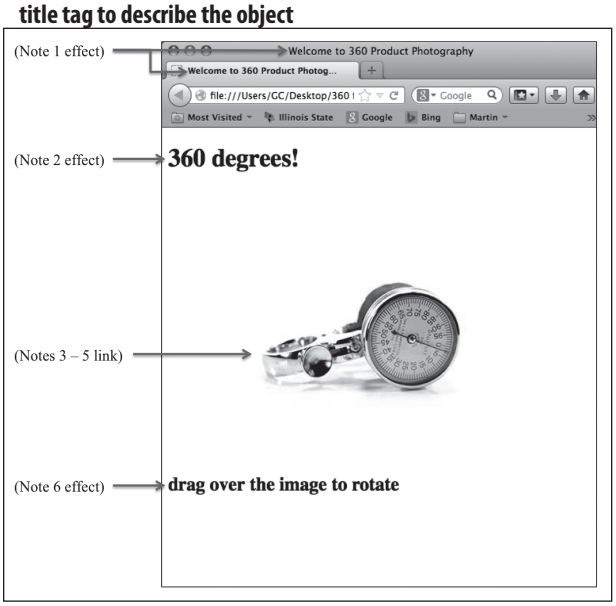

Figure 3

HTML Note 3: Change "caliper" to the folder name that contains the photos. The IMG_{index}.jpg is important because is identifies each file in order. This needs to match the file format exactly and is case sensitive. "index" refers to the numbering of the files which must start at 0; HTML Note 4: Change "36" to number of images in your folder (Remember to add one because they start at 0)

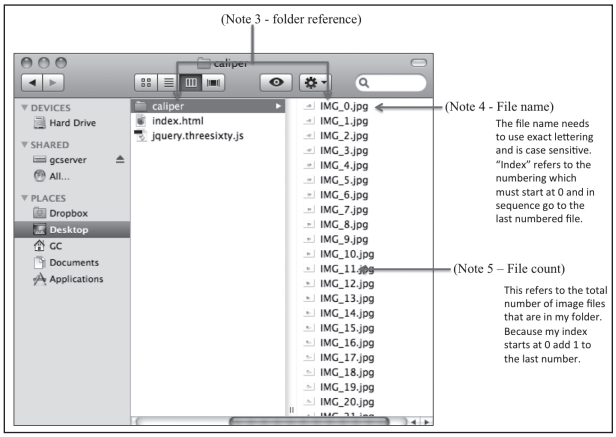

Figure 4

Another Option

There are a number of solutions for deploying the 360° photo to a display. The method described above is appro-

index.html file contents

```
<!doctype html>
<html>
<head>
    <title>Welcome to 360 Product Photography (see note 1) </title>
    <script src="http://code.jquery.com/jquery-1.8.2.min.js"></script>
    <script src="jquery.threesixty.js"></script>
    <script>
    $(document).ready(function(){
    $('.threesixty').threeSixty({
    dragDirection: 'horizontal'
            });
    });
    </script>
</head>
<body>
        <h1>360 degrees! (see note 2)</</h1>
    <div class="threesixty" data-path="caliper(see note 3)<//IMG_{index}.jpg(see note 4)" data-count="36"(see note 5)</></div>
<h2>drag over the image to rotate(see note 6)</h2>
</body>
</html>
```

Figure 5

priate for a website using HTML and JavaScript. However, instructors may wish to use *Adobe InDesign* and the *Digital Publishing Suite*, used primarily by magazine publishers for tablet publishing. This method will require an *Adobe* account, the use of *Folio Builder* and the *Folio Overlays* tool called *Image Sequence.* Much like with the HTML method, the folder of numbered images is required for linking to a picture box. The *InDesign* document page can be viewed with the *Adobe Content Viewer*, downloaded by *Adobe*. As of the date of this publication, Detailed instructions on using *Digital Publishing Suite* tools can be found at the *Adobe* website.

Conclusion

There is demand for 360° product photography for companies both small and large, and the process can be feasible for all product industries on various scales, depending on cost considerations. Although there are few studies that validate the impact of 360° photography on sales, the process is becoming more popular and surely becoming increasingly mainstream in Internet product advertising. After speaking to top management from *ortery.com* and *snap360.com*, the author has learned that both companies are experiencing high demand for the use of their products in the market. It is recommended that graphic communications-related educators incorporate the teaching of 360° photography into their curriculums to assure full relevancy in graphic applications for marketing, advertising, web design, and photography.

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Rendering the Truth: Comparing the Graphics Rendering Speeds of Computers

by Scott McMichael for Professor Phil Snyder, MFA • University of Houston

Introduction

If one were to look at the recent trend in video games, family-oriented movies, and scientific research, it can be said that they have all been going one direction in terms of their display. Family movies are no longer frames of two-dimensional cartoon drawings, but instead are almost all computer-generated three-dimensional scenes. Video games have also become increasingly 3D-based, and are relying on more complex effects (such as lighting and post-processing) than ever. Scientists are now using computer-generated 3D images to simulate virtual physical situations. Science fiction author Herbert W. Franke (1985) attributes all this to a new age in the development of microelectronics, which has made computers more affordable for amateurs and experts alike. He goes on to say that, because of this, computer technology has had an increasing influence in art, media, education, and science. The truth is that today's society is relying more and more on computer-generated imagery (CGI) to visualize their virtual worlds. But as the quality of CGI becomes more advanced and photorealistic, it typically comes at a price: the time it takes for computers to *render* the material increases. The term 'render' refers to the process of translating what the computer sees into an image humans can see. The main problem that needs to be noted here is that today's home computers have relatively slow rendering performance, which increases the time for these computers to render computer-generated images and ultimately slows work down.

The time allotted to render a computer-generated image wildly varies from a split second all the way up to multiple days. University of California professor Samuel R. Buss (2003) insists that "a single ray-traced image may take minutes, hours, and occasionally even days to render," depending on how complex the rendered scene is as well as the speed of the computer. He gives an example of just how major this issue can be when rendering movies with a single CPU, stating that "a movie with 24 frames per second, lasting for 100 minutes, may require 6000 CPU days to render, which is over 16 CPU years". In other words, a single home computer with a traditional CPU would require 16 years (at a render rate of one frame per day) to render a whole CGI-based film. To address this issue, people use multiple computers or a single super computer to render multiple frames at once to slow down the overall rendering time for large-scale rendering projects. Unfortunately, buying multiple home computers, let alone a graphics-rendering supercomputer, can be costly and may even be impossible for those who can only afford one computer.

Long rendering times in general can be a hassle for people and students who want to render high-quality images with their home computers. One issue is whether or not today's computers are actually specialized for rendering. There is the possibility that most of today's computers may not be actually prepared to render CGI in a quick and efficient matter. Some computers may be missing special hardware or software components, such as hardware acceleration, that may better utilize the computer's overall processing power and greatly reduce rendering times. Another issue to consider is the possibility of inconsistency of rendering times across similar computers. One computer may offer much higher rendering performance compared to another computer at roughly the same price, or may offer the same rendering performance as another computer placed at a much higher price.

The consequences for slow CGI-rendering times can be surprisingly catastrophic. Slow rendering times can slow business down, and that in turn can result in increased power consumption per rendered image. More power consumed means that more money is spent for power bills, and that the environment will also take a heavier toll from increased energy consumption. Additionally, higher amounts of running costs for business are spent if more time is taken to render each frame. Finally, companies who are time-constricted for certain computer graphics projects may fail to meet deadlines because the time taken for them to render their images may take too long. Therefore, the use of computers which are better-suited for graphics rendering can be an essential solution for speeding up certain businesses.

Review of the Literature

Frédo Durand (n.d.) of MIT Laboratory for Computer Science describes the rendering process for a virtual scene. A typical computer-generated scene consists of either triangular polygons, vector-based shapes, or a

combination of both. These shapes fill in a grid of pixels which then become the image being visualized, a process called rasterisation. Many other elements can be added to the scene, such as anti-aliasing (smoothing out edges to make them look less jagged), lights, reflections, and shadows. The more details a scene has, the more processing work a computer executes, which means a longer overall rendering time.

There are several components required for this rendering process as a whole, first and foremost being the CPU which is responsible for processing all calculations the computer demands. Another major rendering component is the graphics processing unit (GPU), which can work hand-in-hand with the CPU to process images. As stated by M. Macedonia (2003), a member of the Georgia Tech Research Institute, "The GPUs act as coprocessors to CPUs" when rendering CGI. However, the GPU is normally designed to render only real-time graphics. These graphics, such as videogames and operating system interfaces like Windows, are different from offline-rendered CGI. The latter is typically powered by a process called software rendering, where images are generated exclusively by the CPU.

Programmers are working around the problem of the CPU handling all of the rendering work of non-real-time images. GPU programmers are making progress in transferring processing work from the CPU to the GPU for tasks that are typically done by the CPU only (Andersson & Karlsson, 2008). This hints at the possibility of GPUs assisting CPUs when rendering higher-end CGI. Further evidence of the GPU's potential in the rendering process comes from a study conducted by the University of Oxford. They demonstrate that graphics cards can be utilized to reduce rendering times for electromagnetics simulations "from minutes down to seconds" (Elsherbeni, 2011).

As noted in the introduction, the term 'computer graphics' is commonly associated with its use in entertainment. But CGI has a much wider variety of uses that contribute to society in helpful ways, as Buss (2003) mentions. Virtual reality systems, which use real-time rendered environments, can be used for training for real-world scenarios. Virtual military scenarios and simulated piloting of an aircraft are just two examples of computer-generated training that can help people better prepare for important tasks. Another common use for computer graphics is computer-aided drafting (CAD), which is used for designing and evaluating virtual concepts of objects and structures before they are physically constructed. Computer graphics are also considered a good method for displaying both large quantities of data and scientific simulations such as molecular dynamics for treating diseases (Buss, 2003).

The topic of computer graphics is increasing in popularity among businesses and educators alike. As far back as 1980, businesses have had a growing interest in computer graphics as they began to introduce more hardware and software into offices (Taylor, Schmidt, Birkhahn, Hament, & Quann, 1980). As the popularity of computer graphics increases in schools, more students are assigned school projects that require computer-generated imagery. This can include movie-making, computer-generated 3D images and animations, and Photoshop projects. As told by university lecturers Eike Falk Anderson & Christopher Peters (2009), "computer graphics education has been a minor specialism in computer science curricula, which in recent years has grown in popularity and importance." Students can also create computer-generated media at home for non-educational purposes, such as CGI films to share with friends or the internet. This trend is growing, as a Pew Research study shows that "more than one-half of all teens have created media content, and roughly one-third of teens who use the internet have shared content they produced" (Jenkins, 2009). As more people and institutions resort to computer graphics, it is essential that they have the best hardware to make rendering times for the graphics they produce as short as possible.

There are various software programs that are specifically designed to measure the rendering performance of a computer. One of these programs is *PCMark*, developed by *Futuremark*, which measures general computer performance (Futuremark, 2013). It features multiple tests that simulate common performance-demanding scenarios such as typical desktop actions, video streaming, movie-making, and others. Another software program, known as *Novabench* (2013), gives individual scores for the performance of the CPU, GPU, and RAM. It is particularly quick and easy to install and set up, and is compatible with both Windows and Mac OS's. Finally, there's an internet browser test called *Peacekeeper* which is also developed by *Futuremark* (2014). It does not require any installation of software, as the test can be performed immediately on any internet browser with HTML5 support so long as there is an internet connection. This program runs a series of tests that benchmark the capabilities of a browser, such as rendering speed, compatibility with

special HTML5 elements, and browser performance in various other areas. Scores are given for each category as well as an overall score.

Method

The objective of this research assignment is to compare the rendering speeds of computer-generated images between different computers. To achieve this, each computer that will be subject to this experiment will run the benchmarking test program *Peacekeeper* in an internet browser. *Peacekeeper* was selected due to the ease of use and the fact that no software installation is required. Because of strict store policies, software such as *Novabench* cannot be installed on computers for running tests. Since most demo computers at computer stores have an internet connection, *Peacekeeper* can be run on them immediately. As previously mentioned, it also supports both Mac and PC machines, allowing for a comparison of *Apple Macs* versus *Windows*-run computers. Although *Peacekeeper* displays an overall score for browser performance, only the test's "render score" will be used for the sake of this experiment. The control variables used in this experiment are the type of software to be used, the condition of the computers to be tested on, and the actual performance level of the internet browser to be used.

Plans are to run the test on a variety of demo computers in new condition only. Pre-owned and purchased computers will not be used for the primary tests of this experiment. Special demo computers can be interacted with from a variety of stores, such as *Best Buy*, the *Apple Store*, and the *Microsoft Stor*e, without requiring their purchase firsthand. A relatively equal number of both Macs and PC's will be tested at these three stores. To maintain control variables, all PC's that will be tested will be running *Windows 8.1* and the tests on these will be done on the latest version of *Internet Explorer (IE)*. All Macs will have tests performed on the latest version of the browser *Safari* while running the latest *Mac OS*. Each computer to be tested will be checked beforehand that there are no programs running in the background that could affect render performance besides the internet browser running the test.

One evident issue with running a browser benchmarking test as opposed to installed software in this case is the fact that Macs and PC's use different default internet browsers. As mentioned previously, software cannot be installed on demo computers because of store policies, so IE cannot be installed on a demo Mac, for example. To make up for the potential differences between the different brows ers when running these tests, a special constant will be used to multiply render test scores of the slower browser and interpret them as theoretical scores of the faster browser. To do this, a purchased *Windows* computer will have both *IE* and *Safari* installed, and a *Peacekeeper* test will be performed on both browsers. The higher *Peacekeeper* render score will be divided by the lower score and a constant will be developed. By using this constant, all render scores will be based on a certain "caliber," and therefore a controlled variable is established.

By the time a satisfactory number of computers are tested, the experiment will be finished. The data collected will help compare the rendering speeds of computers, as well as determine if there are any correlations between rendering times and the several factors that differentiate computers. There are plenty of different factors to compare between the computers tested, including the type of computer (PC versus Mac), the amount of RAM, and the CPU/GPU used. An important factor that will be compared is the computer's price. Comparing computers of different prices can help determine how strong the correlation is between a computer's price and the shortness of its rendering time. With that factor in mind, the collected information can possibly help designers find a computer that has a good ratio between price and rendering time. In the end, this project should help anyone who is doing a job or a project that requires heavy-duty rendering, such as movie-making or 3D designing, find the right computer to finish their job as quickly as possible.

Results

The first step was to develop a constant to make up for the performance differences between different browsers. The *Peacekeeper* benchmark test was run four times on a *Windows*-run laptop: two on *Safari* and two on *IE*. It turns out that, on average, *IE* was 25% faster in the render score of the test on the same computer. The resulting correlation, 1.25, is used to multiply the *Safari* render score to keep it up to *IE*'s performance caliber.

For the experiment, a total of 23 computers were tested following the control variables and requirements explained in the "method" section. This number includes 10 *Apple Macs* and 13 *Windows* PC's. Prices of all computers tested range from $600 to $3000 USD. Tables 1 and 2 on the next page sort out all the computers tested by the

render score in *IE*'s performance caliber and the price divided by the render score, respectively.

From looking at the results in Table 1 which are shaded coded with 30% tint being both lowest price and highest performance (such as highest CPU GHz or render score), it can be noted that there is a positive correlation between the render score and the computer's price. It's also shown how the amount of RAM and CPU GHz generally increase with increasing render scores. Additionally, the *Apple Macs* (which are shaded with 10% tint) on average have higher render scores than *Windows* PCs. The most interesting note to make from Figure 1 is how the computer price is not perfectly consistent with the render score. Some computers, such as the 15-inch 2.3GHz *Macbook Pro* and the 2013 *Mac Pro*, have noticeably lower render scores for their prices and even their high RAM and processing power specs. The same results were given for the *Mac Pro* after three *Peacekeeper* tests were performed on two different Mac Pro computers.

In Table 2, the price of the computer is divided by its render score. From here, it's shown that computers with lower prices generally offer better value for the performance based on the *Peacekeeper* render score. The $600 *Microsoft Surface Pro* has the lowest price for the score, while the $3000 *Mac Pro* offers the least value for the score. The one outlier in Table 2 is the *Sony Vaio Ultrabook*, whose render score was unusually low for its price. It is also revealed that almost all of the Macs have a higher price-per-render score than the PC's. It can be said from Table 2 that the higher price of a computer only

Table1: Computer stats sorted by render score, highest to lowest

Computer	Price	CPU	CPU GHz	RAM (GB)	IE Render Score	Safari Render Score
Dell XPS One 27	$1,799.00	Intel Core i7-4770S	3.1	8	118.27	
iMac 27-inch 3.4 GHz, Late 2013	$1,999.00	Intel Core i7	3.5	8	116.90	93.52
Lenovo IdeaCentre A730	$1,499.00	Intel Core i7-4700MQ	2.4	8	116.43	
iMac 27-inch 3.2 GHz, Late 2013	$1,799.00	Intel Core i5	3.2	8	115.08	92.07
iMac 21.5-inch 2.9 GHz, Late 2013	$1,499.00	Intel Core i5	2.9	8	113.15	90.52
Macbook Pro Retina, 15-inch, 2.3 GHz, Late 2013	$2,599.00	Intel Core i7	2.3	16	109.55	87.64
iMac 21.5-inch 2.7 GHz, Late 2013	$1,299.99	Intel Core i5	2.7	8	108.61	86.89
Sony VAIO Flip 15A 15.5"	$1,249.00	Intel Core i7-4500U	1.8	8	107.18	
Macbook Pro Retina, 15-inch, 2.0 GHz, Late 2013	$1,999.00	Intel Core i7	2.0	8	106.70	85.36
Mac Pro, Late 2013	$2,999.00	Intel Xeon E5	3.7	12	104.49	83.59
Macbook Pro Retina, 13-inch, 2.6 GHz, Late 2013	$1,799.00	Intel Core i5	2.6	8	101.55	81.24
Dell XPS 12	$ 799.00	Intel Core i5-4200U	1.6	4	101.45	
Samsung ATIV Book 9 Plus	$1,399.00	Intel Core i5-4200U	1.6	4	101.25	
Sony VAIO Duo 13	$1,399.00	Intel Core i5-4200U	1.6	4	100.19	
Microsoft Surface Pro 2	$ 899.00	Intel Core i5-4200U	1.6	4	99.97	
Macbook Pro Retina, 13-inch, 2.4 GHz, Late 2013	$1,499.00	Intel Core i5	2.4	8	99.76	79.81
Sony VAIO Pro 13	$1,249.00	Intel Core i5-4200U	1.6	4	99.22	
Mac Mini, Late 2012	$ 799.99	Intel Core i7	2.3	4	98.66	78.93
Acer Aspire 23"Touchscreen All-In-One	$ 779.99	Intel Core i5-3230M	2.6	8	92.11	
Microsoft Surface Pro	$ 599.00	Intel Core i5-3317U	1.7	4	88.50	
Toshiba 23"Touchscreen All-In-One	$ 929.99	Intel Core i3-3120M	2.5	6	88.02	
HP Spectre 13 x2	$ 999.00	Intel Core i5-4202Y	1.6	4	86.54	
Sony VAIO Fit Multi-Flip Ultrabook	$ 899.99	Intel Core i3-4005U	1.7	4	69.89	

results in a very slight improvement in *Peacekeeper's* render score. People searching for a computer that renders graphics quickly, in other words, should not look too far into the upper price range, and if they are looking for better value for performance, they should look more towards PCs than Macs.

When running the *Peacekeeper* browser test across all computers, it was discovered that the render score, on average, slightly increased as computer price and performance increased with it. The calculated correlation coefficient between the computer's price and its render score in *Peacekeeper* was 0.57, which is a moderate correlation. This scatter chart below shows the computer's *Peacekeeper* render score compared to its price, along with a line visually describing the correlation. What's notable here is that the render score reaches a peak at around the $1,800 mark and then, as the price further increases, decreases afterward. A high-priced computer to the far right of this chart (the *Mac Pro*), which has an abnormally low *Peacekeeper* render score for its high price, is mostly responsible for this downward slope.

Conclusion

The original hypothesis was that there was a strong correlation between a home computer's price and its rendering performance. This experiment has revealed that the correlation is not as strong as it is expected to be, but there's still a positive correlation nevertheless. It is known that there are other factors that play in to a computer's price besides performance specs, such as monitor size, features such as touchscreens, and storage space. The second lesson learned here, based on this experiment, is

Table 2: Computers sorted by the price per render score point from lowest to highest

Computer	Price	IE Render Score	Price per Render Score
Microsoft Surface Pro	$ 599.00	88.5	$ 6.77
Dell XPS 12	$ 799.00	101.45	$ 7.88
Mac Mini, Late 2012	$ 799.99	98.66	$ 8.11
Acer Aspire 23"Touchscreen All-In-One	$ 779.99	92.11	$ 8.47
Microsoft Surface Pro 2	$ 899.00	99.97	$ 8.99
Toshiba 23"Touchscreen All-In-One	$ 929.99	88.02	$10.57
HP Spectre 13 x2	$ 999.00	86.54	$11.54
Sony VAIO Flip 15A 15.5"	$1,249.00	107.18	$11.65
iMac 21.5-inch 2.7 GHz, Late 2013	$1,299.99	108.61	$11.97
Sony VAIO Pro 13	$1,249.00	99.22	$12.59
Lenovo IdeaCentre A730	$1,499.00	116.43	$12.87
Sony VAIO Fit Multi-Flip Ultrabook	$ 899.99	69.89	$12.88
iMac 21.5-inch 2.9 GHz, Late 2013	$1,499.00	113.15	$13.25
Samsung ATIV Book 9 Plus	$1,399.00	101.25	$13.82
Sony VAIO Duo13	$1,399.00	100.19	$13.96
Macbook Pro Retina, 13-inch, 2.4 GHz, Late 2013	$1,499.00	99.76	$15.03
Dell XPS One 27	$1,799.00	118.27	$15.21
iMac 27-inch 3.2 GHz, Late 2013	$1,799.00	115.08	$15.63
iMac 27-inch 3.4 GHz, Late 2013	$1,999.00	116.9	$17.10
Macbook Pro Retina, 13-inch, 2.6 GHz, Late 2013	$1,799.00	101.55	$17.72
Macbook Pro Retina, 15-inch, 2.0 GHz, Late 2013	$1,999.00	106.7	$18.73
Macbook Pro Retina, 15-inch, 2.3 GHz, Late 2013	$2,599.00	109.55	$23.72
Mac Pro, Late 2013	$2,999.00	104.49	$28.70

Scatter chart arranging all 23 computers tested according to the relation between their render scores and their prices. Correlation line is shown

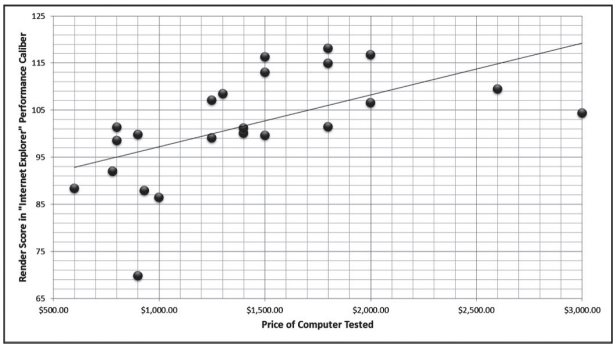

Figure 1

that the lower the computer's price, the better value for rendering performance it offers. Therefore, a more expensive computer may not always offer reasonably better rendering performance for the price increase. Finally, on average, *Windows* PCs offered better value for rendering performance, while *Apple Macs* offered more performance overall. With that in mind, if consumers are looking for a computer for rendering performance on a budget, then *Windows* PCs are currently the preferred choice.

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Developing Cross-Media Designs for Small Business

by Evelyn Rodriguez for Professor Jerry Waite, Ed.D. • University of Houston

Introduction

Small businesses would prosper if they had a successful marketing plan. A majority of large corporations flourish because they integrate both print and electronic media to reach a large audience (Cross-Media, n.d.). Currently, a large number of small businesses do not have enough knowledge on how to use both print and digital platforms to their advantage (Pounds, 2012). A study done by Pew Research found that 51% of adults find businesses through the Internet (Rainie, Purcell, Mitchell, Rosenstiel, 2011). Print advertising is still an important aspect of marketing because it establishes credibility, since many people are afraid of online ads containing spam (Print is dead?, 2012). If graphic design companies do not encourage small businesses to integrate print and digital advertising, small businesses could risk becoming invisible to customers.

Small businesses need an effective marketing plan in order to reach a large audience; a method called cross-media marketing is used to advertise to many different types of people using both print and digital media (Pounds, 2012). Unfortunately, many small businesses do not use the Internet to advertise their services (Rothstein, 2011). There are many reasons why small businesses do not emphasize the Internet in their marketing campaign. Rakesh Agrawal gives a good explanation, when he notes that one of the major roadblocks for owners is that they do not know how to handle things like search advertising. Owners simply do not have the time to run a website and make sure it appears in search engines (Agrawal, 2008).

Creating and managing a website is a long and difficult process, and many owners may become discouraged and may think it is an unreachable goal. Agrawal notes that graphic design companies often overlook small businesses because their salespeople would rather work on pricier campaigns from larger businesses. (Agrawal, 2008).

The fact that many companies are not focusing on small businesses needs to be brought to attention, because they do have needs that are unmet. The amount of money spent on digital advertising is growing; with sales projected to grow in the future (Rothstein, 2011). Graphic and web-design companies need to encourage small businesses to start incorporating digital media into their marketing plans.

Even though digital advertising is important, print advertisements are still needed. Cross- media marketing can increase sales in a graphic and web-design companies, because it requires advertisements to be created for multiple platforms. Presently, there is an increased need for cross-media advertising because businesses need to reach a diverse range of customers (Pounds, 2012). If graphic design companies do not stress the importance of cross-media advertising to small businesses, they will lose out on making sales, and small businesses will lose out to competitors that have many different types of advertisements (Cross-Media, n.d.).

With small businesses facing major competition from more media-savvy businesses, the question that arises is, "How exactly can cross media designs help small businesses increase their visibility?" Cross-media marketing is important for small businesses because it catches the attention of potential customers and makes the business more memorable for future reference. Small businesses also need cross-media marketing in order to differentiate themselves from competitors.

The importance of cross-media marketing needs to be explored in order to provide empirical support to graphic and web-design salespeople when they are selling such marketing to customers. This research ought to explore the dynamic relationship between print and digital advertisement.

The results of this study will provide valuable insight on how both print and web advertising effectively work together to help small businesses target customers more effectively.

Cross-Media Marketing

Cross-media marketing is a concept that has been explored by many researchers. Cross-media advertising is defined as "a strategy used by business owners to market a business using various types of media" (Woodward, n.d.). Michael Ninness states that businesses adopt a cross-media campaign when they feature different ways to reach to customers, such as PURLs or direct mail, and include design elements that are repeated on both the print and electronic platform (Ninness, 2009). The con-

cept of cross-media has been around for some time, but it has become more popular due to the rise of the Internet (Davidson, 2010). Susie Harwood states that cross- media has become more popular because of the increase in channels available to people (2006). David L Zwang (2011) claims that businesses have to develop a cross-media campaign because there are so many different channels of communication, and it is becoming more of a challenge to reach customers.

Cross-Media Marketing and Small Businesses

Cross-media marketing can be very beneficial to small businesses. There are articles that support the use of cross-media marketing in small businesses. In the article *75% of Small businesses Believe in Cross-media marketing*, Howie Fenton (2011) reports that 75% of customers would like to get a combination of e-mail with direct mail. These findings show that customers are interested in hearing from their companies through various methods (Fenton, 2011). Developing this type of campaign is not exclusively for large businesses, and it is flexible enough to meet different types of budgets (Busch, 2011).

In order to encourage cross-media marketing for small businesses, designers need to develop print and digital advertisement that work together to always keep the customers informed and aware of the business. Some companies like Allegra use things like direct mail, e-mail, and PURLs to work together to keep in touch with the customer (Cross-Media, n.d.).

Supporters of Cross-Media Marketing

Researchers who are supportive of cross-media marketing believe it can bring many positive outcomes. Ninness gives an example of a company called Montage Graphics, who has adapted successful cross-media marketing campaign and in 2008 had a growth rate of 15% (2009). Montage graphics uses a personalized cross-media approach; they have a trademark named Particlelogic tools, which is a strategy that sends advertisements through direct mail, the Internet, and e-mail (Ninness, 2009). Ninness states that Montage graphics save time and money because they use the same graphics in different programs (2009). Ninness gives very strong evidence by showing how one company has profited with cross-media advertising. In the article *Marketing Masters*, Chris Bauer (2006) states that a company called Cross-Media is successful because they serve both big and small companies. Cross-Media wanted to help small businesses by creating integrated campaigns that include printing and marketing services (Bauer, 2006). Cross-Media was successful because they offered services at attainable prices and helped companies reduce costs by being their main provider of all their marketing needs (Bauer, 2006). The company Allegra specializes in helping businesses create a cross-media marketing campaign (*Cross-Media*, n.d.). Allegra believes in putting the customer as a priority when it comes to making a web page and sending e-mails, and they stress the importance of finding the target audience when it comes to sending direct mail (*Cross-Media*, n.d.). They strongly believe that customer feedback is important and it should be an important feature in web and print platforms (*Cross-Media*, n.d.).

Adapting a Successful Cross-Media Campaign

In a blog, Ramin Zamini states that companies need to take several things into consideration before adopting a cross-media campaign (Zamani, 2011). He believes that while some companies are successful in adapting cross–media campaigns, other companies struggle because they do not have a clear strategy (Zamani, 2011). Some of the reasons a company might fail are not setting tangible expectations, not developing the right strategies, and a lack of knowledge on the audience they are trying to sell their services to (Zamani, 2011).

Ninness and Bauer both present very strong cases in which cross-media marketing was successful. They managed to show the increase in profit these companies had when they adopted these marketing techniques. They both show how cross-media marketing can benefit the graphic design company and the businesses they are giving their services to. What was missing in Ninness and Bauer's articles was evidence that other companies were successful using this technique as well. Zamani made a good point in his article by stating that while some companies might be successful using cross-media campaigns, others might fail because they do not know how to implement the techniques properly (2011).

There are several articles that show how to capture the attention of audiences, and how find the right channel to use. Manfred Schwaiger and Hugh M.Cannon (2010) made a study that sought to find the effectiveness of cross-media advertisements. Their article provides valuable insight on the concept of cross-media. They

studied students in Germany to see if cross-media synergy was more effective than using print or the Internet alone, and found that Internet advertising became more effective when it was used with print-advertising (Schwaiger and Cannon, 2010). Because most people do not pay attention to Internet ads, they found that a priming synergy effect could be the most effective method, because it uses print advertising first to help promote the ad on the Internet (Schawiger, Cannon, 2010). This article definitely contributes valuable information, because it shows how these two platforms can work together successfully to catch the viewers' attention (Schwaiger, Cannon, 2010).

There are various articles that give advice on how to design a cross-media campaign. Busch states that the components of a cross-media campaign are audience, media, and message (2011). Finding a target audience is important; Harwood believes that it should be the first step in creating a campaign (2006). It is important to find the right type of media in order to get the audience's attention at the right time (Harwood, 2006). In terms of the message, the print advertisement needs to have a "call to action", which shows how you can contact the business (Woodward, n.d). In an article named "Branding pointers for small businesses," several tips are given for small businesses when they are in the process of branding. One of the tips is that they need to have a consistent message in both the digital and print platforms, because it helps establish their image and brand (Anonymous, 2011).

Method

M-R Delivery and Moving Services

Research focused on a small moving company named *M-R Delivery and Moving Services*. It is located in Houston, Texas. Melesio Rodriguez, who has over 20 years of experience as a mover, owns this company. M-R has not successfully developed a cross-media campaign. Their primary form of marketing is through word of mouth and distribution of business cards. They specialize in moving office furniture, and they primarily work with companies who sell office furniture. This moving company is in great need of both online and print advertising.

Research

The method was split into two phases. The first step of Phase One was to create a website and a flyer. The flyer, shown in figure 1 and figure 2, contained a QR code that takes people to the website when it is scanned with their smartphones. A mobile version of the website was also created. The flyer also contained the website address so that people can manually type it in their computers. The website contained all of the company's contact information. It was important to make the business more visible on search engines, so the website was made to contain key words that helped it appear on search engines. A Facebook and Twitter account were also created to help promote the business. The design of both the website and the flyer looked industrial in order to make it attractive for the target audience.

When both the printed ad and website were ready, the flyer was distributed to local storage companies, apartment offices, and furniture stores. After the website and

Front of flyer

Figure1

Back of flyer

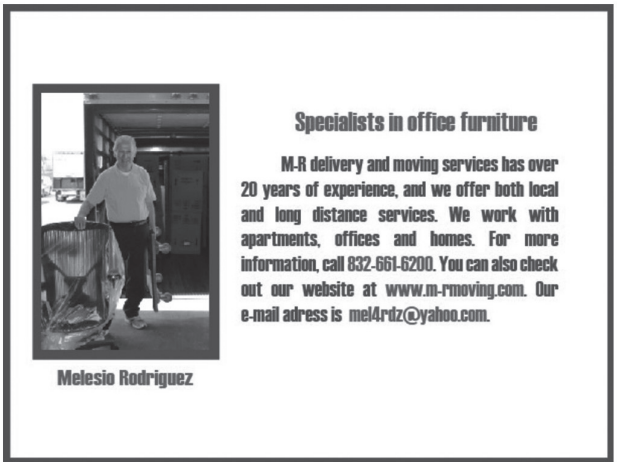

Figure 2

print ads were completed, there was close observation on the number of views the website received. In order to track the page views, *Google Analytics* was used to measure website traffic. *Google Analytics* has the ability to track both mobile and desktop views.

Table 1: Phase 1 Results

	Direct	Referral
Acquisition	76%	24%

For Phase Two of the method, a survey was created to evaluate how people feel about both web and print advertisements. There were six questions in the survey, which can be seen in Tables 2–5. For the first three questions of the survey, participants looked at the flyer that was made for the moving company. They were asked if they prefer to contact the company through web, phone, or email. They were also asked if they would visit the website that was listed in the flyer. It was also important to ask them whether or not the flyer made the company more memorable in their mind for future reference. The next three questions asked them about how they prefer to find businesses. One of the questions asked them if they like to pick up printed advertisements. Another question asked if they prefer to find businesses through web or print. The last question asked them if they trust print or online advertisements more.

Table 2: Question 1

	Phone	Email	Web
1. How would you find out more about this company, by phone, email or web?	57%	30%	13%

Table 3: Questions 2, 3, 4

	Yes	No
2. Does this advertisement make the company more memorable in your mind?	78%	22%
3. Would you visit the website shown in this advertisement?	80%	20%
4. Do you like to pick up printed advertisements such as flyers and business cards	65%	35%

Table 4: Question 5

	Web	Print
5. Do you prefer to find businesses through web or print?	78%	22%

Table 5: Question 6

	Print ads	Online ads
6. Do you trust print or online ads more?	63%	37%

This method aimed at exploring the need for both print and digital advertisements. Phase One of the experiment evaluated how a cross-media campaign helped the moving company become more visible through web and print. Phase Two aimed to discover if it is important to have both print and digital advertising.

Results

Google Analytics has an acquisition feature that lets you see how people find a given website. (Brown, 2013). The three ways people could find your website is through direct, referral, or organic acquisition. For phase one, the results showed that more people found the website through direct acquisition. Direct acquisition means that people manually typed in the URL of the website into their browsers (Brown, 2013). In Table 1, it can be seen that 76% of people found the website through direct acquisition, and 24% found the website through a link that was referred in another website. The results also showed that the website was not found through organic acquisition, which is defined as finding in through *Google* (Brown, 2013).

For Phase Two of the method, the results were interesting. In Table 2, the results of question one showed that by looking at the flyer, people preferred to go to the website to find out more information. For Table 3, the results of question four showed that the majority of people said that they do like to pick up business cards. In Table 4, question five showed that the majority of people prefer to find businesses through the Internet. In Table 5, question six showed that the majority of people trust printed advertisements more than online advertisements.

Conclusions

In Phase One, the results showed that the flyer was effective in promoting the website, since the primary form people found it was through direct acquisition. It also showed that nobody found the website through *Google*. For a small business, it can be difficult to appear at the top of search results because larger businesses have spent more time and money on search engine optimization.

For Phase Two, the survey results showed that more people are using the Internet to find businesses, whether it is through search engines or online directories. Despite this finding, the results of the other questions showed why it is still important to have print advertisements. The majority of people still like to pick up business cards. The results for question six showed that most people trust

print advertisements more than online ads. Perhaps many people fear that online advertisements are spam, participants were least likely to find out more about the company through an ad they see posted online. For a small business, establishing credibility is extremely important.

Overall, the results show that cross-media marketing does help a small business increase their visibility. Cross-media marketing helps businesses reach out to more potential customers. Digital and print advertisements can work together to both get the company noticed and establish credibility among people.

Recommendations

There should be more research done on small businesses that have adapted a successful cross-media campaign. This research could help people gain more depth on cross-media marketing. More research should also be done on how people find websites, whether it's through direct, referred, or organic acquisition.

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The Effectiveness of Using Augmented Reality on Generating Return on Investment

by Bilal Tawil for Monika Zarzycka, M.S. M.Div. • University of Houston

Definition and Description

Augmented reality (AR) is a technology that combines the real environment with computer-generated simulated information (Azuma, 1997). AR is a visualization system that boosts the individual's experience and comprehension of physical element, by superimposing virtual data into a real-world perspective (Thornton, Ernst, & Clark, 2012). AR adds simulated digital materials to present objects, so it can be perceived as a unified environment (Yuen, Yaoyuneyong, & Johnson, 2011).

Through AR an immersive state can be reached, where real approaches similar to those of relating with the real world are experienced (Liu, 2009). This technology joins cognitive, emotional and physical experiences with the interacted object. The visual experiences supported by AR, can be produced by a computer, a head mounted camera or simply a smart device (Kroeker, 2010). Markers should be placed on the actual objects, like Quick Response (QR) codes and "invisible ink", which can be spotted by a specific application. Then the simulated environment can be channeled through the smart device of choice. Interactions with the appearing 3D shapes or hologram can be viewed through the same device.

General Application

One of the first experiences with AR was through the two researchers Caudell and Mizell. They established trial AR system at *Boeing Corporation* to aid technicians in installing wiring harnesses in airplanes (Caudell & Mizell, 1992). AR presented a great potential as a skill training and development tool in different domains. Step through step the processes can be showed by superimposing interactive components on objects to aid assembly workers, with less margins for error (Ennakr, Domingues, Benchikh, Otmane, & Mallem, 2009).

It is also affecting the accuracy and efficiency in the medical field (Azuma, 1997). AR is showing a great potential in enhancing the security, cost effectiveness and productivity of medical procedures. (Samset et al. 2008).

In architecture AR is contributing by enabling potential employers to visualize the blueprint of buildings under construction, so that they can identify the upcoming results (Behzadan 2008). When it comes to academia, AR is providing the students with better engagement in topics and better learning experiences, and increasing motivation while building self-efficacy to learn new topic with less perceived difficulty. (Regenbrecht, Baratoff, & Wilke, 2005).

AR has been tested in different domains, some of which entertainment, military, advertising, and marketing (Yuen, Yaoyuneyong, & Johnson, 2011).

Measuring Return on Investment by Customer Engagement

Sense of engagement is the way customers or potential customers feel about a certain brand or a company. When this connection is established, the customers incorporate deeper positive feelings that will increase the sales of the brand by advocating the customers as a word of mouth sales strategy. This sense of engagement can be established through new innovative technologies based on the *Adobe* experiment on emerging technology touch points as a potential ROI (2008).

Problem Statement

The primary goal of advertising is to introduce a product to a group of audience. In theory, making the introduction experience more memorable and pleasant might result in a potential consumer. However, if the viewer is not knowledgeable of the technology or not willing to spend the extra time to interact with the commercial or simply not interested, the technology or technique will become just an extra cost on the company.

Method

To test the effectiveness of AR as an advertising tool, a basic survey was filled by a diverse group of people. The survey provides data that will help in assessing the knowledge of the participants about AR, the accessibility of AR to them, their interest in the technology and finally their overall impression about it. The group consists of 100+ individuals from different demographics, different educational/cultural backgrounds, and belongs to various age groups. The participants are reached via three different means of media: one direct survey invitation email, one post on Facebook and one post on LinkedIn. The survey contains the questions in table 1. The purpose of the survey is to measure and analyze the following factors:

- General knowledge about AR
- Current accessibility to AR Overall interest in this technology
- Willingness to learn more about it and to use it in the future

One of the major limitations of AR is that it requires a mobile device (smartphone or tablet) and a non-universal/custom mobile application to function. Thus, to be able to experience an AR advertisement, the viewer must have a mobile smart device and a QR code scanner application to scan the code that will lead him/her to the actual AR custom application. The accessibility and knowledge about AR is reached through the results of the first part of the survey (questions 1–7).

The second part of the survey (questions 8 and 9) will test the participants' interest and willingness to learn more about AR, by watching a one-minute video (figure 1) that will provide a general idea about this technology. The video will demonstrate an example of AR as an advertisement tool (magazine) and will show the viewers how they can interact with the ads. Dividing the number of views on the video from the total number of participants will result in the percentage of the tested individuals who are interested in learning more about AR and who actually went through the process and watched the video, which will also prove their willingness.

- After watching the video, question 9 will assess the level of the participant's interest in AR by categorizing their answers in the following four main classes:

Table 1: Survey questions
1. How did you receive the invitation to participate in this survey?
2. Which device did you use to access this survey?
3. Do you know what a Quick Response Code (QR code) is?
4. Do you have a QR code scanner app?
5. Do you know what Augmented Reality (AR) is?
6. Have you ever used an AR technology to enhance viewing experience?
7. What is the biggest reason why you haven't utilized the AR technology?
8. Would you be willing to watch a 1 min video on AR?
If you answered "Yes" to question 8, then please watch the video.
9. What is your overall impression of the AR technology?
10. What is your field of study/work?
11. What is your age group?

- Participants who are interested in learning how to build AR.
- Participants who are interested in using AR more often.
- Participants who are not interested in AR.
- Participants who believe that it is time consuming to use AR.

QR code links to the intervention video

Figure 1

The last part of the survey (questions 10 and 11) will provide more information about the participants in terms of age groups and educational/work backgrounds and will ensure that the survey is unbiased to a certain group. Thus, this section will evaluate the spread of AR based on age and education/work fields.

Having the information above will help in identifying the diffusion of AR among individuals, and how likely they are going to use the technology. The results of the survey/experiment will demonstrate the solution(s) of the problem.

Results

The survey was sent to 500 email addresses on February 20th, 2014 at 9:00 AM. The email addresses were collected from the University of Houston and personal email database. At the same time, a *Facebook* survey invitation was posted on a personal *Facebook* page (accessible to 280 individual) and a *LinkedIn* post was shared with 300 individuals. The survey was closed on February 25th, 2014. A total number of 107 individuals have successfully completed the survey in the five days span.

Based on the results:

- 33% of the participants have general knowledge about AR.
- 45% have accessibility (smart device/QR code scanner).
- 63% are interested in AR.
- 77% are willing to learn more about it in order to use it in the future.
- The range of the participants' age is between 16 and 43.
- More than 25 different fields (education and profession).
- Four different countries and eight different cities.

Data Analyses

Assessing and analyzing the data gathered from the survey using Lean Six Sigma tools and methodology will provide solutions and suggestions in the most efficient and effective approach. The first stage in the analysis process is to prioritize the causes and sub-causes of the main problem(s) by focusing on measuring the negative factors. Based on the results from question 5, it is clear that the lack of knowledge about AR is the leading cause that is affecting the spread of this technology (67% of the participants have not heard of AR before completing the survey). Thus, applying Pareto's principle the 80/20 Rule (80 percent of the outcomes come from 20 percent of the inputs) on this particular problem will generate the major improvement impact on the overall causes and will reduce the rest of the sub-causes (accessibility, interest, and willingness).

The Pareto Chart (figure 1) displays data in prioritized bar & line graph form, and the Interrelationship Diagraph (figure 2) confirms that the "lack of knowledge about AR" is the key driver which is the leading cause of the problem that has a major influence on the other factors. The diagraph shows that the lack of knowledge about AR is affecting the three other causes, but it is not affected by any, and that the outcome is "the participant's willingness to use AR if available for them" because it is affected by three causes and not affecting any.

Conclusion

Since providing a memorable customer experience will result in a potential customer, and might lead to a ROI, and based on the results of the survey, 77% of the tested individuals are willing to learn more about AR in order to use it. Increasing the population's knowledge about this technology will eventually result in ROI.

Today AR is not effective when it comes to ROI, but based on the populations' readiness and willingness to use this technology, tackling the knowledge barrier, might lead to a promising future for AR.

Pareto Chart displaying the importance of the main factors.

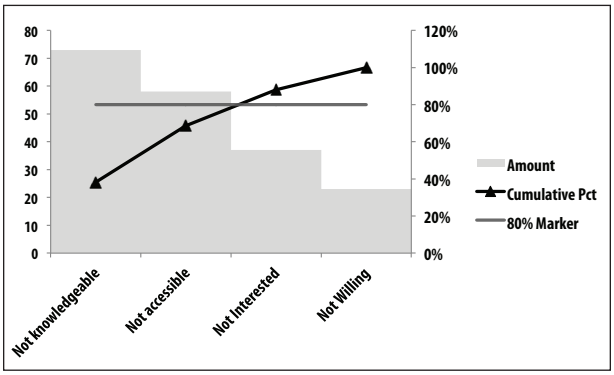

Figure 2

Interrelationship Diagraph confirms that the "lack of knowledge about AR" is the leading cause of the problem that has a major influence on the sub-causes.

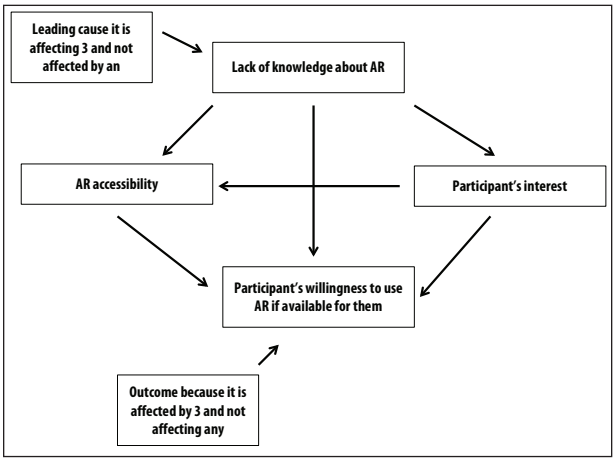

Figure3

Future Suggestion

Educating people, spreading knowledge, promoting the use of AR and making it more accessible, might engage more users, whom might become potential consumers, which might lead to a return on investment. It would be of great importance if future studies will be conducted regarding this issue after creating an educational intervention about AR through direct interaction with the technology instead of a video demonstration. This study reveals the willingness and the readiness of the population in using new platforms and technologies such as AR. Supplying the population with the proper exposure and learning experience will be crucial for the spread of this technology.

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- Submit a Microsoft Word document, maximum of 10 pages (excluding figures, tables, illustrations, and photos). Do not submit documents created in page-layout programs.
- Word documents must have been proofread and be correct.
- Call out the approximate location of all tables and figures in the text. Use the default style "Normal" on these callouts. The call-outs will be removed by the designer.
- Use the default Word styles only. Our designer has set up the page layout program styles to correspond to those style names.
  - Heading 1
  - Heading 2
  - Heading 3
  - Normal

Graphics

- Be sure that submitted tables and other artwork are absolutely necessary for the article.
- Write a caption for each graphic, include captions in a list at the end of your Word document.
- Electronic artwork is preferred and should be in PDF or TIFF format.
- Send all artwork files and hard copies of these files with your submission.

Tables

- Set up tables in separate documents, one document for each table.
- Do not attempt to make it "pretty." Use the default Word style "Normal" for all table text. Do not use any other formatting.
- Do not use hard returns inside the table ("enter" or "return").
- Get the correct information into the correct cell and leave the formatting to the designer.
- Tables will be formatted by the designer to fit in one column (3.1667" wide) or across two columns (6.5" wide).

Artwork

- Scan photographs at 300 ppi resolution.
- Scan line drawings at 800 ppi resolution.
- Screen captures should be as large as possible.
- Graphics should be sized to fit in either one column or across two columns.
  - One column is 3.1667" wide, two columns are 6.5" wide.
  - Graphics may be larger than these dimensions, but must not be smaller.