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DEVELOPMENT OF A MODEL MEDICAL ILLUSTRATION CURRICULUM FROM A COMPETENCY-BASED PERSPECTIVE

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DEVELOPMENT OF A MODEL MEDICAL ILLUSTRATION CURRICULUM FROM A COMPETENCY-BASED PERSPECTIVE

by

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Dedication

This dissertation is dedicated to the friends who became teachers and the teachers who became friends. Looking back on my many years of education, a number of individuals come to mind that, for a variety of reasons, have made a substantial impact on my knowledge base and drove me to aspire to achieve more. Here are some of the truly inspirational friends and teachers that have helped me attain my educational and professional goals . . .

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DEVELOPMENT OF A MEDICAL ILLUSTRATION CURRICULUM MODEL FROM A COMPETENCY-BASED PERSPECTIVE

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The field of medical illustration is experiencing fundamental changes which demand that new knowledge bases be incorporated into existing academic curricula. Students admitted into medical illustration programs come with diverse backgrounds, skills, knowledge, and experiences. This necessitates a comprehensive list of competencies for medical illustrators. However, no such list currently exists. The purpose of this study was to (1) identify all of the tasks (competencies) required of a professional medical illustrator; (2) analyze the necessary level of achievement assigned to each competency by practicing, professional medical illustrators; and (3) organize competencies into curricular themes for the development of a competency-based academic curriculum.

A Medical Illustration Competency-Based Process Model (MICBPM) was developed as a methodological tool to establish a competency-based curriculum and was followed to address the research objectives.

A panel of experts identified the competencies; a survey was designed consisting of 89 competencies. The survey was sent to 678 medical illustrators from the Association of

Medical Illustrators' (AMI) 2002-2003 membership database who had addresses in the United States. Respondents were asked to rate these competencies on their perceived level of achievement necessary. One hundred-forty-two surveys were returned representing a 20.9% response rate.

Frequency distributions for demographic characteristics were calculated. ANOVAs were used to investigate differences among average scores for competencies within demographic groups. Demographic characteristics, such as gender, age, time in the field, school affiliation and levels of freelance were analyzed. Factor Analysis determined 21 dimensions of highly correlated competencies. Findings indicated that demographic characteristics did not generally influence the perceived level of achievement needed for medical illustration competencies. Factors were organized into curricular themes; three broad subject headings.

This study has provided a structure for a list of important competencies, provided by medical illustrators themselves. Educational administrators will have information with which to restructure their curricula. Governing bodies for medical illustration program accreditation can use the competencies developed in this study.

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Chapter I

Introduction

> Not only are communication and education largely synonymous, but they are also part of one continuum in that necessary passage of data from the mind of the investigator who makes a new observation to the minds of other scientists, students, and to the public. (Ruhe, 1963)

BACKGROUND

Medical illustrators specialize in the visual display and communication of scientific information. Their graduate level training in science, art and communications enables them to understand and visualize scientific data and concepts. They create visuals and design communication to teach medical professionals and the general public. Their clients are health professionals, basic scientists, lawyers, publishers, pharmaceutical companies, and medical advertising agencies. The accredited programs prepare students for careers in academic or research health science centers, industry, or consulting. As members of the health career profession with strong communication skills, medical illustrators work closely with clients to interpret their needs and create visual solutions through effective problem solving (Essentials, 2003).

Biomedical illustration is a very small, competitive and eclectic field, drawing heavily upon the diverse disciplines of medicine, art, and allied health. Medical illustrators are professionals who work within the allied health field, specifically biocommunication. They are artists with extensive training in medicine and science who create visual material to help record and disseminate medical and biological knowledge. Medical illustrators not only produce such material but also function as consultants,

educators, and administrators within the field of biocommunication. Obenshain (1977) states that "health science communicators must be educators first" and "the communication process is, in many ways, synonymous with the educational process" (pp. 2-3). A strong foundation in the basic sciences is necessary for admission to a program. Prospective students must be able to understand, visualize, and conceptualize medical and biological processes and nuances. Additionally, individuals need to know about various presentation and production processes to disseminate this working knowledge to others. Creative and artistic talents are important for producing clear, concise, and unique visual depictions for audiences ranging from elementary school students to specialty surgeons. Audiences for medical illustrations are other health professionals, students, patients, and the lay public. Medical illustrators work directly with a variety of professionals ranging from surgeons to other artists and even attorneys. Each professional group that works with the medical illustrator has different needs, and medical illustrators must respond appropriately to each of these particular groups. Having both understanding of medical subject matter and artistic sensibilities, medical illustrators suggest to their clients the best manner in which to present material that is "informationally" correct and easily understood, while still maintaining artistic appeal. Consequently, individuals training for this field need to have imagination and creativity, while adhering to uncompromising, inflexible medical intricacies and procedures. Medical Illustration as a Career, a pamphlet produced by the Association of Medical Illustrators, describes aspects of the field and qualities of aspiring medical illustrators (see Appendix A, Medical Illustration as a Career).

Medical illustrations are generated primarily for print and projection media in medical textbooks, medical advertisements, professional journals, instructional videotapes and films, computer-assisted learning programs, medical-legal exhibits, lecture presentations, general magazines and television programs. Three-dimensional work includes production of anatomical teaching models, models for simulated medical procedures, and cosmetic parts for patients.

Currently, there are five accredited Masters degree programs in the United States (See Appendix B, Accredited School Programs), and each is two years in duration. Additionally, the University of Toronto is recognized by the Accreditation Review Committee for the Medical Illustrator (ARC-MI) for its compliance with the standards for accreditation in the US. Wilson-Pauwels (1993) states that Max Brodel was responsible for establishing the first academic program to offer university courses in medical illustration (p. 33). This was accomplished at The Johns Hopkins University School of Medicine in 1911, thus professionalizing the medical illustration discipline (Wilson-Pauwels, 1993).

The field of medical illustration has been undergoing substantial change throughout the last 15 years (Ansary and El Nahas, 2000; Barrett, 1991; Bekier, 2005; Benschoter, 1994 and 2000; Clarke, 2002; Ludwig, 1993; Skiba, 2005; Tovey, 2003). Like so many other professions, it has moved from being technologically limited, to a technologically driven, if not technologically dependent, field. This fact has been substantiated by McDonald and Singarella's 1991 national study identifying computer utilization trends in biomedical art and illustration in North America (McDonald & Singarella, 1993). Specifically, the study found that groups of respondents were highly

convinced that computer knowledge and skills were necessary for medical illustrators in today's job market, and that computer technology "definitely has an expanding role" (p. 9). Traditional approaches to the creation of work-product have been replaced, improved upon, or augmented by digital computer-enhanced methods (Clarke, 2002; Morton, 1995). Every advancement in information transfer, medical technology, or scientific knowledge has impacted the medical illustrator's knowledge base. For example, widespread promotion of laparoscopic surgery and use of the scanning electron microscope has required medical illustrators to keep abreast of medical and technological advancements as has the introduction of high-end computer software. In teaching and research institutions,

> [b]iomedical communications units have evolved from analog television, board-based illustration, film, and instructional design of traditional media to a heavy reliance on computers and technology. Most production is now heavily computer-based, and services are offered on everything from Web page design to interactive distance education. (Singarella, 1999, p.19-20)

In a 2002 editorial from the Journal of Audiovisual Media in Medicine, it was stated that:

> [t]he world of media in medicine is changing at a remarkable rate. The digital revolution has taken a firm grip on all areas of design, photography and video. Medical illustrators have become conversant with digital imaging, multimedia production and web streaming. This allows clinicians to view clinical images in Electronic Patient Records, promote their services on the hospital website, and teach students remotely. Medical illustrators are constantly embracing changes in technology to give clinicians the best possible service but there is also a strong pull on the profession to develop standards for many of our longstanding processes. (p. 53)

Morton et al. (2000) state “[t]he growth of the information age has led to a revolution in teaching and learning. This revolution has been compared to the industrial revolution

300 years ago, and its effect within hospitals and universities has been profound". (Clarke, as cited in Morton, 2002, p. 65). However, some in the field of biocommunication view technology's impact upon medical illustration with uneasiness. Reba Benschoter, Ph.D., a past president of both the Association of Biomedical Communications Directors (ABCD) and Health and Science Communications Association (HeSCA), has expressed on a number of occasions the growing concern about the future of medical illustration. Benschoter (as cited in Bekier, 2005) cites:

> the growing concern with the rapidly changing technology and the decreasing need for biomedical communications services. Computers, video equipment, and cameras have become much simpler to operate, as well as less expensive. As a result, many of our clientele are turning to cheaper, "non-professional" alternatives or to production of their own media. A significant number of our membership felt that biomedical communications, as a discreet field, was at a "crossroads" and could very well be absorbed by an information technology service. (p. 41) (http://www.jbiocommunication.org/31-1/index.html

Publishing companies, too, are demanding technological advances be employed in image transfer and submittal. They have increasingly demanded that final artwork be submitted in digital format. Production houses now require that artwork be transferred and saved on computer disks and no longer allow submission of two-dimensional traditional flat art. Medical illustrators, while still using traditional modes of art creation, are now using digital drawing tablets, scanners, printers, plotters, fax machines and modems. Vocabulary words such as Pict, EPS, GIF, and raster have become staples in the medical illustration vocabulary, replacing terms such as blue line, rubylith, registration marks, overlay, and paste-up. The impact that these changes have in professional settings, not to mention on academic curricula, is immense.

Since 1948, our economy has changed from an industrial economy to one based on the creation and distribution of information (Naisbett, 1982; Singarella, 1991) and Bekier (2005) states “[t]oday, the U.S. economy is predominantly service-driven” (p. 6). Medical illustration, a field inherently tied to information services, is affected by these changes.

A review of scientific communication literature clearly illustrates these trends, as well as the growing importance of scientific communication. For instance in 1973, Dr. Martin Cummings, past director of the National Library of Medicine, said, "Scientific literature doubles in size every 15 years and shows evidence of continued growth . . . (p. 6). Since then John Naisbett (1982) states that each year the amount of scientific and technical information increases 13 percent (p. x), and Thomas Singarella (1991), past president of the Health Sciences Communications Association, states that "the amount of medical information to be managed is now doubling every eight years" (p. 12). Cummings, Naisbett, and Singarella depict continuing and steady increases in medical information. Never before has there been such a crucial need for "facilitating information transfer to improve health care delivery" (Battles et al., 1989, p. 2). The use of technology has brought significant change to information dissemination (Sevel, 1986, p.6). As a result of the increased role of technology in biocommunication as well as the " . . . the expansion of medical knowledge, one can see an increase in the reliance on visuals [and] medical illustration" (Wilson-Pauwels, 1993, p. 202). Medical illustrators:

> multimedia specialists and ‘as computer-based systems of all kinds are applied to education and documentation in medicine and related fields, the medical communications specialist has to be the master of multiple media.(Morton, R., 1997, p.162)

Slocum (1966) states “the accelerated rate of developing scientific and technological development tends . . . to speed up greatly the changes in occupations” (p.100).

However, academic organizations, including medical illustration programs, have been slow in keeping up with these fundamental technological advances now in demand (Jessup, 1992, p. 2; Stead et al., 1971, p. 16). Russell (1979) states that "the great potential of contemporary technology has yet to be recognized fully by education and, more importantly, truly utilized" (p. 12). Likewise, Clark (1992) states "[h]ospitals and health care have traditionally lagged seven to 10 years behind other industries in implementing information technology" (p. 8). The 1992 NSF Report of the panel on Graphics, Image Processing, and Workstations found that "most academicians and scientists have hardly been affected by the revolution in computer graphics technology and that western society is not inclined to accept, let alone favor, 'any level of non-verbal communication in science.'" (McCormick, 1987, as cited in Jessup). What are the ramifications of this incongruity between education and industry for students who are training for medical communication? Does this apparent differential affect not only what communication technologies are *used* in the health sciences, but also the *preparation* of medical communications students for their roles in professional practice?

"The health care delivery system is dependent upon the successful acquisition, analysis, retention, utilization, and transfer of information" (Student handbook, graduate program in medical information science, University of California, San Francisco, May

1984). Given this fact, Sherman (1980) recognizes biocommunication's role in these information-related processes. She states:

> Biomedical communication has emerged as an answer to some of the problems of modern health science education. It is primarily concerned with conjoining communications technology and the educational process within health sciences curriculum development. (Unpublished doctoral dissertation, p. 10)

"[T]he way health care students are taught makes use of many advanced methods and techniques;" therefore, "applying these to the [*best*] effect is where the biomedical communicator makes an essential contribution to the educational process" (emphasis added: Morton, 1995, p.8).

However, the question can be raised regarding whether medical illustrators are applying methods and techniques to the best effect. In the area of education, Ansary (2003), cites Cattell, by stating “medical illustration has immense scope which medical illustrators have not exploited” (p. 162). Therefore, task competency attainment can be questioned. Academic medical illustration program directors should consider evaluating and assessing students according to "the problems of modern health science education" (Sherman, 1980, p. 10). Administrators must make the necessary curricular modifications to promote task competency for these problems in health science education. Assessment is crucial for successful student competency as well as for continued relevant and timely program curricula. Ewell (1985) states:

> Assessment is a feasible art. And assessment bears clear benefits. Those campuses where comprehensive systems for measuring student learning and outcomes are now in place report improvements in curricula, instruction, collegiality, student advisement, retention, placement rates, and certification exam scores. (Ewell, as cited in Lucas, 1996, p. 211)

But is curricular assessment being carried out? Is it being done adequately, and is it efficient and effective? By what measures are curricula assessed and developed? Rowse et al. (1975) state:

> [C]urriculum development, particularly in schools of higher education, has commonly followed a building block process. Typically a faculty builds its program around the specific strengths and resources of its members and then adds independent units of curriculum one at a time as resources become available and as the undesirability of existing weaknesses become evident. (p.13)

The building block process may not best serve students nor help in establishing a timely or useful curriculum because it does not consider practices occurring outside the walls of academia.

Current medical illustration education administrators are faced with a multitude of previously unrealized concerns, least of which is the mounting dilemma that there is too much information and technical skill to teach in two years (Winn, 1976). Wilson-Pauwels (1993) states:

> it is becoming impossible to teach everything in the limited time available in most programs (p. 203) [because the] content of basic and clinical sciences courses has expanded. Today, medical illustrators must not only be familiar with . . . their basic knowledge in anatomy and pathology, they must also keep up-to-date regarding information in cell biology, neuroscience, immunology, etc. (unpublished doctoral dissertation, p. 202)

Bill Winn, co-chairman of the medical illustration graduate program at The University of Texas Health Science Center at Dallas, states that "all aspects of communication important to the [medical] illustrator cannot be taught in two years" for students to be adequately prepared for current workplace demands (Winn, 1976, p. 28). Recent graduates are not only expected to be competent in the traditional application

techniques of line (pen and ink), color, and continuous tone, but also in many computer programs and digital production processes. Deciding to drop traditional biocommunication classes in basic illustration-related techniques to make way for the newly required expertise with computer driven modes, consequently, has caused some academic programs to develop a particular area of expertise. However, all accredited medical illustration programs have a set of standards that must be adhered to in order to maintain accreditation.

> The Association of Medical Illustrators (AMI) developed the first set of standards for accreditation and began accrediting programs of medical illustration in 1967. In 1987 these standards were modified to comply with the standards of the Committee on Allied Health Education and Accreditation (CAHEA) of the American Medical Association (AMA). The resulting Essentials and Guidelines of an Accredited Educational Program for the Medical Illustrator were jointly adopted by the AMI and the AMA. In October 1992, the AMA announced plans to discontinue sponsorship of programmatic accreditation for allied health education. The Accreditation Review Committee for the Medical Illustrator (ARC-MI) and the AMI Board of Governors voted in 1993 to join CAHEA's successor accrediting agency, the Commission on Accreditation of Allied Health Education Programs (CAAHEP). The Essentials are revised periodically to reflect changes in the field, and accredited programs are reviewed every five years to verify compliance with the Essentials. (http://www.ami.org/education/education.php)

Even with the Essentials, or a set of standards in place, Wilson-Pauwels (1993) states:

> . . . academic programs of the 1930s to 1960s were more homogeneous than they have been since the late 1960s. As well as offering the basic curriculum suggested in the "Essentials" for AMI [Association of Medical Illustrators] accredited programs, many directors have reassessed and diversified their curricula to include course electives and specialized streams of study. (Unpublished doctoral dissertation, p. 202)

Curriculum review, therefore, is of paramount importance for the distribution of biomedical information. Currently there is only a broad, loosely suggested curricular outline of course guidelines promoted by the AMI's curriculum development committee; this is still under development. This reassessment basically consists of updating

terminologies in an established guidelines brochure (Appendix C, Essentials and Guidelines). Gould et al. (1991) states that the five accredited U.S. programs have a "unifying element in the Accreditation Essentials and Guidelines (Committee on Allied Health Education and Accreditation, 1988), which specify subject matter, competencies, and courses necessary for a medical illustration program" (p. 2). His statement uses the word "competencies;" however, a comprehensive list of the competencies referred to by CAAHEP has not been tested. Further, CAAHEP requires:

> Accreditation standards [which] are the minimum standards of quality used in accrediting programs that prepare individuals to enter the medical illustration profession. The accreditation standards therefore constitute the minimum requirements to which an accredited program is held accountable. The program must have the following goal defining minimum expectations: 'To prepare competent entry-level medical illustrators in the cognitive (knowledge), psychomotor (skills), and affective (behavior) learning domains.' Programs adopting educational goals beyond entry-level competence must clearly delineate this intent and provide evidence that all students have achieved the identified basic competencies prior to entry into the field.
> (http://www.caahep.org/caahep/accredit.asp?doc=MI_SG).

CAAHEP also requires that academic program directors "must possess a master's degree, and must be a certified medical illustrator. The director must be a competent medical illustrator and have appropriate experience in education". (http://www.caahep.org/caahep/accredit.asp?doc=MI_SG) See Appendix D.

Full- and part-time faculty, too, "must be responsible for teaching each course assigned by the program director, evaluating students and reporting their progress as required by the sponsoring institution, and cooperating with the program director in periodic review and revision of course materials. Didactic faculty must maintain appropriate expertise and competencies through continuing professional development."

CAAHEP further requires:

> Clinical faculty must be knowledgeable of the program goals, clinical objectives, and clinical evaluation system. Clinical faculty must provide students with appropriate and adequate clinical supervision and must evaluate student clinical competence.
> (http://www.caahep.org/caahep/accredit.asp?doc=MI_SG)

The curriculum must be designed at a master's degree level and must demonstrate compliance with the latest edition of *The Standards and Competencies for an Entry-Level Medical Illustrator* approved by ARC-MI and the Association of Medical Illustrator's Council on Education and Board of Governors.

Evaluation of students must be conducted on a recurring basis and with sufficient frequency to provide both the students and program faculty with valid and timely indications of the students' progress toward and achievement of the competencies and learning domains stated in the curriculum.

The word “competencies” is used over and over again by both CAAHEP and ARC-MI who oversee the curricula of academic medical illustration programs. Specifically, the 1998 Standards and Guidelines when referring to a program’s curriculum and core competencies, state:

> Medical illustration programs must stress the professional competencies required of a practicing medical illustrator. Educational programs in medical illustration are required to develop core curricula to satisfy these competencies as well as their own stated objectives. (http://www.caahep.org/caahep/accredit.asp?doc=MI_SG)

Further, the 1998 Standards state that a comprehensive curriculum must follow a plan that documents, “[a]ppropriate learning experiences and curriculum sequencing to develop the competencies necessary for entry into the profession” (http://www.caahep.org/caahep/accredit.asp?doc=MI_SG). The Commission on Accreditation of Allied Health Education Programs urges that Accreditation Essentials

contain statements of competencies all students must demonstrate as opposed to specifying content and course requirements (http://www.caahep.org/caahep/accredit.asp?doc=MI_SG). In 2003, CAAHEP stated in its minimum expectations states that programs must have the following goal:

> To prepare competent entry level medical illustrators in the cognitive (knowledge), psychomotor (skills), and affective (behavioral) learning domains. Programs adopting educational goals beyond entry-level competence must clearly delineate this intent and provide evidence that all students have achieved the identified basic competencies prior to entry into the field. (CAAHEP, 2003, p. 2).

Yet, "at this time, no validated competencies exist for the medical illustration accreditation review process" (Katz, 1996, p. 13). These elements are missing as they relate practically and professionally to the modern-day workplace. The impact of identifying these competencies would be both immense and potentially beneficial to medical illustration education. A curriculum review, and the subsequent evaluation processes that would result from this identification process would facilitate better school-to-work articulation, increase medical illustrator productivity, and ultimately result in better and faster information dissemination than currently possible. Heiss (1970) concisely points out the need for curriculum review. She states:

> [T]he quality of a school changes faster than its clientele recognizes; and colleges that have developed a novel or more demanding program cannot get the students to match it, while other institutions that have decayed cannot keep students away who should no longer go there. Colleges can change inside their shells with hardly anyone noticing and the results can be tragic, not only for the misled students, but for imaginative faculty and administrators who may not live long enough to be rewarded by the appearance of good students attracted by the change. (p. 75)

Katz, in an unpublished dissertation (1996), states, "[B]ecause the field of medical illustration is changing rapidly, recommendations for . . . research would be in forecasting competencies for the future based on anticipated changes in the environment

and job markets of the medical illustrator" (p.191). However, "[d]ue to time constraints, the relationship of the competencies to the tasks and functions was not explored in [the] study. (p. 173)"

The literature pertaining to medical illustration competencies almost exclusively concerns the illustration aspect of the field, to the exclusion of the biological and medical content matter. Medical illustration curricula have an illustration techniques component as well as possessing human gross anatomy, neuroanatomy, embryology, pathology, and histology components (See Appendices A, C & D). Illustration techniques classes and medical courses are taught concurrently during a student's enrollment but are taught in different departments or colleges. Although important to medical illustration education, the medical subject-matter curricula will not be addressed in this study. This study is only attempting to investigate the competencies and curricular concerns that academic medical illustration administrators face within their own departments.

STATEMENT OF THE PROBLEM

The field of medical illustration is experiencing drastic and fundamental changes on both its artistic and medical/surgical bases, particularly as a result of changing technologies and expanding job roles. These changes are therefore demanding that new knowledge bases be incorporated into an already stringent and comprehensive academic curriculum. Therefore, it is important to ascertain the knowledge and skills each student possesses and teach to that student's knowledge/skill level. This necessitates a competency list for medical illustrators; however, none exists in the literature. A comprehensive competency list for the medical illustrator needs to be created by asking the individuals who possess those skills: practicing, professional medical illustrators. However, many medical illustrators work within a niche of medical illustration or

biocommunications and may have specialized skills. Additionally, professional medical illustrators have various demographic characteristics that may impact their perceived value of a given competency. For example, a veteran medical illustrator most likely was trained differently than a recent graduate in regards to preparing images for production and image archiving. For these reasons, sex, age, experience, accreditation affiliation, level of education, and percent time freelancing may affect the perception of necessary competencies.

STATEMENT OF PURPOSE

The purpose of this study was:

1. To identify all of the current tasks (competencies) required of a professional medical illustrator.
2. To analyze the necessary level of achievement assigned to each competency by practicing, professional medical illustrators.
3. To organize competencies as curricular themes for the development of a model, modern day, academic medical illustration program.

SECONDARY PURPOSES

Additional objectives of this study were:

1. To analyze the differences and/or similarities of responses by respondents of differing genders, ages, professional time in the field, and accreditation affiliations.
2. To assist educational administrators of medical illustration graduate departments in determining which curricular elements should be deleted from, remain within, or be adopted into a two-year program of study.
3. To assist in the articulation of school and work by helping to align educational training and professional job tasks.
4. To identify future competencies for future practice based upon the current competencies identified for contemporary practice.

5. To assist accreditation and certification entities in establishing guidelines and standards for medical illustration education programs.

RESEARCH QUESTIONS

(1) What competencies are required of a professional medical illustrator?

(2) What are the necessary levels of achievement for activities in the medical illustration field, as perceived by professional medical illustrators?

H_1: There will be no significant difference between males and females regarding the perceived levels of achievement ascribed to major competency groupings.

H_2: There will be no significant difference between respondents of differing age groups regarding the perceived levels of achievement ascribed to major competency groupings.

H_3: There will be no significant difference between new graduates and those experienced in the field regarding the perceived levels of achievement ascribed to major competency groupings.

H_4: There will be no significant difference between professionals from accredited academic programs of medical illustration and those from non-accredited programs regarding the perceived levels of achievement ascribed to major competency groupings.

H_5: There will be no significant difference between professionals working in a freelance capacity and those who do not freelance regarding the perceived levels of achievement ascribed to major competency groupings.

(3) How can competencies be organized as curricular themes for development of a model, modern day, academic medical illustration program?

SIGNIFICANCE OF THE PROBLEM

Fundamental problems are insufficiency in medical illustration curricular literature, workplace competency concerns, expansion of medical illustration knowledge

bases, and time. There exist only a handful of articles pertaining to medical illustration curricula, and much of this is subsumed under the biocommunication literature. Additionally, there is a seeming lack of information regarding professional competencies in the field of medical illustration. Medical Illustration accreditation agencies require that their programs have "competent" faculty and administrators but those very agencies have not specified what those competencies should be. These agencies also require that graduates from medical illustration programs be "competent" regarding the tasks necessary for entrance into the profession, but there is not a comprehensive list of those competencies. The current knowledge base and job role of the medical illustrator have expanded due to the increase of medical and scientific information, as well as from developing production technologies and communication transfer processes. Yet, there still remains the need for newly graduated medical illustrators to be competent in the traditional modes of art production while being adept at current methods of digital creation processes. These elements (curricular competencies) must be mastered within the specified two-year program of study, regardless of additional information and process familiarization. Academic administrators are faced with the task of structuring their curricula to include the new information base within the time frame provided. A model identifying the process and/or competencies for use in (re)designing such a curriculum has not been found to exist in the medical illustration literature. Such a model, however, was developed from the review of biocommunications literature that will be discussed in the following chapter.

DESIGN OF THE STUDY

The design of the study began with a needs assessment followed by a comprehensive literature review. Academic curriculum theory, including competency-based education, as well as the biocommunication literature relating to curricular issues

was addressed. These literature reviews established the framework and a methodological approach for the study; they also presented theoretical assumptions and identified the needs of the medical illustration field. A "purposive" sample approach was undertaken for the formation of a panel of experts in the field of medical illustration. The panel of experts consisted of two practicing professional medical illustrators who also had expertise and experience in medical illustration education. Focus groups were conducted with these experts for the purpose of identifying competencies. Each focus group member was asked to compile a list of established practicing medical illustrators who had experience in medical illustration education. A group of ten individuals were identified from all three lists; each focus group member contacted three to four of these individuals and conducted a phone interview. The interviewer asked respondents about curricula themes and elements. From these phone interviews, literature reviews, review of job descriptions, and standards of practice, a competency list was generated. Based on the resultant competency list, the researcher designed a survey to corroborate the existence of each competency. Additionally, the researcher examined the perceived level of achievement necessary as ascribed to each competency by each respondent. The researcher pilot tested the survey with a small purposive sample of medical illustrators and subsequent revisions were made. Surveys were distributed to all professional medical illustrators (respondents from the pilot test were removed) and responses were analyzed. This information provided the researcher with answers to research questions one and two and addressed hypotheses 1 - 5. Based on a combination of research questions one and two, and consideration of hypotheses 1 - 5, the researcher formulated answers to research question three. This third research question, organizing competencies into curricular elements, was achieved through factor analysis. This statistical method identified specific competencies as correlated thus

providing broad topic areas that can be used by academic administrators for designing competency-based curricula. The task of assigning minimum levels of competency to each identified task was not addressed in this study.

POPULATION

A comprehensive list of practicing medical illustrators was obtained from the Association of Medical Illustrators' (AMI) 2002-2003 membership database. The medical illustrators studied included persons employed in small medical education companies, Veterans' Administration hospitals, university teaching hospitals, state and private supported medical, dental and veterinary colleges and private clinics as well as freelance medical illustrators working independently for physicians, pharmaceutical, publishing, advertising, and medical instrument companies. This population was used to study the competency-based process model. Specifically, the population was asked to respond to a list of competencies (derived from an expert systems' analysis) to determine perceived levels of achievement necessary for each competency item.

LIMITATIONS AND ASSUMPTIONS

Limitations

1. The survey was limited to medical illustrators listed in Association of Medical Illustrators' (AMI) 2002-2003 membership database; a number of professional medical illustrators do not belong to the AMI.
2. The survey was limited to medical illustrators listed in the AMI's 2002-2003 membership database with an address in the United States.
3. The survey was limited by the willingness of the participants to respond accurately to and return the surveys.
4. The survey was limited to the competencies which could be taught within a medical illustration department (techniques) and did not address the possible competencies

derived from human gross anatomy, neuroanatomy, embryology, pathology, or histology departments.

Assumptions

1. It was assumed that a model medical illustration curriculum can be designed.
2. It was assumed that the purpose of a degree in medical illustration is to attain employment as a working professional in the field of medical illustration.
3. It was assumed that a competency-based curriculum is a valid approach for the field of medical illustration.
4. It was assumed that a complete competency task list can be accurately derived from those who work in the field.
5. It was assumed that the number of medical illustrator respondents of this study was broad and varied enough to accurately represent the necessary task criteria indicative of the entire medical illustration field.

DEFINITION OF TERMS

Accreditation Review Committee for the Medical Illustrator (ARC-MI) ─ A component of the Association of Medical Illustrators created to establish, maintain and promote appropriate standards of quality for educational programs in medical illustration, and to provide recognition for educational programs that meet or exceed the minimum standards outlined in the accreditation standards. These standards are used for the development, evaluation, and self-analysis of medical illustration programs. On-site review teams assist in the evaluation of a program's relative compliance with the accreditation standards**.** ARC-MI recommends program accreditation to the Commission on Accreditation of Allied Health Education Programs (CAAHEP).

Association of Biomedical Communications Directors (ABCD) ─ The membership of ABCD is comprised of individuals who are employed by and who hold direct administrative responsibility for operations of a biomedical communications

facility in a school or in an academic health science center, both of which must grant degrees in health or life sciences.

Association of Medical Illustrators (AMI) ─ The international professional organization whose members are primarily artists who create material designed to facilitate the recording and dissemination of medical and bioscientific knowledge through visual communication media. Members are involved not only in the creation of such material, but also serve in consultant, advisory, educational and administrative capacities in all aspects of bioscientific communications and related areas of visual education. (See Appendix E.)

Biomedical Communications ─ A service within the health sciences which has as its goal the improvement of information transfer, processing, retention, and utilization, including the improvement and utilization of educational technology. (Association of Educational Communications and Technology Task Force on Definitions and Terminology, 1979, pp 12-13.) This field is broad in scope and houses smaller fields such as medical illustration, photography, and audio-visuals. "The diversity of the field makes bioscience communications, health science communications, biocommunication and biomedical communications synonymous terms" (Grupp, 1975, p.7).

Commission on Accreditation of Allied Health Education Programs (CAAHEP) An accreditation committee set up in accordance with ARC-MI to evaluate and accredit academic medical illustration programs. (Essentials and Guidelines, p. 7)

Competencies ─ "identified and assessable behaviors (or behavioral indicators) reflective of requisite, professional knowledge, performance skills, therapeutic applications, and attitudes" (Broski et al., 1977, p. 39).

Competency ─ A task, or "a generic knowledge, skill, trait, self-schema, or motive of a person that is causally related to effective behavior referenced to external performance criteria" (Klemp, 1979, p. 42).

Competency-Based Education (CBE) ─ A system of education which places high emphasis on the specification, learning, and demonstration of those competencies which are of central importance to the effective practicing of a given profession or career. It encompasses all major educational constituencies, and it includes all of the professions (Schmieder, 1973, p.51-52). The emphasis is on achievement and the psychological viewpoint is that learning is enhanced if the student is actively involved in the achievement of the objectives (May, 1977, p. 28).

Correlation ─ A measure of association between two variables.

Criteria referenced ─ Performance used to determine if the student has achieved the desired competencies. Performance is measured against behaviors or established performance objectives which define each point along a continuum of achievement (May, 1977; Stenstrom, 1981).

Curriculum ─ "Those sequenced experiences that the School consciously and purposely provides for the learner, directed toward the achievement of terminal objectives" (Drumheller, 1971, as cited in Broski, 1977, p. 39).

Dimension ─ Classification of independent variables derived from the Principle Components phase of Factor Analysis, where the objective is data reduction. In this study, each dimension was composed of the sum of 89 products (solution derived weight times the average for each item). The data set resulted in correlation coefficients which had eigenvalues $\geq$ 1.00. In this study, 21 real dimensions were identified as having large eigenvalues.

Efficiency ─ A construct identifying respondents' perceived ability to complete a task effectively.

Eigenvalue ─ (or characteristic or latent root) "A mathematical property of a matrix; used in relation to the decomposition of a covariance matrix, both as a criterion of determining the number of factors to extract and a measure of variance accounted for by a given dimension" (Kim and Mueller, p 83).

Expert ─ An individual who possesses special knowledge and skills. In this study, the group of experts possessed special knowledge and skills as exhibited by knowledge and skills as a practicing, professional medical illustrator as well as having experience in academic settings, experience in curricular design, experience as AMI administrators, and experience in focus groups.

Factor ─ Derived from the statistical operation, factor analysis. A factor is a dimension reduced to include two or more related competencies. In this study, it consisted of a group of correlated competencies that were scored similarly by professional, practicing medical illustrators. There were two categories of Factor structures identified in this study: Major and Minor. Major and Minor Factors were determined by the amount of variation each accounted for and the number of competency items each factor contained.

Freelance medical illustrator ─ An individual who pursues the profession of medical illustration without long-term commitments to a particular employer; a contractor, or professional who derives a percentage of their professional practice from contract work.

Function ─ Categories identified by Alice Katz (1996) as a result of focus groups from freelancers, medical illustrator supervisors, and employers and clients of institutional medical illustrators. These categories are relevant to the field of medical

illustration for established, professional, experienced individuals in supervisory or managerial positions. These broad terms (ie: visualize, sketch, produce, design, consult and art-direct) were used to create more specific tasks, or competencies, for this study.

Health sciences ─ Any one of the life or social sciences dealing with the physical, social, and/or mental health of humans or animals which typically pertains to the treatment, diagnosis, and education of patients.

Industry ─ Workplace environments outside of medical illustration academic training programs, such as companies and hospitals, which employ professional medical illustrators.

Information transfer – Dissemination of medically related subject matter, including images from traditional means (print) and now digital/electronic modes. This term can also refer to the sending of information from one location to another by electronic means such as modems and computer networks.

Mastery learning ─ Learning in which students are "required to meet only the established degree of competency, and nothing more . . . when given specific learning goals, sufficient learning resources, and a flexible schedule" (Stenstrom, 1981, p. 28).

Medical communication ─ Pictorial or written medical information created with the specific intent to educate.

Medical Illustration (MI) ─ Pertains to the production of clinical illustrative imagery specifically in the areas of patient education, medical education and medical research.

Medical Illustrator ─ A professional artist with training in medicine and science who creates visual material to record and disseminate medical, biological and scientific knowledge. Medical illustrators not only produce such material but function as consultants and administrators within the larger field of biocommunication.

Needs assessment ─ "Any systematic process for collecting and analyzing information about the educational needs of individuals and organizations" (Adelson et al. 1985, as cited in Sevel, 1987).

Principle components ─ "Linear combinations of observed variables, possessing properties such as being orthogonal to each other, and the first principle component representing the largest amount of variance in the data, the second representing the second largest, and so on; often considered variants of common factors" (Kim, 1978, p86).

Quantify ─ To apply a numerical value to a defined term; in this case, competency statements were assigned a numerical rating based on the perceived necessary levels of achievement for activities used by practicing, professional medical illustrators.

Task analysis ─ A detailed description of the occupational activities of professional medical illustrators; the consensus of the combined opinions of experienced, practicing experts.

Task ─ In this study, a task is defined as a competency, or job item related to medical illustration.

Varimax rotation ─ "A method of orthogonal rotation in factor analysis which simplifies the factor structure by maximizing the variance of a column of the pattern matrix" (Kim, 1978, p87).

SUMMARY

This chapter has provided an introduction to the study by presenting a foundation of medical illustration and the changes that are occurring that affect its practice and teaching. The literature indicates that academia has not effectively or adequately addressed fundamental changes occurring in the field. Further it has been stated that

current curricula may not adequately prepare individuals for workplace situations. Questions have also been raised regarding how the medical illustration accreditation agencies are determining whether programs, faculty, administrators, and students are deemed competent without a quantifiable, comprehensive list of professional competencies. Also presented were a statement of the problem, a statement of the purpose, research questions, a description of the significance of the problem, an explanation of the design of the study, its population, limitations and assumptions, and a set of working definitions. Literature appropriate to medical illustration competency-based curriculum development is reviewed in Chapter 2.

Chapter II

Literature Review

Theory is the result of our desire to create a world we can understand (Elliot W. Eisner, 1985, p. 29).

> [E]ducation assumes the ability to rank order what should be learned, what shall be taught, what is important, what is trivial, what is beautiful and eternal, and what is pedestrian and fleeting. No curriculum can include all of the knowledge that it is possible to instill, for time and resources are always scarce. There cannot be a class on every subject, every book cannot be assigned, and every tad of information on the Internet cannot be absorbed. We have to choose between Shakespeare and Schwarzenegger, Danny Devito and Darwin. But if we must choose, what is the framework for making the choices? Any consensus on the study of a core curriculum or of the great works appears to be unraveling, and knowledge fragmentation often deprives educators and students of their compass. Yet, education involves selectivity. If the only basis for selectivity is politics and power, then the *raison d'être* of universities is lost . . . .
>
> (Mark Yudof, 1994, The University of Texas at Austin Graduate School Convocation)

Chapter 2 contains a review of literature relating to both curriculum and medical illustration. The chapter's six sections begin with analysis of general curriculum thought and theory, and their conceptions, definitions, and principles. Next, the tenets of competency-based education are described and a singular definition is explored. The third section assimilates ideas of competency-based education into medical illustration education. The fourth section begins to narrow the focus by presenting eight studies in the biomedical communications field. It reviews biomedical communication and medical illustration in terms of specialization, competency-based education, and the function of industry. Further, the fourth section will present four related studies: dissertations that are worth mentioning, because each is tangentially related to medical

illustration competency-based education. The fifth section focuses on process strategies and case studies for competency-based curriculum development. The sixth, and final, section serves as a conclusion and ties the other sections together. In the following chapter, Chapter Three, key principles of curriculum, competency-based education, and medical illustration will culminate in the development of a model for an original, medical illustration, competency-based curriculum process. Attention will now turn toward the concept of a curriculum

CURRICULUM: CONCEPTIONS, DEFINITIONS, AND PRINCIPLES

Schubert (1986) has analyzed the concept of curricula in the broadest sense(s) of the word, and categorizes these classifications into what he calls eight "conceptions." These conceptions, which can be thought of as images or characterizations, represent the major philosophical areas or tenets in the curriculum field. It is beneficial to list and briefly characterize each conception to understand the scope of current curriculum thought, particularly before entering a discussion of competency-based education. Additionally, a broad review such as this is important in light of the difficulty for assigning a concrete definition to the term "curriculum" (Beauchamp, 1975; Bellack and Kliebard, 1977; Draper, 1936; Jackson, 1992; Kliebard, 1989; Pinar et. al, 1995; Pinar, 1999; Rowse et al., 1975; Schubert, 1986; Taba, 1962; Tanner, 1980).

Schubert's first conception, curriculum as content or subject matter, is equated solely with the subjects being taught. This conception is the most traditional and common view of curriculum, stemming back to antiquity and the seven liberal arts. The liberal arts curriculum was divided into the trivium (grammar, rhetoric, and dialectic) and the quadrivium (arithmetic, geometry, astronomy, and music) (Schubert, 1986, p.

26). Curriculum, from this perspective, is simply named categories of like-oriented materials.

Schubert's second conception, curriculum as a program of planned activities, views curriculum as a written document and/or as unwritten plans. The thrust of this conception is that planning is essential, regardless of whether the curriculum is written. The end result is to see that planned activities are delivered to students. "[I]t is the activity ─ what students do ─ that is the curriculum" (Schubert, 1986, p. 28).

Curriculum as intended learning outcomes is Schubert's third conception. This idea of curriculum places emphasis on outcomes as opposed to the activities planned for delivery to students. In other words, it focuses on the ends as opposed to the means. "[C]urriculum is the realm of intentionality that fosters the intended learning outcomes" (Schubert, 1986, p. 28).

Curriculum as cultural reproduction is the belief that "curriculum in any society or culture should be a reflection of that culture [reproducing] salient knowledge and values for the next generation" (Schubert, 1986, p. 28). This is Schubert's fourth conception of curriculum.

Schubert identifies "curriculum as experience" as his fifth conception. John Dewey advocated this conception in his belief that "educational means and ends are inseparable parts of a single process: experience" (Schubert, 1989, p. 30). "Curriculum as actual learning experiences is an attempt to grasp what is learned rather than to take for granted that the planned intents are in fact learned" (Schubert, 1989, p. 30).

Schubert's sixth conception is a curriculum viewed as discrete tasks and concepts that assume a predetermined end, usually with behavioral interpretations. This approach stems from training programs where a set of tasks need to be mastered. This view requires that potential learners be pre-tested and assessed as to their knowledge base. Finally, post-tests are conducted to assess the degree of learning that has been accomplished.

Curriculum as an agenda for social reconstruction is Schubert's seventh conception. It is based on the idea that no society or culture is flawless and that education's intent is to improve the social order, thereby improving society. Schubert (1989) states:

> [T]his view of curriculum holds that schools should provide an agenda of knowledge and values that guides students to improve society and the cultural institutions, beliefs, and activities that support it. (p. 32)

Finally, Schubert presents the last major conception of curriculum; curriculum as "currere." This view regards curriculum as emphasizing "the individual's own capacity to reconceptualize his or her autobiography" (Schubert, 1989, p. 32). Founded on the sharing of autobiographical accounts, this conception espouses recovering and reconstituting perspectives of life events. It becomes a process where individuals better understand themselves, others and the world around them through "interpretation of lived experiences" (Schubert, 1989, p. 32).

These eight conceptions incorporate most of the ideas in the curriculum field today. They have been presented to give a broad understanding of the breadth and depth of current curriculum thought. One just has to look at a collection of books on curriculum to get the idea that there are various philosophies, all of which are valid attempts at conveying the meaning of curriculum. Schubert (1985) states that "more than 1,100 curriculum books have been written in the present century" (p. 26). This is a

considerable number given that not every resource has a singular definition of "curriculum." Further, as has been previously mentioned, there is lack of a common definition and concept for the term "curriculum." Moreover, Beauchamp (1975b) states that there is a "grave need for the definition of the existent range of meanings that are to be associated with the scope of events that belong to the curriculum field" (p. 77). Pinar et al. (1995) state that the numerous definitions are not to be viewed as a disturbing problem that must be urgently solved; rather this occurrence is "a state of affairs that has to be acknowledged" and "[i]n a field comprised of various and autonomous discourses, it is inevitable" (p. 26). John Henry Cardinal Newman's beliefs regarding curriculum, for example, drastically differ from that of Abraham Flexner's (Newman, 1959; Flexner, 1968). Newman, believed for example, that research should be a distinct and separate entity from teaching (Levine, 1978). On the other hand, Flexner believed the university should be concerned with scholarship in both research and teaching (Levine, 1978). This is not to say that either philosopher is wrong; pertinent tenets can be taken from both philosopher's paradigm and definition of curriculum. In fact, some of their notions are congruent with one another, some are somewhat supportive, and still others are in direct opposition. Nonetheless, for the purposes of a dissertation that attempts to identify, and ultimately isolate, curricular elements that can be assimilated into a "model" curriculum, certain definitional assumptions must be made. To do this, a working definition will be explored from both word-origins and curriculum field consensus.

The term "curriculum" in Latin means "race-course" or "career;" Cicero (as cited in Pinar, 1995, p. 25) expanded this idea to include "the course my mind runs on." John Dewey, "the most important American philosopher of education," (Pinar, 1995, p. 14) brought the idea of "experience" to the definition of curriculum in his 1902 book entitled

The child and the curriculum (Pinar, 1995). Up to that point there was very little in the concept of curriculum other than the "organization of subject matter" (Draper, 1936, p. 10).

However in 1992, upon completing a major study, Philip W. Jackson identified characteristic definitions for curriculum that have endured over time. They are as follows:

1. Curriculum is a course; a regular course of study or training, as at a school or university (OED).
2. Curriculum is a course, especially, a specified fixed course of study, as in a school or college, as one leading to a degree. The whole body of courses offered in an educational institution, or by the department thereof (Webster's New International Dictionary, 2nd edition).
3. Curriculum is all of the experiences [students] have under the guidance of teachers (Caswell & Campbell, 1935).
4. Curriculum encompasses all learning opportunities provided by the school (Saylor & Alexander, 1974).
5. Curriculum [is] a plan or program for all experiences which the learner encounters under the direction of the school. (Oliva, 1982) (Jackson, 1992, pp. 4-5)

These definitions further contribute to understanding the concept of curriculum. They can be viewed in light of the conceptions already mentioned by Schubert. Because no one definition unequivocally describes the term curriculum, additional curricular descriptors, or properties, will be explored.

One of the great exemplars of curriculum development, Ralph W. Tyler, identified four basic principles of curriculum to provide a "rationale for viewing, analyzing, and interpreting the curriculum and instructional program of an educational

institution" (Tyler, 1949, p. 1 as cited in Pinar, 1995, p. 33). Tyler's "basic principles," as they have come to be known, are presented in the form of four questions:

1. What educational purposes should the school seek to attain? [Objectives]
2. What educational experiences can be provided that are likely to attain these purposes? [Design]
3. How can these educational experiences be effectively organized? [Scope and Sequence]
4. How can we determine whether these purposes are being attained? [Evaluation] (Tyler, 1949, as cited in Pinar, 1995, p. 33-34)

These are the "quintessential articulation[s]" of the curriculum development paradigm (Pinar, 1995, p. 15) from which much of the current curricula literature is rooted. Tyler's 1949 book, *Basic Principles of Curriculum and Instruction*, from which his principles emerged, "was rated along with John Dewey's *Democracy and Education* as one of the two most influential books on curriculum thought and practice" (Schubert, 1986, p. 171). Jackson (1992) calls this work "the Bible of curriculum making" and says "a more influential text within the field of curriculum would be hard to find" (p. 24). It is "the most widely cited curriculum book . . . and has been translated into at least 10 languages" (Schubert, 1986, p. 171).

In conclusion, it has been stated that Tyler's influence in curriculum thought is strong. His four basic principles provide the theoretical basis for most areas of curriculum development. However, to be answered completely and succinctly, particularly for the purposes of a study that attempts to identify, and ultimately isolate, curricular elements that can be assimilated into a "model" curriculum, Tyler's principles need to be viewed in a particular context. Beauchamp (1975a) supports this notion, stating that basic components in the theory-building process require identifying technical

terms and fencing in the field of inquiry (p. 20). "Fencing in" curriculum thought, from Bauchamp's perspective, must be accomplished by narrowing the field of study. One can only determine a specific educational objective if contexts, such as, mission, purpose, and level of education are considered. This context is necessary to affect any practical aspect of curriculum development theory. While Schubert provides several paradigms from which to view curriculum as a whole, in this dissertation it is necessary to narrow the context of curriculum development to competency-based education in the particular field of medical illustration. The need, intent, and purpose of a medical illustration education will be explored and related to Tyler's four principles. In attempting this, Tyler's principles will be compared with those of additional philosophers, academics, and practitioners in both the competency-based education and medical illustration fields; this will be undertaken in the next two sections of this chapter. Finally, a practical process will be identified and related to Tyler's theoretical basis. This will serve to tie theoretical and practical thought together within a particular field: the field of medical illustration. To achieve these goals, however, concentration will now turn to competency-based curricular tenets.

COMPETENCY-BASED LEARNING: COMPETENCE AND COMPETENCY-BASED EDUCATION

Competency is a widely used term, connoting various meanings. Klemp (1982) describes competency as “a generic knowledge, skill, trait, self-schema, or motive of a person that is causally related to effective behavior referenced to external performance criteria . . . (p.42). He distinguishes competency from performance, for he believes that competency is a knowledge, skill, or trait that results in an effective performance. Performance, however, is the behavioral outcome. Competence is generic and therefore translates to varying behaviors in different situations. Evaluation of competence,

therefore, is specific to the particular professional role and setting and requires a concise definition of what constitutes competence. Three approaches for defining professional competence were identified by McGaghie (1991). The most common approach is identification of groups of senior professionals, called a panel of experts. These individuals serve on committees with the charge of identifying standards of criteria for practice. The second approach is the appointment of special task forces, evaluation committees, or think tanks whose role is to develop up-to-date criteria and procedures for a profession. Jones (2001) encouraged using competencies identified by professional groups in curriculum development because they reflect the best thinking in the field and demonstrate clear links between education and success in the work force. (p. 370). The last approach identified by McGaghie was research on professional practice, but at the time of his study, it was rarely used (McGaghie, 1991). McGaghie goes on to state that there are various research methods that can be utilized for defining professional competence such as: review of accomplishment records, observational studies, and most interestingly, survey research and job analysis. Therefore, a definition of competency as described by McGaghie and Klemp can become the basis for an educational purpose, and the formulation of a competency-based educational system.

Foss et al., (2004) citing Knowles, (1975, 1980), state "[c]ompetency-based learning is a method of education that allows for flexibility, reduction of duplicity, and building on previous knowledge." "A competency-based education is a system of education based on the specification of what constitutes competency in a given field and requires that the student perform at prescribed competency levels" (Stenstrom, 1981, p.27). Long (2000) states:

> competency-based education (CBE), 'implies a training process that results in proven competency' in certain skills and behaviors required to practice that profession. Each trainee would have to demonstrate the acquisition and application [of] the required knowledge, skills, and behavior in order to complete training (or move to the next step in the curriculum). (as stated in Baum and Axtell, 2005, p. 26)

Competency-based education is based on the premise that mastery learning is the major criterion for performance (Knott, 1975, p.28). It does not differ from other curricula in its goals, but rather it assumes that desired outcomes can be stated in terms of defined and recognizable competences (Knott, 1975, p. 28). Ainsworth (1977) calls it a "non-normative . . . instructional system" where the student's ability is "determined independently of that of other students" (p. 322). This type of evaluation is called criterion-referenced evaluation; students are compared to performance standards rather than to other students. These criteria, or standards, are usually derived from professional practice. Stenstrom (1981) states that in competency-based education, the curriculum is determined by the competencies necessary to enter the job market . . . not . . . by the teacher" (p.28). In fact, Bannister (2005) states "[t]he starting point in developing a competent practitioner is the development of the knowledge base necessary to support their clinical practice" (p. 18). A student may attain the desired competencies through a variety of avenues (Ainsworth, 1977). Competency-based education is based on the premise that the time required for the student to achieve a specified competency level may vary, the individual instructional event may vary, but the product in terms of an acceptable competency level remains constant (Leung, 2002; Miller, 1990; Stenstrom, 1987). This focus on an end product as opposed to the means of getting there "allows for curricular content to be derived in a systematic, scientific fashion" (Ainsworth, 1977, p. 323). Knott (1975) identifies three basic elements of a curriculum designed around "competences:"

> First, an overall statement of competences to be acquired for a successful completion of the program; second, sets of evaluative criteria for each competence which define the proficiency levels required form successful attainment; and third, sets of experiences designed to assist the student in attaining the required competences. (p. 28)

Jones (2001) cautions that the initial hurdle for faculty when designing a competency-based curriculum is "articulate[ion] and reach[ing] consensus on the competencies required for success in the work force" (p.370).

Broski et al. (1977) distinguish four qualities implicit in a competency-based curricular model. A competency-based curriculum must: 1) be visible, 2) have the quality of accountability, 3) be revisable, and 4) be transferable. Additionally, Ainsworth (1977) describes potential benefits of competency-based education. He states:

> Competency based education rests on the premise that if one can define expertise in terms of behaviors an expert in a particular skill or discipline exhibits and if one can make these behaviors the target of one's instruction, then many former evils of education will be removed. The student will be able to know exactly what he will be able to do after a particular course of instruction, a third party ─ an employer, a graduate school admissions staff ─ will know exactly what a graduate from a particular course or institution can do, and equally important administrators will be able to know what students should be able to do in course completion and can hold instructors accountable for promoting this performance. (p. 323)

Finally, it is believed that focus on outcomes enhances learning when "objectives are shared before the start of each learning experience" because "motivation becomes internalized" (May, 1977, p. 32). "The student is actively involved in the achievement of the objectives" (May, 1977, p. 28).

A competency-based curriculum "is a purposely provided vehicle for ensuring that learners possess predetermined professional attributes" not determined by the teacher (Broski et al., 1977, p. 39). Therefore, when deciding which objective should be

taught, the ultimate concern should always be the "professional role the graduate must play" (Stenstrom, 1987, p. 84).

Stenstrom cautions that when identifying professional competencies not to assume that there is a universal definition of competence. In fact, he states that competencies are influenced by subspecialties within fields. However, determination of competence must be generalized to the "essential elements of the [individuals'] professional competence" (Stenstrom, 1987, p. 84).

To summarize, a competency-based curriculum possesses a number of qualities. Broski et al. (1977) compiled eight traits common to most definitions of competency-based curriculum. Despite the date that this compilation was created, it represents the most comprehensive summary of competency-based curricular elements found in the literature. First, and most recognizable, "competencies are derived from an assessment of the knowledge, skills, and attitudes needed to perform in the professional role" (Broski et al., 1977, p. 39). Second, "competencies are stated in behavioral terms," meaning that they are "observable and measurable" (Broski et al., 1977, p. 39). Third, competencies to be mastered are publicly known and clearly stated for both teachers and students (Broski et al., 1977). Fourth, competency achievement is evaluated in a criterion-referenced fashion where "learners are compared to performance standards rather than to other learners" (Broski et al., 1977, p. 39). Fifth, instruction is self-paced. More explicitly, Stenstrom (1987) states the time and individual instructional event may vary, but the product in terms of an acceptable competency level remains constant. Sixth, before advancing to subsequent behaviors, students must demonstrate mastery of prerequisite behaviors. Seventh, learners are offered instructional alternatives conducive to their particular learning style and/or preference (Broski et al., 1977). Finally,

instruction is organized into units called modules. Broski et al. point out that each of these modules contains a number of common elements, including:

> a statement of the competencies (behaviors, objectives) to be achieved; a motivational statement relating module objectives to the professional role; an assessment of prerequisite skills; alternative learning activities; assessment of achievement of module objectives; and diagnostic feedback cued to remediational activities. (Broski et al, 1977, p. 39)

Understanding the tenets of competency-based education is becoming increasingly important for those who work in education. Voorhees (2001) observed that "[d]evelopments in higher education, the workplace in general, and health care more specifically have made the adoption of competency-based education more appealing" (as cited in Foss et al., 2004, p. 369). Voorhees further observed that "a revolution is occurring in which the labor market progressively holds postsecondary institutions more accountable for demonstrating that students have learned the competencies needed in the workplace. (p. 369). Additionally, there has been documentation that a switch is occurring from a knowledge-oriented educational approach to a competency-based approach within both higher education and medical education world-wide (Achtenhagen, 2001; Arguelles & Gonczi, 2000; Barnett, 1994; Baum & Axtell, 2005; Carraccio & Englander, 2004; Leung, 2002; Levesque, Lauen, Teitelbaum, Librera, & MPR Associates, 2000; Nahrwold, 2005; Samuelowicz, 2001; Tovey, 2003; Vermunt & Verloop, 1999). Supporting this documented trend, Carraccio (2004) states:

> [c]ompetence requires the application of knowledge in the performance of authentic tasks, rather than mere acquisition of knowledge. Formative feedback is critical to the achievement of competence (p. 382).

Leung (2002) states that the competency approach:

> originated from parallel developments in vocational training in many countries, such as the national qualifications framework in New Zealand, the national training board in Australia, the national skills standards initiative in the United States, and the national vocational qualifications (NVQs) in the United Kingdom (p. 693).

These trends, their impact upon medical education and medical illustration will be discussed further in the next section.

MEDICAL ILLUSTRATION EDUCATION: TRENDS IN MEDICAL EDUCATION, SPECIALIZATION, AND THE FUNCTION OF INDUSTRY

"Medical education is currently in a state of rapid evolution" (Musick, 2005, p. 244). "Medical education is evolving rapidly with new methods; increased emphasis on lifelong learning; and new ways of assessing the knowledge, skills, and attitudes of . . . students" (Musick, 2005, p. 248). As a result, "the competency approach has become prominent at most stages of undergraduate and postgraduate medical training in many countries" (Leung, 2002, p. 693). "Medical education in the United States of America (USA), and worldwide, is increasingly concentrating on the process and outcome of the educational experience" (Baum and Axtell, 2005, p.22). The assessment of performance in the real world of medical practice is now widely accepted as the goal of assessment at the postgraduate level. Therefore, "[t]here has been an increasing emphasis on the process, and most recently, the outcome, of medical education" (Baum and Axtell, 2005, p.22). Baum (2005) further states:

> The latest trends in the USA medical education focus on the outcomes of the learning process. At the forefront of this movement is the American Council on Graduate Medical Education (ACGME), which accredits all USA post-graduate training programs. (p.22)

In the late 1990s, The Accreditation Council for Graduate Medical Education (ACGME) and the American Board of Medical Specialties (ABMS) moved their "focus from a structure and process system of graduate medical education to one that is

outcomes based" (Carraccio, 2004, p. 381). In fact, "[t]he competency of practice-based learning and improvement is now a requirement for accreditation of all residency programs by the Accreditation Council for Graduate Medical Education" (Nahrwold, 2005, p.168) The American Association of Medical Colleges also supports a "shift to competency-based education and aligning those competencies with those of the ACGME" (Baum and Axtell, 2005, p. 26).

"Post-graduate training programs are now mandated to focus on outcomes rather than curriculum delivery in order to maintain accreditation." (Baum and Axtell, 2005, p. 26) Baum (2005) further states:

> All programs will have to demonstrate that their graduates have acquired certain skills, such as professionalism and patient care (as opposed to demonstrating that the program teaches these skills), in order to be accredited. It is a significant shift in the accreditation process: the programs much [sic] demonstrate what their trainees have learned rather than what they have been taught. (p. 26)

In their efforts to focus graduate medical education on the outcomes for its trainees, the ACGME and ABMS created the Outcomes Movement. "This concept requires educators to pay increased attention to not only the process of education (i.e., how we teach), but also to the outcomes of the process (i.e., whether students actually learned what we claim to have taught them)" (Musick, 2005, p. 244).

Baum and Axtell (2005) state:

> The ABMS was developing competencies that all physicians should display throughout their practicing lives. ABMS, the umbrella organization for the 24 certifying boards, was developing a program that would ensure that diplomats periodically display to their boards the competencies expected of contemporary physicians. The leadership of ACGME and ABMS discovered the obvious: the competencies that practicing physicians should display should be the same as those that were taught and learned during residency training. (p.168-169)

Musick (2005) states:

> The new emphasis on outcomes is primarily a result of an educational paradigm called "the competency model" of education. National accreditation bodies for medical schools, as well as for residency and fellowship training programs, have adopted the competency model in earnest. Notable here, for example, is the new "Six General Competencies" model, a competency-based educational approach that has been adopted by both the Accreditation Council for Graduate Medical Education (ACGME) and by the American Board of Medical Specialties (ABMS). (p. 245)

> To clarify the concept of competency-based learning, the National Postsecondary Education Cooperative (NPEC) (2002) convened a group of experts in competency-based, postsecondary education to synthesize knowledge and develop a guide for college educators interested in implementing competency-based learning. This group defined competency as the blend of skills, abilities, and knowledge needed to perform a specific task. (National Postsecondary Education Cooperative as cited in Foss et al., 2004, p. 368)

Medical education is changing "due to the introduction of innovative techniques in the medical practice and constant review of curricula" (Ansary and El Nahas, 2000, p. 71). Medical illustrators will be required to "understand educational content planning besides being able to advise clients on all aspects of digital, audiovisual and communications technologies." (p.71)

Cattell (1971) states that "medical illustration has immense scope which medical illustrators have not exploited" (p. 162). "We have an important role in the effective utilization of multimedia to support medical education at all levels, and we do need to develop our skills to understand better the needs, processes and mechanisms of medical education" (Ansary, 2003, p. 161-162). Ansary and El Nahas (2000) cites Marks (1981) stating "the medical illustrator needs to acquire skills in the field of education, educational planning and educational technology in preparation for the changing role in medical education" (p. 71). Ansary and El Nahas (2000), and Penta and Spengler (1974) believe that these should include:

> knowledge of the various domains of instructional objectives (i.e. cognitive, affective and psychomotor), selection of appropriate learning experiences, planning of teaching strategies, and evaluation based on goals and objectives of production and development. Expertise in both technology and education will facilitate choices of techniques and their implementation. (Penta and Spengler, 1974, as cited in Ansary and El Nahas, 2000, p. 71)

As the accreditation and academic entities are focusing on the outcomes of healthcare education, a general trend is occurring by those who directly benefit from these outcomes. Adsit & O'Neill (1987) state, "Americans are taking more responsibility for their own health maintenance" (p. 23), and William Millard (1983), past president of the Health Sciences Communications Association (HeSCA), believes "the consumer is going to play a much more active role in his or her own health care" (p. 4). President John F. Kennedy forecasted the need for people to care for themselves better as a preventative measure to health care concerns over 40 years ago when he addressed Congress in 1962, stating:

> The accumulation of knowledge is of little or no avail if it is not brought within reach of those who can use it. Faster and more complete communication from scientist to scientist is needed, so that their research efforts reinforce and complement each other; from researcher to practicing physician, so that new knowledge can save lives as quickly as possible; and from the health profession to the public, so that people may act to protect their own health. (p.169)

All of the paired groups mentioned by President Kennedy inherently involve biomedical communication in their interactions. For example, medical illustrators provide scientists with the visual depiction they require to disseminate their findings to a variety of health care professionals. Medical illustrators work in conjunction with doctors to discern which optimum surgical and procedural steps to include when illustrating cutting-edge treatments or techniques. Medical illustrators also collaborate with the various strata of health care experts to discern what information will ultimately

best educate the public. The illustrator acts essentially as a visual communicator or educator, working as a liaison between medical professionals and/or medical professionals and the public (Battles, 1989, p. 2). In fact, "the health care delivery system is dependent upon the successful acquisition, analysis, retention, utilization, and transfer of information" (Student handbook, graduate program in medical information science, University of California, San Francisco, May 1984). The medical illustrator's training enables the illustrator to not only communicate information both aesthetically and accurately, but also to use the current technologies supported by communication industries, such as publishing companies and production houses. Therefore, in training individuals for these needs, President Kennedy indicated tacit support for the idea that academia would act in concert with the requirements of the industries promoting health care. Consequently, it can be inferred that Kennedy's statement has direct impact upon the continually evolving fields of medical illustration and medicine as well as indirectly impacting the field of post-secondary education. However, the assumption that academia is in concert with industry has not been substantiated in the field of medical illustration. In fact, Lynch (1996) acknowledged that there is "a conspicuous lack of research and academic inquiry" for biomedical communications (p. 6). Attention must be focused on what, if any, curricular analyses have been undertaken, ensuring that what is being taught is adequate for medical illustration employment requirements, thus serving the needs of industry. Benschoter (1978) states:

> Because so little research has been done in the field of biomedical communications generally . . . there are many avenues yet to be explored which would benefit both present and future training programs and the total field of biomedical communications. As the number of training program graduates employed in the field increases, it would be of value to survey this group to determine what skills and knowledge areas have been most important to them in their work and what changes in curricula they might suggest. The response of such students coupled with the expert practitioners' ratings could yield valuable information about desirable curricular content from both the supervisors' and student-employees' points of view (p. 161-162).

This is especially true in light of the fact that technology, driven primarily by industry, is fundamentally changing the field of medical illustration (Barrett, 1991; Clarke, 2002; Jessup, 1992; Lynch, 1996; McDonald & Singarella, 1993; Morton, 1995; Morton et al., 2000; Sevel, 1986; Skiba, 2004; Stredney, 1991). Additionally, as was previously mentioned, there is a continuing increase of medically-related information that impacts upon the medical illustrator's knowledge base and skills ability. Ansary and El Nahas (2000) state:

> [t]he new age of information technology and digital communication is here to stay and the medical illustrator has to harness the tools of new media and technology to provide for the demands of the clients and the challenges of medicine and its teaching. Therefore, the authors believe that there is a need to re-evaluate the medical illustrator's role in medical education. (p. 69)

The role of the medical illustrator has continued to develop due to technological advances, health care changes, and growth of the medical illustration profession.

Before examining whether or not academic medical illustration programs are in accordance with the needs of industry, it must be stated that the assumed purpose of a graduate-level medical illustration curriculum is to prepare students with the tools necessary for job attainment (Battles, 1989; Morton, 1995; Sevel, 1986; Stenstrom, 1981 & 1987; Winn, 1976). With this as a premise, the function of a graduate-level medical

illustration degree can be examined through its curriculum. McNeil (1985) lists four functions or purposes of curriculum: 1) common or general education; 2) supplementation; 3) exploration; and 4) specialization. Of McNeil's four curricular functions, the one that most closely "explains," and almost defines, a graduate level academic program, is his specialization function. He states:

> [the] specializing function is rendered by a curriculum in which the current standards of a trade, profession, or academic discipline prevail. Students are expected to emulate those who are successfully performing as skilled workers or scholars. Entry into such a curriculum requires that students already have considerable expertise and drive. (p. 90-91)

Stenstrom (1987) states that the intended result of a program in medical art "is a medical professional who can perform at a defined level of proficiency" (p. 84). Additionally, a competency-based medical illustration curriculum assumes that the "varied roles and functions required within the medical artists' professional activities are clearly defined and then expressed and encompassed within the medical art curriculum" (Stenstrom, 1987, p. 84). Therefore, by using McNeil's specialization function, the question has been answered concerning whether industry demands are of any importance in analyzing a medical illustration curriculum. His mention of "skilled workers" and "scholars" implicitly points to industry and job attainment as a function or outcome of curriculum. Stenstrom (1981 & 1987), in fact, states that employment is the ultimate outcome for medical illustration training; he goes as far as stating that determination of professional competencies is necessary to designing a curriculum. Although the job market ultimately determines competency criteria, Stenstrom (1987) believes that the communication needs of the health science community, and the resources available to assist in meeting those needs, direct the building of the medical art curriculum. Many factors affect a program and its curriculum; Stenstrom (1987) identifies specific factors

that impact the medical illustration curriculum at the Medical College of Georgia (See Appendix F, Program Impact Factors).

Bennett (1968) too, supports McNeil's idea for the specialization function of curriculum as it pertains to biocommunication. Bennett states:

> [s]ince this is the age of specialization, it seems logical that specialists in communication should develop, such as a person who can guide others to help avoid inefficient communication. However, if specialists are to develop fully, the need arises for an administrative grouping in which they can work and where their professional growth will not be hampered by narrow responsibilities and the conflict with the vested interests with others. (p. 13-14)

Specialization itself, particularly at the graduate level, can be argued to be desirable. However, at the graduate level, medical illustration students already possess a varied and respectable knowledge base. How do graduate students, who already possess a substantial and diversified educational base, receive the training that they do not already possess? How are possessed skills evaluated? How should new skills and knowledge be presented to such students? How should new skills be evaluated? What are the best ways to structure a curriculum so that efficient visual biocommunicators are educated for the industries that need them? How and/or should current academic programs be modified so that students are afforded a purposeful education? Alfred North Whitehead, addresses this last pertinent question. He states:

> We are becoming aware that in adjusting a curriculum, it is not sufficient to agree that some specific subject should be taught. We have to ask many questions and to make many experiments before we can determine its best relation to the whole body of educational influences which are to mould the pupil. (Whitehead, as cited in Bellack, 1977, p.1)

From this statement, Whitehead seems to be calling for the answers to these aforementioned questions. He believes that education should be built around the learner and that all students should receive a general and specialized education (Whitehead,

1957, p. 15). Whitehead believes that three primary curricula (literary, scientific and technical curricula) should each include the other two fields in their course of study (Levine, 1978, p.264). As a mathematician, he respects competence; he wants thorough teaching as opposed to the teaching of a broad number of courses covered superficially (Whitehead, 1957, p. 2). Whitehead feels that "different subjects and modes of learning should occur at times fitting to the pupil, when they have reached the proper stage of mental development," of which there are three. . .1) romance, 2) precision, and 3) generalization (Whitehead, 1957, p. 15). The romance stage introduces the student to the new material where connections are explored. Next, the student acquires new facts "in systematic order which thereby [forms] both a disclosure and analysis of the general subject matter" (Whitehead, 1957, p. 19). This represents his precision stage. Finally, the most poignant stage as it relates to postsecondary education is generalization. This stage involves applying, exploring, and dreaming, (a return to a romance-like stage) but it now has the added qualities of appropriate techniques and ordered ideas (Whitehead, 1957, p. 15). Whitehead believes these stages are cyclical and college is the point-in-time where the refinement of skills and knowledge take place.

Whitehead mentions that students move through these stages at different rates and points-in-time. Whitehead also espouses the belief that education should have a practical purpose. Specifically, he defines education as "the acquisition of the art of the utilization of knowledge" noting that "education should be useful, whatever your aim in life" (Whitehead, 1957, pp. 2-4). Finally, he believes in the need for mastery of subject matter as both part of his cyclical learning process and as his aim of education.

Tenets such as unspecified time, usefulness of education, and competence lend credence to a competency-based education perspective. This educational approach has received much attention in education literature (Ansary and El Nahas, 2000; Bannister,

2005; Baum and Axtell, 2005; Carraccio and Englander, 2004 and 2005; Counte and Newman, 2002; Foss et al., 2004; Leung, 2002; Musick, 2005; Nahrwold, 2005; Southgate et al., 2001; Tovey, 2003). Curricular relevance, student assessment, and lack of workplace competency have all contributed to the growing interest in competency-based curricular design. Stenstrom (1987), when referring to the specific profession of medical illustration, supports this fact by suggesting that it may be possible to find "some medical art graduates limited in their skill in performing the common illustration tasks which most certainly will occupy the major portion of their professional lives" (p. 84). If this is the case, he states, then "the curricula must be changed to prepare more appropriately the graduate to meet the professional challenges of the future" (Stenstrom, 1987, p. 84). Stenstrom (1987) states that "the educational quality of the programme will be judged by the success with which its graduates meet the visual communication needs of the typical health science community" (p. 85). He goes on to say that "no school should perpetuate an educational program in which medical illustration competence is defined largely by academic proficiency rather than practical ability" (Stenstrom, 1981, p. 27). Rowse et al. (1975) state that "[i]t is possible that if curricula were built around the needs of the clients to be served (students desiring to become members of a specific profession)", . . . experiential learning weaknesses [and] poorly integrated curricul[a] . . . would not occur frequently (p. 13). Wilson-Pauwels (1993) recognizes the notion of learning experiences. She offers a model for its implementation stating:

> It may be beneficial for medical illustration curricula to develop around 'learning experiences' because it is becoming impossible to teach everything in the limited time available in most programs. (p. 203)

To this point, Bennett, McNeil, Whitehead, Stenstrom, Rowse et al., and Wilson-Pauwels support the concept of, or elements inherent within, a competency-based education model. Wilson-Pauwels goes as far to state:

> The 'competency model' . . . may be an effective way to evaluate students in the future. It may be that faculty should more directly relate the content of exams to the performance required by graduates working in the field. (p. 203)

In summary, Bennett, McNeil, Whitehead, Stenstrom, Rose et al., and Wilson-Pauwels have been cited to endorse competency-based tenets for use in medical illustration education. The following section will present studies pertaining to medical illustration curricula and competency development.

PREVIOUS FINDINGS IN BIOCOMMUNICATIONS CURRICULA AND COMPETENCY IDENTIFICATION

This section describes research done in the biocommunications field that is related to medical illustration curricula, competency development, and the role of the medical artist. Nine early attempts at defining competencies for the biocommunicator and medical illustrator will be presented. This section will serve to summarize sources of competency-related materials within biocommunications and medical illustration literature.

Stenstrom's Medical Illustration Competency-Based Curriculum at The Medical College of Georgia

Stenstrom (1981) designed a list of instructional objectives for use in medical illustration curricula. That list identified materials, media, and equipment for use by students. He developed this list for use in the Department of Medical Illustration at The Medical College of Georgia's competency-based education (CBE) program. The outline contained nine headings: utilize basic communication skills, utilize basic instructional technology skills, interpret in visual form a client's information, prepare camera-ready

copy for printing, produce software for specified communication media, describe the reproduction process and acceptable quality of reproduction of specified visual communication media, develop and manage a medical illustration service, seek employment in an appropriate manner, work within the parameters of the profession (See Appendix G). Many of the materials and equipment are now considered dated, and there has never been a study or survey created from these competencies to validate that the competency list is appropriate, timely, or comprehensive. Additionally, these competencies were never rated by practicing, professional medical illustrators for determining necessary levels of achievement.

Competency-based Curriculum for Medical Illustration at the University of Toronto

In an unpublished document, Linda Wilson-Pauwels (1989) undertook a study to identify competencies for a competency-based program in medical illustration at the University of Toronto (Katz, 1996, p.18). Twenty-two questionnaires were mailed to two groups, one she described as "users" (employers and clients) and the other as "doers" (medical illustrators) from the various subfields of medical illustration. From the 18 returned surveys, competency statements were divided into two categories: behavioral and performance. The results indicated that users and doers rated different competencies differently. The users highly rated business and professional attitudes, ability to work well on a team, strong sense of purpose, desire to pursue scholarly activities and professional growth, meeting deadlines and quoting fees accurately. The doers highly rated ethics, personal pride in self and work, theory of communication, and mechanical process of preparing photo-ready artwork. One key point this study offers is that data should be gathered from a variety of sources ─ from employers, clients, and practitioners.

Defining Competencies for the Medical Illustrator

Alice Katz, (1996) in an unpublished dissertation, investigated competencies of outstanding performers in medical illustration, working as production artists, employed to create visual communications for the biomedical sciences in two job settings: a health care institution and a freelance or small business setting. She employed a Job Competency Assessment (JCA) process developed by McBer and Company of Boston to identify attributes of outstanding medical illustrators. The JCA had never before been applied to the visual arts.

One important finding from Katz's study was the "Medical Illustration Job Functions" listing from which this study's survey instrument was developed. This functions list was created from a literature review and focus group discussions. A Behavioral Events Interview (BEI) technique was used to collect incidents (information) from thirty subjects including ten outstanding freelancers, ten outstanding institutional illustrators, and ten novices. The interviews were coded and fifteen competencies important to outstanding practice were identified. Next, thirteen experts comprised of seven freelancers and six institutional illustrators completed a Competency Rating Questionnaire (CRQ) to validate the competency model. These experts rated twenty-five competencies regarding importance to the job, performance for job entry, and performance for outstanding practice. The BEI and the CRQ techniques produced agreement on seven competencies: Acquisition of Expertise, Self-confidence, Client-Service Orientation, Achievement Motivation, Information Seeking, Visual Thinking, and Initiative.

A surprise finding was that novices and outstanding performers had similar profiles on the behavioral scales and performance levels. Novices scored higher on the "Sharing Expertise and Developing Others" category than was expected. Katz attributed

the differences that did occur to lack of experience and maturity and not to competence differences. Also, it was found that freelancers and institutional medical illustrators exhibited differences in their competency profiles; freelancers scored high in areas such as "Career Management" and "Accurate Self Assessment." Conversely, institutional illustrators scored high in areas such as "Team Cooperation" and "Organizational Awareness."

One objective of Katz's study was to identify the major tasks and functions of the medical illustrator. Katz states that the:

> Tasks and functions of the medical illustrator were identified and used to code BEI [Behavioral Event Interview] narratives. Due to time constraints, the relationship of the competencies to the tasks and functions was not explored in this study. (p. 173)

She goes on to say, "[t]his relationship is a recommendation for further study" (p. 191). Overall, the thrust of Katz's study was to identify the differences and similarities of expert illustrators in two differing work settings. She used two methods for undertaking her objectives: the JCA and the BEI. Katz found that the JCA "did not do a thorough job of identifying knowledge and skills (p. 191)" and recommended further research using a "data collection method more suited to this task, like job or task analysis" (p. 191).

Curricula in Biomedical Communications: Do They Meet the Perceived Needs of the Field?

A study by Benschoter (1978) attempted to determine the knowledge and skills necessary to perform duties of the biomedical communications specialist working within a health sciences education setting. Also, she examined the curricula in existing graduate training programs for biocommunication specialists to determine if program content provided the knowledge and skills deemed necessary by competent practitioners. In undertaking these objectives, she explored various definitions of biomedical

communications and traced its development for the training of general media specialists. Her methodology consisted of developing a list of knowledge and skills applicable to training biomedical communications specialists. The list was in the form of a 42-subject area questionnaire instrument with a five-point rating system. These 42 items were based on a similar list developed by Chisholm and Ely (1976). The questionnaire was created for and sent to two groups: directors of biomedical communication services and directors of graduate training programs in biomedical communications. Benschoter then compared the importance of specific knowledge and skills identified by directors of biomedical communications facilities with that of directors from academic graduate level training programs. The results indicated "generally, the training programs are meeting the perceived needs of the field in all the functional areas" (Benschoter, 1978, p. 147), yet "there were some areas of difference noted between the two groups' responses" (Benschoter, 1978, p. 149). Regarding specific theory and skill areas, the schools were not covering material in as much depth as the practitioners felt was necessary to a degree that there was "insufficient preparation for adequate performance" (Hall, 1981, p. 16). Management skills were found not to be stressed enough in the schools. Additionally, practitioners did not consider production skills as important as those in the schools.

Jobs in Instructional Media Study

In 1968, the National Education Association's Department of Audiovisual Instruction (DAVI) carried out the Jobs in Instructional Media Study (JIMS). This was done in an attempt to define the media specialist's job, job analysis, in operational terms. Essentially, a two-dimensional matrix was used to look at "what the worker does" (Functional Job Analysis) and "what gets done" (Domain of Instructional Technology) (Wallington, p. 18). One hundred-ten jobs in the media field were analyzed and all the

tasks involved were identified. These tasks were then clustered at appropriate skill levels. Skill levels were of utmost importance because the JIMS project was created to meet unmet demands for personnel in the media field. The JIMS concept employed a career ladder training theory for working media specialists (Bernotavicz and Wallington, p. 30). Analysis of the project concluded that its method of job analysis within the media field was feasible since it produced data that could be used in developing curricula for training programs. It could also be used in defining and organizing jobs for media specialists working within the field, and as a result "for the first time, jobs and curriculum can be coordinated" (Wallington, 1969, p. 5). However, the drawbacks to the JIMS process are that it requires a highly complex technique 1) in data collection and analysis and 2) in using the information for curriculum and job planning. Nonetheless, it proved to be a successful, early approach for associating a curriculum to professional job tasks.

Chisholm's Composite List of General Tasks/Functions for the Media Specialist

Chisholm developed a list of essential functions for the media specialist from analyses of the following reports: The Professional Education of Media Service Personnel Report, Media Guidelines Report, and The Jobs in Instructional Media Study Interim Report (Chisholm, 1976, 6-15). She found that 10 functions represent a comprehensive view of the role, responsibilities, and skills required to practice successfully as a media specialist within the field. The functions identified were: organizational management, personnel management, design, information retrieval, logistics, production, instruction, evaluation, research and utilization (Chisholm, 1976, 11-12).

Teaching Methods for the Development of Creativity In Medical Illustration

Anderson reviewed the medical illustration literature for a master's thesis (1975) and found that no "established specific performance objectives for the professional medical illustrator" (p. 8) were in existence. She was able to propose four performance objectives for developing creativity based upon what information was in the MI and associated literature. She found that one should:

> (1) demonstrate ability to conceptualize and visualize medical pictures, designs or diagrams; (2) demonstrate ability to abstract the essence of complex information and present it in visual form; (3) Manifest flexibility and versatility in the aesthetic handling of varied media and production techniques; and (4) Exhibit adaptability to change in the medical environment and the new communication technology. (Anderson, 1975, p. 9)

A Study of the Administrative Tasks and Functions of the Director of Biomedical Communications as Perceived by the Director and his Administrative Superior

An unpublished dissertation by Richard Hall (1981) attempted to verify and clarify a set of administrative tasks and functions common to directors of biomedical communications. The study compared the perceptions of the directors and their administrative superiors regarding the relative frequency that twenty-four tasks were performed by directors of biomedical communications relative to a given set of five administrative functions. The study also determined if the administrative tasks and functions verified were congruent with those which had been identified in comparable studies. These objectives were carried out by modifying an existing survey instrument and sending it to members of the Association of Biomedical Communications Directors (ABCD) and their superiors. Respondents were asked to rate how frequently they should and did perform certain tasks while engaged in five preconceived functions: planning, organizing, staffing, directing and leading, and controlling. Consistencies were found between the perceptions of the director and his administrative superior, but

the frequency with which these occurred varied. Comparisons between hospital administrators found only a moderate degree of consistency regarding the ranking of certain functions and the amount of time spent in various workday functions. For example, hospital administrators spent more time with various governing supporting bodies in activities such as public relations, community programs, and fund raising. Academic administrators and directors of biomedical communications were found to be very consistent regarding how each ranked the frequency with which tasks and functions were performed, except for the task entitled "to analyze." In this case, the administrative superiors felt that the directors should "analyze" more often than the directors felt they should. Collectively, the findings indicated that the tasks and functions were common in the administration of biomedical communications.

Related Studies Regarding Biomedical Communications and Medical Illustration

An unpublished dissertation by Linda Wilson-Pauwels (1993) entitled, "The Development of Academic Programs in Medical Illustration in North America from 1911 to 1991" provided a chronology of the medical illustration profession and highlighted the directors and their academic programs.

An unpublished dissertation by Donna Ruth Walker (1988) entitled, "Biomedical Communications Administration: Leadership Style as Related to Unit Size, Organizational Placement, Task Structure, Experience and Education" presents findings on the leadership style of biomedical communication managers. The average biomedical communications manager was found to be "task-motivated" in his/her management style, as opposed to "socio-independent" or "relationship-motivated." Additionally, leadership was correlated with variables representing organizational and personal dimensions, but findings were not significant. Also, the presence or absence of

1) informational services and 2) the manager's direct involvement within the unit accounted for up to seventeen percent of variance of leadership style predictability.

An unpublished dissertation by Andrea Leslie Sherman (1980) entitled, "A Proposal for Integrating Biomedical Communications Programs within Health Sciences Settings" identified guidelines that educators might use to link biomedical communications with health science education. Conclusions drawn were that the biomedical communications specialist needs to become part of the total educational system in the health sciences setting. Centralized biomedical communications programs are needed to provide an array of services, prevent duplication of services, and assure compatibility and standardization of hardware and software within the organization. Collaboration between the biomedical communications specialist and health sciences educators must be fostered.

An unpublished dissertation by William Jack Stenstrom (1989) entitled, "The Relationship of Life History Experiences and Personal Characteristics to Professional Success of Medical Illustrators" explored retrospective data regarding the early childhood activities, family backgrounds, and relationships of "highly successful" and "less successful" illustrators. A causal relationship between early life history factors and professional medical illustration success was examined. Thirteen factors were used to compare questionnaire responses: academic achievement, athletic participation, warmth of parental relationships, social introversion, socioeconomic status, intellectualism, independence/dominance, parental control, positive academic attitude, scientific interest, expression of negative emotions, religious activity, and sibling friction. Statistical analyses found significant positive relationships between highly successful medical illustrators and the mean factor scores for sibling friction and intellectualism. Additionally, a significant negative relationship was found between highly successful

medical illustrators and the mean factor score of social introversion. Additionally, personal characteristics (academic achievement, religiosity, parental control, socioeconomic status, and athletic participation) were found to have statistical significance.

PROCESS STRATEGIES FOR COMPETENCY-BASED CURRICULUM DEVELOPMENT

As has been previously stated, there is relatively little in the medical illustration literature pertaining to curriculum design, specifically considering a competency-based approach. The few studies that do consider a competency approach, specifically Stenstrom (1981, 1987) and Katz (1996), either provide a listing of artistic techniques, or present “functions” loosely described here as broad, non-medical illustration specific job descriptions. Nowhere in the biocommunications literature does there exist a comprehensive, task-specific, list of medical illustration competencies or a method for attaining and analyzing them. Therefore, models that describe and identify the benefits of a competency-based approach will need to be drawn from related literature found in the allied health and medical education fields. Approaches from the specific fields of physical therapy and ophthalmology, as well as a general approach to health-science curriculum systems design will be explored. Additionally, two universal, non-discipline-specific approaches to a competency-based curriculum design will be described.

Integrated Problem-Solving Curriculum Design

The purpose of an integrated problem-solving curriculum is "acquiring . . . the necessary competencies to practice effectively as a physical therapist" (May, 1977, p. 813). Bruner (1960) states that "problem-solving learning . . . is enhanced by organizing curricular content and learning experiences around the basic themes of a discipline" (as cited in May, 1977, p. 807). "Grasping the structure (theme) of a subject is

understanding it in a way that permits many other things to be related to it meaningfully" (Bruner, 1960, as cited in May, 1977, p. 807). Themes help integrate subjects and "sequence the integrated learning experiences serially from the simple to the complex; major concepts should recur at increasing levels of difficulty (May, 1977, p. 807). Using these beliefs as a foundation, May (1977) designed an integrated, problem-solving, competency-based, physical therapy curriculum. Identification of entry level competencies for physical therapists were written as terminal objectives of the program. This served as the first step May sites for designing an integrated problem-solving curriculum. Terminal objectives were written as statements of competencies (behavioral objectives) for each learning experience in the curriculum. Competencies were derived from 1) the Standards for Physical Therapy Education provided by the American Physical Therapy Association (1971), and 2) "expert judgment of physical therapists involved in the initial planning of the curriculum" (May, 1977, p. 808). Second, major themes were identified from the activities of physical therapist and subject matter was allocated to each theme. Both specific learning and terminal objectives were reviewed annually to ensure "continued relevancy" (May, 1977, p. 808). Third, sequential learning experiences were considered. These sequential learning experiences were drawn from subject matter that was initially derived from the behavioral objectives. These learning experiences were sequenced from the simple to the advanced. Additionally, these experiences were arranged to fit the academic calendar (May, 1977, p. 812). May stated the quarter system employed at the Medical College of Georgia had little if any relation to the requirements of the learning experiences. Faculty reviewed the calendar annually and the necessary modifications were made to time allocations. These changes are derived from ongoing evaluation processes inherent in the curriculum. This evaluation measure represented May's fourth step in an integrated

problem-solving curriculum design. Evaluative measures included "student progress, report of graduates, listening to students, and regular faculty review of the curriculum in relation to the terminal objectives" (May, 1977, p. 812). Written course evaluations were completed by students at the conclusion of every course. Additionally, student "oral evaluations are held on a regular basis" (May, 1977, p. 812). Outcomes of these evaluative measures include favorable feedback of those physical therapists that employ MCG graduates. Such employers stated:

> . . . [the] design seems to enable the student to see relationships between elements in a more effective manner than the more traditional subject-oriented curricula. . . . [S]tudents are less afraid to cope with new situations and are better able to see and analyze total problems. (May, 1977, p. 812)

Ohio State Competency Based Education (CBE) Project

Broski et al. (1977) describe how six allied health divisions, acting as a group, attempted the development of a competency-based education (CBE) curriculum. It was suggested by divisional project directors that Johnson's (1973) model be generalized to *any* medical or allied medical specialty (Broski et al., 1977, p. 40). (See Appendix H, Process Model for Developing Competencies in Allied Health Fields) Some project directors, however, felt that the model was inductive rather than deductive in nature. It was feared that an inductive developmental process would produce competencies that "replicate[d] clinical practice as it is, rather than what it should be" (Broski et al., 1977, p. 40). Project directors were therefore given the freedom to "proceed in a manner most consistent with their philosophy and mode of reasoning" (Broski et al., 1977, p. 40). However, most used the process suggested by Johnson; the conclusion proffered for this was that "most allied health practitioners are more comfortable working with the specifics of their practice than conceptualizing at a higher cognitive level" (Broski et al., 1977, p. 40). Broski et al. state that all project directors were at different thinking levels

at the beginning of the process, but progress sharing and cooperative efforts enabled each to grow. At a given point, each director independently became aware that a conceptual frame of reference was helpful for this type of a developmental undertaking (Broski et al., 1977). It was established in this study that "all health professionals are required to teach, manage, and problem solve. It is the specialty practice which dictates the content to be addressed" (Broski et al., 1977, p. 41). Six named problems were encountered in undertaking this process allied health-related competency development model. The first identified problem ─ time ─ needed to be evaluated on two levels. The first idea of time theorized that competency-based curriculum development, implementation, and evaluation can span a 10-year time frame (Broski et al., 1977). This necessitates "sound planning to insure the incorporation of both current and new competencies relevant to changes within the professions" (Broski et al., 1977, p. 41). On the other level, "writing educational objectives relevant to each competency is time consuming and can compete with the more immediate demands put upon health professional faculty" (Broski et al., 1977). The second problem encountered by the divisional project directors was communication. Broski et al. concluded that "allied health educators are primarily health educators and are unfamiliar with educational jargon" (p. 41). Additionally, because each participant represented a different health profession, tasks were approached from differing frames of reference (Broski et al., 1977). Another problem encountered was lack of resources ranging from lack of competency-based related research in particular fields to evaluating findings in terms of validity (Broski et al., 1977). It should be noted that Broski states that "recent graduates provided the most valuable data related to current competencies" (Broski et al., 1977, p. 42). It should also be noted that a general lack of research done in specific fields relative to CBE made it acceptable and necessary to draw from "alternate career fields

and existing programs for concepts, guidance, and ideas" (Broski et al., 1977, p. 42). The fourth problem identified was simply getting started. It was implied that the reasons for this were 1) an individual's limited frame of reference, 2) partial contemplation of ideas, and 3) reliance on, and comfort with, the familiar (Broski et al., 1977, p. 42). Involvement of faculty represented the fifth problem mentioned. Time constraints and resistance to change were the main points associated with this problem, yet it was stated that it is crucial to include faculty expertise and experience (Broski et al., 1977, pp. 42-43). Finally, the sixth problem cited was that of identifying competencies and writing objectives. The total profession, not specific tasks, must initially be taken into account. This includes both a deductive process (identifying the objectives of the profession) and an inductive process (identification of specific competencies) (Broski et al., 1977, p. 43).

Role-Based Curriculum

Rowse et al. (1975) present a four-step process for developing a health systems curriculum. It integrates problem-solving tenets with: 1) change strategies designed to develop a perceived need for curriculum development, 2) an ideal systems approach, and 3) a program planning approach (p. 14). A needs assessment, called mandate development, is the first step involved in this strategic approach. A needs assessment, as defined by Adelson et al. (1985) refers to "any systematic process for collecting and analyzing information about the educational needs of individuals and organizations" (Adelson et al. 1985, as cited in Sevel, 1987). Recognition of a problem with opinion and involvement of leaders in the profession or occupation is the purpose of this initial step (Rowse et al., 1975, p.14). Their continued support and interaction are crucial during this phase of the process. Pilot studies are undertaken "to evaluate the adequacy of the occupation and the educational system that prepares and maintains that

occupation" (Rowse et al., 1975, p.14). Literature searches, site visits, and questionnaires serve as the methods for this task.

The second step in this four-step process is role definition. This consists of a three-stage process involving 1) client and practitioner problem exploration, 2) identification of solution components, and 3) role synthesis (Rowse et al., 1975, p.14). These processes should stem from the activities undertaken in the needs assessment concerning current and desired occupational roles, as well as exploration of problems encountered by clients of the occupation. A practitioner task analysis is posited as being a valid means of problem exploration. Additionally, understanding client problems or pitfalls in light of their objectives assists in role definition. Involvement of reputable and experienced individuals with diverse perspectives will facilitate this effort. It is further preferable to involve a multidisciplinary team of both theorists and practitioners. It is suggested that a synthesis of information, the third subset in role definition, be carried out from a systems (broad) perspective because it offers a variety of viewpoints and knowledge bases.

The third step for developing a health systems curriculum involves generation of the ideal curriculum. This consists of developing the best curriculum possible regardless of any limiting factors. It begins with identifying "knowledge, attitudes and skills needed by individuals performing the defined roles." This step can be re-refined (Rowse et al., 1975, p.17). Again Rowse et al. suggest using a multidisciplinary team of experts to provide this information. Various levels of learning need to be established and assessed on a scale so that information obtained can be related to "specific informational content and learning mastery levels" (Rowse et al., 1975, p.18). Rowse et al. state that such a scale "is certainly more complete than the curricular statements of most

university departments" (Rowse et al., 1975, p. 18) because scales are tangible, measurable levels of achievement.

Finally, the last step in the curriculum development process deals with dividing the responsibility for the ideal curriculum by "formally and systematically separating, coordinating and avoiding duplication of learning objectives for courses, departments, or programs" (Rowse et al., 1975, p. 18).

Industrial Curriculum

Smith (1930) presents six steps to the process of “industrial curriculum” building. Industrial curriculum is similar to tenets inherent within vocational education. The purpose of industrial curriculum building is to study individuals working within a particular industry or occupation. Smith (1930) states, "the best industrial courses are those prepared for an especially selected homogeneous group" (p. 9). The first step entails isolating this group for extensive study, by going into that industry and observing what the members of the group do. Step two entails the ultimate determination of curricular objectives. Smith presents two ways for this to be accomplished; he proposes investigating the activities of the select group which must meet employment situations and identifying those activities in which these persons should be more efficient. In doing so, "education would approach the learner from the standpoint of his present condition and prepare him to meet new situations and added responsibilities" (Draper, 1936, p. 132). Step three pertains to arranging the activities, skills, and knowledge into groups conducive for organization into teaching material. Smith states that it is important for material, before it is to be taught, to be structured into comparable elements and related to one another (p.10). This allows for the analysis of technical content. Step four: "select the actual content in each subject which will produce the desired effects" (Draper, 1936, p. 132). In this way, curricular criteria are created and

organized by topic. Next, the fifth step, subject matter is arranged in each group according to logical sequence and degree of difficulty, building upon previously possessed skills and knowledge. Finally, Smith suggests arranging courses “into a curriculum according to the logical order of presentation and feasibility of administration and supervision" (Draper, 1936, p. 133).

Although the material is seventy years old, industrial curriculum building was an early attempt to determine curricular content by going directly to the workplace and investigating what it is that the worker must know how to do. This approach firmly begins with the workplace demands as a starting point for course content and curricular design.

Technique for Determining Curricula Content

Spivey (1971) presented a technique for determining curricular content. He states that every discipline will need to identify "the minimum acceptable knowledge, attitudes, and skills for its graduating students" (p. 269). Spivey states this determination of content technique is "predicated on the idea that a list of expectations for student performances should be composed of complete educational objectives in order to facilitate their measurement" (Spivey, 1971, p. 269). Determination of content, Spivey states, consists of "analyzing and delineating potential performances into their component parts (terminal behaviors)" (Spivey, 1971, p. 269). These behaviors must then be presented to appropriate groups of respondents. Spivey suggests that a variety of individuals, representing a multitude of backgrounds and viewpoints should be consulted for determination of content; not just teachers. This approach, as it was applied to ophthalmology for medical students, resulted in a "clear, quantitative indication of minimum acceptable performance" (Spivey, 1971, p. 269). A curriculum can be designed ultimately from: 1) the results, and 2) determination of minimum acceptable

performance in the context of institutional goals, time, space, staff, faculty, and student body (Spivey, 1971, p. 269). Evaluation of the curricular content must occur regularly and be inherent in the curriculum to ensure appropriateness (Spivey, 1971, pp. 269-270).

A questionnaire was developed as an instrument for determining curricular content. Questionnaire development was initiated by first brainstorming with ophthalmology residents and faculty to list the possible content in a medical school curriculum. Second, content experts in the field of ophthalmologic education were consulted. Third, outlines were compiled from "previous personal experiences in [both] teaching and experiencing a program" (Spivey, 1971, p. 270). Fourth, outlines were also created from the subspecialty areas of ophthalmology, including areas contained in the board examination.

Following these processes, a refinement stage was undertaken. This included listing sequentially the possible performances in behavioral terms from easily acquired performances to those deemed sophisticated (Spivey, 1971, p. 271). Next, five quantifiable responses ranging from "essential" through "I have no basis for judgment" were established for the questionnaire. Finally, rewording of statements to avoid educational psychology jargon was undertaken and a pilot study was sent to a small group of faculty, medical students, residents, and private practitioners and then evaluated. Additional revisions concerning question order and wording were carried out. Another pilot was sent to a similar group of respondents, and the questionnaire was finalized (Spivey, 1971. p. 272).

The outcomes of the technique described were found to be beneficial by Spivey. "Specificity" was an outcome characteristic he identified as "advantageous" (Spivey, 1971, p. 274). He states:

> specificity aids: the respondent, by offering him concrete examples while he formulates his opinion; the curriculum designer, by providing him with a large portion of the conditions involved in learning experiences; and the student, by allowing him to see what is expected and some of the conditions under which evaluation might occur. In addition to the advantage of specificity, the educational researchers can determine priorities for curricular inclusion by asking the respondents to rate each behavior separately. Responses can easily be quantified and utilized in discussions of curricular appropriateness. (p. 274).

Secondly, Spivey (1971) recognizes detailed behavioral objectives as greatly aiding the learning process. He cites a study by Mager and McCann (1961) which found student groups possessing detailed behavioral objectives had: 1) a 65 percent reduction in learning time as compared to students who had no such objectives 2) more confidence and knowledge 3) markedly reduced need for instruction time and 4) a rating from subsequent supervisors as "better trained" as compared to students without behavioral objectives (Mager & McCann, 1961, as cited in Spivey 1971).

Spivey states that this technique can be "employed within and beyond medicine [and] has wide applicability" (Spivey, 1971 p. 274). Additionally, he states this technique also can be used in any setting, particularly one that is "well circumscribed and the range of competency to be acquired is not great" (Spivey, 1971 p. 274).

This section served to present five different, but related, approaches to a competency-based curriculum design. A review of the literature revealed no process model that established a medical illustration competency-based curriculum model. However, a number of curricular approaches were found in the biocommunications literature that had aspects which could be used in developing a medical illustration competency-based curriculum model. Step-by-step accounts from each process identified the various competency-based elements deemed beneficial for the development of a health science curriculum. Aspects from each approach will be

assimilated and the result will culminate in a medical illustration competency-based curriculum process model. The next chapter will compare and contrast the methodological approaches of all five of these process models in great detail.

CONCLUSIONS

In summary, this chapter reviewed the literature on curriculum. Various concepts, definitions, and principles of curriculum were introduced. The first section of the chapter dealt with the varied views of curriculum through exploration of Schubert's (1986) curricular conceptions. These conceptions, or beliefs, helped to establish a current, broad-brush view of the whole curriculum field so that an extensive understanding of all issues and tenets could be achieved. Next, Jackson's (1992) five time-tested definitions of curriculum were presented. Since those definitions did not unequivocally define "curriculum" (and it was argued that a definition could not and should not do so), focus turned to Tyler's (1949) "basic principles." These widely upheld principles of curriculum were presented as a means of identifying the purposes of education by acknowledging objectives, design, scope and sequence, and by the process of evaluation.

In the second section of this chapter, the very broad concept of a curriculum was narrowed to a view espousing predetermined professional attributes, namely a competency-based perspective. Studies by Ainsworth, Broski et al., Klempt, Knott, May, McGaghie, and Stenstrom introduced general concepts, definitions, and attributes of a competency-based educational system.

The general, "competency-based" educational approach was further narrowed in the third section to include perspective from those individuals working in or studying the medical, biocommunications, or medical illustration fields. This section began by questioning the need for medical illustration educational programs. President Kennedy's

acknowledgment of the need for medical information dissemination provided a purpose. Further, McNeil's four functions of curriculum were identified and his "specialization" function was determined to suit the purpose of a graduate curriculum, specifically, a medical illustration curriculum. A competency-based perspective was espoused for medical education by Baum and Axtell, Corraccio and Englander, Counte and Newman, Leung, Musick, Nahrwold, and Southgate et al.. Ansary and El Nahas, Stenstrom, Tovey, and Wilson-Pauwels championed a competency-based educational approach, specifically for medical illustration education.

The fourth section of this chapter presented previous studies in both biomedical communications and medical illustration. Stenstrom identified materials, media and equipment used by professional medical illustrators for The Medical College of Georgia's computer-based education (CBE) program. Wilson-Pauwels looked at the perceptions by medical illustration employers and illustrators of competencies, while Benschoter compared the perception of skills by directors of biocommunication service departments with those of academic program directors. Hall looked at the perception of the tasks and functions of biomedical communication directors and their superiors. Katz studied the similarities and differences of outstanding medical illustration performers in an institutional setting with those from a freelance setting. Anderson identified four performance objectives for medical illustrators.

Additionally, the fourth section of this chapter briefly described four dissertations that were worth mentioning, although they were not directly related to medical illustration competency-based curricula. These unpublished dissertations were completed by individuals of importance in the biocommunications and medical illustration fields and the topics were deemed to be tangentially related to medical illustration competency-based education. Each was included to provide the reader with

a complete presentation of biocommunication (as it pertains to medical illustration) research.

Lastly, five practical process models related to competency-based education were described under the final section entitled "Process Strategies for Competency-Based Curriculum Development." An integrated problem-solving curriculum design, the Ohio State CBE project, a role based curriculum, an industrial curriculum, and a technique for determining curricula content were presented. Specific steps were identified and summarized for each of these named process models in an attempt to set the foundation for development of a medical illustration competency-based curriculum model.

In essence, up to this point, "curriculum" has been defined (Jackson), conceptualized (Schubert), and its principles identified (Tyler). More specifically, medical illustration curricula have been shown to be justified (Kennedy, McNeil, and Stenstrom), their objectives were identified (Anderson), their content suggested to be "practically" organized (Katz, Stenstrom, Wilson-Pauwels), and possible "how to" approaches for developing their structure were presented (May, Broski et al., Rowse et al., Smith, and Spivey).

The following chapter will serve as an assessment of the literature. Using the literature as a basis for argument, elements from these five processes will be compared and related to Tyler's "basic principles." Next, an attempt will be made to coalesce and assimilate specific named elements from each of these five processes into a comprehensive curriculum design approach for medical illustration education. Development of a competency-based design approach for medical illustration education, derived from allied health and curricular literature reviews, will serve as the ultimate objective for this chapter.

Chapter III

Medical Illustration Process Model Development:

Integrating Theory and Practice

> "Theory and practice are not static entities that exist in isolation; both develop and evolve with time, hopefully in line with current evidence" (Rafferty et al., 1996, p.685) Understanding the interplay between theory and empirical research on the topic of emerging programs and institutions requires a discourse rooted both in epistemological and political arguments about knowledge production and the development of the curriculum. (Karseth, 1995, p. 195) The existence of a theory/practice gap can be viewed as a failure within education, practice and research. (Rafferty, et al., 1996, p.23)

A comprehensive curriculum development process model was constructed using Tyler's basic principles as a foundation for a competency-based curriculum design for medical illustration. From these basic principles, the five aforementioned process models were considered, evaluated, and interrelated. Specific elements of each were then incorporated into a competency-based, curriculum-related process for medical illustration education. Figures constructed to aid in comparison are presented in this chapter. Tyler's basic principles are listed below to aid as a review.

1. What educational purposes should the school seek to attain? [Objectives]
2. What educational experiences can be provided that are likely to attain these purposes? [Design]
3. How can these educational experiences be effectively organized? [Scope and Sequence]
4. How can we determine whether these purposes are being attained? [Evaluation] (Tyler, 1949, as cited in Pinar, 1995, p. 33-34)

COMPARISON: MAY AND TYLER

Of the five curricula designs mentioned in the last section of the previous chapter, the one that most closely parallels Tyler's (1949) design is the integrated problem-solving curricular design described by May (1977). Her four steps match Tyler's basic principles point for point (See Figure 1). May recognizes the identification of competencies as the answer to Tyler's question regarding educational purpose. She elaborates by identifying two information sources: the Standards for Physical Therapy Education provided by the American Physical Therapy Association (1971), and expert judgment of physical therapists involved in the initial planning of the curriculum. From these sources, major themes were established to aid in the construct of her curriculum design. Like Tyler, this was the second step in her curriculum development process.

Tyler's second question regarding providing educational experience was answered by May's need for identification of major themes. May and Tyler use the same terminology regarding organization of educational experiences. The term they both use is "sequence." Tyler asks how experiences can be organized, through scope and sequence. May answers this by suggesting sequencing subject matter and themes from simple experiences to ones more sophisticated. Additionally, she states that imposed constraints such as academic calendars and semester hours affect curricula design. Finally, May identifies faculty review, listening to students through written and oral course reviews, student progress, and reports of graduates as means to answering Tyler's question regarding evaluation. May's integrated problem-solving curricular design approach is very closely aligned to Tyler's four questions in objective, design, sequence, and evaluation.

Figure 1:

Relationship of Tyler's "Basic Principles" to May's Integrated Problem-Solving (IPS) Curricular Design and Johnson's Ohio State Competency Based Education (CBE) Design

Tyler's "Basic Principles"	Integrated Problem-Solving Curricular Design: May	Ohio State CBE: Johnson
1. What educational purposes should the school seek to attain? **[Objectives]**	1. Identify entry level competencies A. derived from "Standards" B. expert judgement	1. Review literature A. professional practice B. educational practice 2. Review data sources A. job descriptions B. manpower projects C. existing curricula D. standards of practice E. USDL Job Analysis Sch. 3. Collect data from sources A. special interest groups B. educators C. national leaders D. practitioners E. employers - Gov't officials 4. Analyze data A. literature B. data 5. Determine competencies A. tasks B. functions C. roles 6. Validate competencies A. graduates B. practitioners C. educators - employers 7. Make competencies public A. students B. employers C. professional organizations
2. What educational experiences can be provided that are likely to attain these purposes? **[Design]**	2. Identify major themes from activities	
3. How can these educational experiences be effectively organized? **[Scope and Sequence]**	3. Sequence learning experiences	
4. How can we determine whether these purposes are being attained? **[Evaluation]**	4. Evaluate curriculum A. faculty review B. listening to students 1. written course reviews 2. periodic oral course evaluations C. student progress D. report of graduates	

COMPARISON: BROSKI ET AL. AND TYLER

Johnson's process model (presented by Broski et al.) dealt only with the steps needed to develop, validate and make public competencies for health care practitioners. In essence, Johnson's model only pertains to Tyler's first principle: identification of educational purposes (See Figure 1). Johnson's process model, applied in the Ohio State Competency Based Education (CBE) project, however, is useful in the following ways.

First, it clearly identifies the various sources of information for determining competencies and explains the processes, thereby, as Tyler suggests, determining educational purposes. Johnson's process model presents a foundation for the competency identification process presented by May. It suggests a review of literature and data sources before collecting data from various sources. Although May identifies the need for gathering competency-related criterion from a variety of sources, Johnson points out the need for preliminary research. Additionally, Johnson's model expounds upon May's competency identification process by adding two distinct points after identification of competencies; validation of competencies and dissemination of their existence. It could probably be argued that these points would be better viewed in the evaluation stage already mentioned by Tyler and May. However, Tyler and May both view evaluation in terms of *curriculum* evaluation; the Johnson model deals with development of *competencies*, not curriculum. Broski et al. (1977) state the purpose of using Johnson's model, "was to guide competency development" (p. 39). This distinction between competency and curriculum is obvious, but requires further explanation in light of relating both to evaluation. The Ohio State CBE project hasn't developmentally advanced to the point justifying classification as a curriculum. Broski et al. (1977) identify the fact that the six allied health disciplines involved in the Ohio State CBE project were at different stages ranging from competencies, through criteria, to curriculum. Therefore, curriculum, in this view, is distinguished from competency identification and, in fact, is a more advanced developmental entity.

In summary, Johnson's model was included here to support and expand upon May's identification-of-competencies step. Additionally, the Johnson model helped to bolster the "purpose of an education" presented by Tyler. It appears to be a clear and comprehensive process for guiding competency development.

COMPARISON: ROWSE ET AL. AND TYLER

> The purpose of the role-based curriculum development model was to present:
>
> a systematic process strategy and useful structures or taxonomies for improving a curriculum when specific roles or tasks which will be required of the program's graduates can be identified. (Rowse et al., 1975, p. 13)

Rowse et al. present a needs assessment involving: professional or occupational leaders in the field; and undertaking pilot studies to evaluate the adequacy of the educational system that prepares and maintains that occupation. These processes are included in the mandate development steps espoused by Rowse et al. Therefore, when comparing their initial step to Tyler's first principle, the Rowse et al. approach provides needed background for determining educational objectives (See Figure 2). Role definition is the second step to curriculum development identified by Rowse et al.. This step includes task analysis, client-practitioner problem exploration, solution component identification, and finally, role synthesis. For Rowse et al., role synthesis provides further background for determination of educational objectives. It includes practitioner task analysis, client-practitioner problem exploration, identification of solution components and creation of a role definition. These elements contribute to, but do not definitively ascertain an educational purpose. However, Rowse et al. present a step concerning the development of an ideal curriculum; this is where the determination of an educational objective is finally considered. Rowse et al. call for the identification of specific curricular objectives "needed in performing defined roles" (Rowse et al., 1975, p. 17). The term "objective" is used repeatedly as it pertains to curricular purpose; this fact relates directly to Tyler's primary concern for developing an educational objective. Rowse et al. identify the determination of a learning hierarchy, or level of learning, as the second step for generation of an ideal curriculum. This can be directly related to

Tyler's second principle regarding curricular design. Rowse et al. describe development of a scale that "permitted systematic integration of instruction for the roles or conversely the need for role based individualization of instruction" (1975, p. 18). The scale relates to named curricular roles; elements relevant to health systems engineering education. It represents a clear example of a curricular design element specific to rating students. Therefore, the role based model championed by Rowse et al. supports Tyler's need for identifying learning experiences.

Scope and sequence was addressed by Rowse et al. in their last step for developing a role based curriculum. This step identifies development of a practical curriculum, considering factors such as financial resources, faculty motivations, and student characteristics. However, they identify "systematically separating, coordinating and avoiding duplication of learning objectives for courses, departments or programs" as considerations for this step. These considerations relate directly to Tyler's third principle pertaining to curricular scope and sequence. Tyler's final principle, evaluation, has no corresponding equivalent in the role based curriculum model presented by Rowse et al..

Figure 2:

Relationship of Tyler's "Basic Principles" to Role Based Curriculum

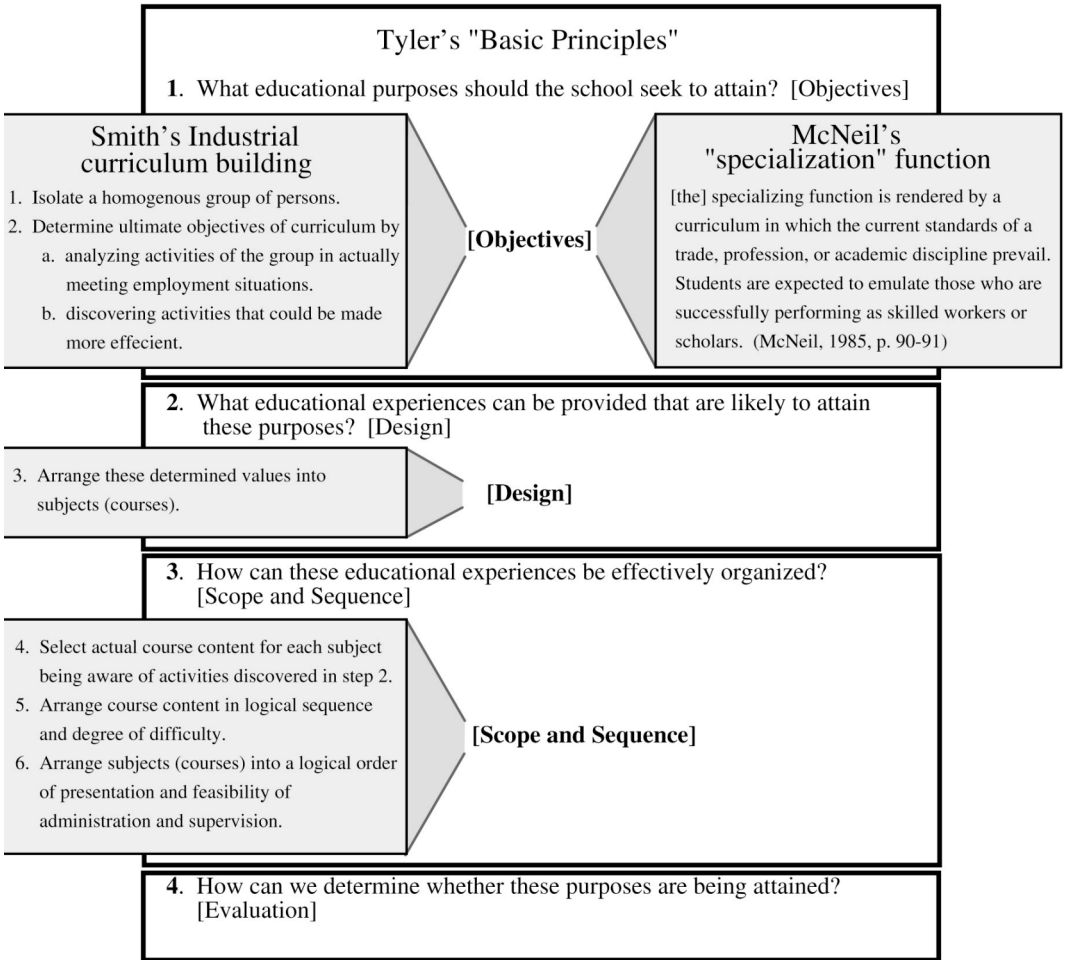
Tyler's "Basic Principles"	Role Based Curriculum: Rowse et al.
	1. Mandate development/Needs assessment A. identify and involve group leaders of profession B. undertake pilot studies 1. literature search 2. questionnaire surveys 3. site visits 2. Role synthesis through A. practitioner task analysis B. client and practitioner problem exploration C. identification of solution components D. role definition
1. What educational purposes should the school seek to attain? **[Objectives]**	3. Generation of the ideal curriculum A. identify specific curricular objectives, "knowledge, attitudes and skills needed in performing defined roles"
2. What educational experiences can be provided that are likely to attain these purposes? **[Design]**	B. determine the level of learning (learning heirarchy) via development of a scale
3. How can these educational experiences be effectively organized? **[Scope and Sequence]**	4. Develop a practical curriculum A. systemically separate learning objectives B. avoid duplication of learning objectives
4. How can we determine whether these purposes are being attained **[Evaluation]**	

COMPARISON: SMITH AND TYLER

In attempting to understand the theoretical concepts of curriculum, it became apparent that Tyler's seminal "basic principles" incorporated all of the steps identified by Smith nearly two decades earlier. Each of Smith's six steps for building an industrial curriculum can be easily distilled into a one-word categorization that Tyler has identified by name in his four-question approach for identifying the basic principles of curriculum (see Figure 3). However, Tyler's last principle, evaluation, was not mentioned by Smith as an independent aspect of industrial curriculum building. Both theorists were aware of the concept and need for evaluation, but each viewed it differently. Additionally, both theorists identified the four basic principles of curriculum, but each presented them in different formats: Tyler by four questions (theory); Smith by six steps (practice).

Figure 3:

Interelationship of Smith's Industrial Curriculum building and McNeil's "Specialization" function to Tyler's "Basic Principles"



It is necessary at this point to justify how Smith's steps are equated to the four singular principles espoused by Tyler. To do so it is best to turn to the original syntax that the theorists used to formulate their ideas. (See Figure 3) As was mentioned, Tyler provides the singular terms; objectives, design, scope and sequence, and evaluation, in the creation of his questions. Smith's terminology or nomenclature will be related to Tyler's four named principles.

First, "objectives:" Smith states "[w]ith these six steps as a working basis we propose to examine the field, determine the need, and evolve an adequate curriculum" (Smith, 1930, p. 12). This is a pretty clear overall objective for determining a curriculum or, as Tyler states, "for viewing, analyzing, and interpreting the curriculum and instructional program of an educational institution" (1949, p. 1). When referring to the examination of "the field," Smith is speaking about a specific industry for which he is designing an industrial training program. This defines his first step; "determining a definite [homogeneous] group of persons in industry" (Smith, 1930, p. 10). Like Tyler, Smith actually uses the word "objective" by name in his second step for determining curricular objectives through analysis of group activities. In his initial question, Tyler asks: "What educational purposes should the school seek to attain? [Objectives]" (1949, p. 1). Smith restates this initial question in his second step. Specifically, Smith proposes the determination of "ultimate objectives of the curriculum" by analyzing and identifying activities that constitute the basis for curricular content.

As a third step for building an industrial curriculum, Smith suggests that one must "arrange… determined values into groups . . . for organization" (Smith 1930, p. 132). This step is congruent with Tyler's second step: design. A "design" is a synonym for the term "arrangement" (Webster, 1971). Both theorists feel that organization through a design or arrangement is essential to formulating instructional content. Tyler's third principle deals with the organization of educational experiences through scope and sequence. When explaining his fourth step, Smith states "course content capable of producing [desired] values must be selected. Such is the purpose of this step" (Smith, 1930, p. 133). This explanation implies organizing subject matter into, as Smith states, "comparable groups . . . convenient for organization into teaching material" (Smith, 1930, p. 10). Both Smith and Tyler believed that organization of subject matter through

logical continuity is important. Smith elaborated further regarding how to arrange course content in ever greater degrees of organization. In fact, his fifth and sixth steps successively build upon the fourth step, and all three deal with how to "arrange" courses sequentially. Smith uses phrases such as "proper sequence," "logical sequence," '"logical order," and "continuity of subject matter" as descriptors for the function of these two steps. Specifically, he stated that step five intends to "secure such sequence and continuity" of subject matter, for "knowledge must relate itself to some knowledge already in possession" (Smith, 1930, p. 133). Additionally, Smith stated "[a]s the proper sequence and continuity of material within a course is essential, so the order of presentation of separate courses within the curriculum is important" (Smith, 1930,p. 12) This leads to Smith's step six, which has a two-part function: "(a) arranging separate courses in logical order of presentation, and (b) arranging course schedules from the standpoint of administration and supervision" (Smith, 1930, p. 133). Again, both Smith and Tyler believed that organization and arrangement of subject matter by both administrative and logical sequence are important. In fact, both philosophers used the word "sequence" by name in explaining their ideas. However, this is where the similarities end. Tyler proposed a fourth principle of curriculum for which Smith had no corresponding step. This principle is "evaluation." Tyler saw evaluation as a ("last") step in a cyclical sequence that would continually redefine curricular objectives. Smith recognized evaluation as an integral process of curriculum design, but not as a cyclical element. Rather he "proposes a checking technique which evaluates" each activity in his six-step process "by competent judges selected from the fields of industry, education, and organized labor" (Smith, 1930, p. 9). These three bodies act in concert with one another to evaluate the functions of every step. In fact, Smith's intent for developing his six-step, industrial curriculum building sequence was to gain efficient and practical

qualitative insight for task activities. He believed the qualitative type of inquiry had been lacking, stating evaluation of task activities such as "frequency of occurrence" were often only quantitative (Draper, 1936). Smith promoted a group-conference method, a checking technique, which evaluates on a qualitative basis each activity on a 100-point scale. In other words, he proposed an evaluation of all tasks in each step of his six-step process (Smith, 1930). The three representative groups collectively evaluate the purpose of every step as a function within the six-step process. It is evident that evaluation was an important consideration in Smith's curriculum development process. However, it was incorporated *into* each step as opposed to being established *as* a separate step.

Finally, McNeil, too, supports Tyler's first principle ─ to ask the educational purpose of the school or department (See Figure 3.) McNeil's four functions of curriculum were presented in the previous chapter. To review, his "specialization" function was determined to suit the purpose of a graduate curriculum, specifically, a medical illustration curriculum. McNeil answered Tyler's question of an educational purpose by providing the framework for which a given curriculum is proposed to be designed. McNeil's framework is specialization, and by establishing this, he sets the stage for determination of the objective. Therefore, McNeil believes that beginning with a specific field of study, a particular set of objectives can be determined, and a curriculum developed. Additionally, by providing the concept of a specialization framework, McNeil helps to add credence to Smith's requirement for isolating a homogenous group in determination of their specific needs.

COMPARISON: SPIVEY AND TYLER

Spivey's technique for determining curricular content is only concerned with Tyler's first principle, identification of curricular content (See Figure 4). In fact, the title of Spivey's technique simply states its only purpose. Spivey suggests the development

of a questionnaire for determination of curricular content. The elements considered for the questionnaire design are derived from a variety of places, Spivey contends. Consultation of content experts in a given field along with outlines developed from previous feedback and subspecialty information aid in this process. A list of tasks, or performances, is identified from these sources and a scale is developed for quantifying questionnaire responses. A pilot survey is sent to a small group, revised and resent. All of these steps conclude with a comprehensive list of elements necessary for developing a curriculum. If the view is taken that curricular content stems from educational purpose, as it is in a competency-based perspective, then these curricular elements are determined by an educational objective. Therefore, it can be assumed that, under the competency-based perspective, Tyler's first principle and Spivey's technique are congruent.

Figure 4:

Relationship of Tyler's "Basic Principles" to Spivey's Curriculum Development Technique

Tyler's "Basic Principles"	Technique for Developing Curricular Content: Spivey
1. What educational purposes should the school seek to attain? **[Objectives]**	1. Design questionnaire to determine behavioral objectives A. consult content experts in the field B. outlines developed from previous feedback C. outlines developed from subspecialties of the field D. list performances deemed necessary from #1 through #4 E. design a scale for quantification of questionnaire responses 2. Send pilot 3. Revise questionnaire 4. Send second version of pilot
2. What educational experiences can be provided that are likely to attain these purposes? **[Design]**	
3. How can these educational experiences be effectively organized? **[Scope and Sequence]**	
4. How can we determine whether these purposes are being attained **[Evaluation]**	

The five process models described here represent the interrelationship between practical approaches and a widely supported theoretical foundation regarding curriculum development. From a competency-based perspective, the five process models can be subsumed within Tyler's "basic principles" of curriculum. These process models, and Tyler's principles, were assimilated for the purpose of developing a medical illustration process model.

CREATING A MEDICAL ILLUSTRATION PROCESS MODEL: A COMPETENCY-BASED PERSPECTIVE

The ultimate purpose of medical illustration, as recognized by the Association of Medical Illustrators, is "to facilitate the recording and dissemination of medical and bioscientific knowledge through visual communication media" (www.ami.org). This broad objective aids in identifying the ultimate goal for medical illustration: visual education. This objective is not, however, specific in describing how to go about doing this. Achieving competency in named tasks is the *ultimate* educational purpose or objective for the Medical Illustration Competency-Based Process Model (MICBPM) (See Figures).

The MICBPM was created for this study using the four steps identified by Tyler. Chosen aspects from the other, previously presented process models were also used to formulate specific elements of the model.

As was presented previously, Rowse et al. cited a needs assessment as the first step in their role-based curriculum development model. Believing a needs assessment was a necessary first step in development of a curriculum process model, it was included in the MICBPM. The medical illustration literature was reviewed, but a comprehensive process model was not found. The literature that does exist recognizes that medical illustration training programs stress competence in their curricula, yet no list of competencies was found. The results of the needs assessment justified developing a comprehensive medical illustration process model.

Figure 5:

Development of a Medical Illustration Competency-Based Process Model

Tyler's "Basic Principles"	Medical Illustration Competency-Based Process Model
1. What educational purposes should the school seek to attain? **[Objectives]**	1. conduct a needs assessment 2. review literature a. professional practice b. educational practice 3. review data sources a. job descriptions b. existing curricula c. standards of practice 4. identify competencies a. consult content experts in the field b. from previous feedback c. from subspecialties of the field d. list performances deemed necessary from #3, a through c. e. design Likert scale for quantifying responses 5. send test pilot to choice few 6. revise survey as per feedback from initial pilot 7. send second version of pilot (respondents from first pilot removed from pool) a. graduates b. practitioners c. educators - employers 8. analyze survey responses a. confirm comprehensive competency list b. quantify competency importance by analyzing rated responses from surveys 9. establish a level of learning (learning heirarchy) of competencies-through use of a scale
2. What educational experiences can be provided that are likely to attain these purposes? **[Design]**	10. identify major themes from activities: arrange the activities, skills, and knowledge into broad groups
3. How can these educational experiences be effectively organized? **[Scope and Sequence]**	11. sequence learning experiences: arrange subject matter in each group according to logical sequence and degree of difficulty
4. How can we determine whether these purposes are being attained **[Evaluation]**	12. evaluate curriculum a. faculty review b. listening to students 1. written course reviews 2. periodic oral course evaluations c. student progress d. feedback from industry e. report of graduates in professional practice

The second step in the MICBPM is a literature review to identify the relevant research in the field. A literature review was identified as a key process step by both Rowse et al. and Johnson. The literature review attempting to locate medical illustration competencies and a competency-based process model was described in Chapter Two. Both the professional and educational arenas were included to ensure complete consideration of current curricular thought, as well as current medical illustration practice and theory.

The third step in the MICBPM is a review of data sources such as standards of practice, job descriptions and existing curricula. Johnson cited review of data sources as being necessary for a competency-based design. May too cited identifying competencies from "standards" and expert judgment as key components in integrated problem-solving curricular design. Southgate et al state:

> Standards that reflect the complexity of medical practice may best be developed through an `expert systems' analysis of clinical conditions for which desired health care outcomes reflect the contribution of several health professionals within a complex, three dimensional, contextual model (p.474). Professional groups are interested in standards from the perspective of an intrinsic desire to `have good standards'. They possess the expertise to judge their peers and tend to define quality and standards without external involvement. (Southgate et al., 2001, p. 475)

In the next chapter the procedures through which a list of appropriate competencies were developed for this study will be described.

Steps 4 through 7 in the MICBPM are identifying competencies, send test pilot to choice few, revise survey as per feedback from initial pilot, and send second version of pilot. They are based on Spivey's technique for developing curricular content.

Step 8 is analyze survey responses. Johnson noted the need for graduates, practitioners, and educators to validate competencies in determining an educational purpose. As will be explained in the next chapter, information on competencies that was

collected through a survey was analyzed in this study. Additional sub-steps in Step 8 are to confirm that the list of competencies identified is comprehensive and to quantify the relative importance if each competency.

Step 9 was establish a hierarchy of competencies through the use of a scale. Rowse specified that entry-level, minimally accepted standards for professional competency be established for each competency. In other words, each task or competency should be assigned a corresponding value to identify a certain minimum level of competency. Completion of these nine steps, according to the MICBPM would establish the educational objectives, as Tyler proposed in the first of his four Basic Principles.

The second of Tyler's principles is Design, which constitutes Step 10 in the model. May stated that major themes should be identified from competencies. This step establishes how competencies are arranged into associated groupings and presents an educational design, or structure. This process will be explained in great detail in the following chapter.

The eleventh step in the MICBPM pertains to the further arrangement of tasks and courses into a logical order according to degree of difficulty and feasibility of administration and supervision. This notion was borrowed from May's Integrated Problem-Solving curricular design and corresponds to Tyler's third principle pertaining to the Scope and Sequence of educational experiences.

Step 12 is evaluation. This was Tyler's fourth principle. It was also presented by May and is a driving factor in any competency-based approach. "Competence requires the application of knowledge in the performance of authentic tasks, rather than mere acquisition of knowledge. Formative feedback is critical to the achievement of competence" (Carraccio, 2004, p. 382). As indicated in Figure 5, evaluation methods

include faculty review, listening to students through written course reviews and oral course evaluations, reviewing student progress, obtaining feedback from the industry and reports from graduates. This Medical Illustration Competency-Based Process Model became the basis for the remainder of this study.

SUMMARY

Exploration of various interrelationships that existed among the five process models described in Chapter 2 and Tyler's "basic principles" were considered in this chapter. First, May's curricular design was shown to follow most closely Tyler's "basic principles" in both sequence and nomenclature. Second, Johnson's model was presented and determined to support only Tyler's "objective" principle, but in a comprehensive fashion. Third, a role based curriculum was introduced and specific steps were presented to support Tyler's first three principles. Next, interrelationships were explored among Tyler's four questions, Smith's six steps, and McNeil's specialization function of curriculum. It was concluded that both Smith's and McNeil's curricular ideas could be combined into Tyler's four points. Furthermore, it was suggested that McNeil and Tyler's curricular theory could be supported through Smith's practical application supposition.

Finally, a comprehensive model was developed based on the literature. This Medical Illustration Competency-Based Process Model provides a basis for study through (1) identification of the current tasks (competencies) required of a professional medical illustrator; (2) analysis of the necessary level of achievement assigned to each competency by practicing, professional medical illustrators; (3) organizing competencies as curricular themes for development of a model, modern day, academic medical illustration program.

The next chapter will describe in detail the methodological approaches that were undertaken to carryout this study's objectives utilizing the Medical Illustration Competency-Based Process Model. Specific attention will focus upon: the competencies that were formulated, the population that was surveyed, the materials that were used, and the various data analyses that were employed.

Chapter IV

Methodology

> As the number of training program graduates employed in the field increases it would be of value to survey this group to determine what skills and knowledge areas have been most important to them in their work and what changes in curricula they might suggest. (Benschoter, 1978, p. 161)

INTRODUCTION: METHODOLOGICAL OVERVIEW

The purpose of this study was: (1) to identify the current tasks (competencies) required of a professional medical illustrator; (2) to analyze the necessary level of achievement assigned to each competency by practicing, professional medical illustrators; (3) to organize competencies as curricular themes for the development of a model, modern day, academic medical illustration program. This study was carried out using the Medical Illustration Competency-Based Process Model developed in Chapter 3.

A search of available literature was undertaken to locate a comprehensive list of medical illustration competencies. A search was also undertaken to find a test instrument that could be used to establish levels of achievement for these competencies. These searches generated no such competency list or test instrument. However, a medical illustration job function list was found in a 1996 unpublished dissertation by Alice Katz. Her findings served as a starting point for identification of medical illustration competencies. The manner in which this was done is described in great detail later in this chapter.

The first purpose of this study, identification of required competencies for professional medical illustrators, was accomplished through consultation with content

experts, review of the literature and data sources. This resulted in the development of a survey instrument. Purpose two, analysis of the necessary level of achievement for each competency, was executed through analysis of the survey responses. Survey respondents were asked to ascribe a numerical value to named competencies. Statistical analyses were run on the survey responses. The results of these statistical analyses produced themes or broad groupings. This addressed the third purpose: to organize competencies as curricular themes for the development of a model, modern day, academic medical illustration program. The study design was constructed around an industry driven philosophy where workplace requirements direct academic training (as was presented in Chapters 2 and 3).

At the time of this study, there were 740 active members of the Association of Medical Illustrators, including 61 Canadian members. The sample used for this study consisted of 678 active members of the AMI who had addresses in the United States. (The author is an AMI member and removed himself from the study).

Figure 6 provides a graphical overview that links the Medical IllustrationCompetency-Based Process Model to the research questions and the hypotheses. It also provides a discussion of the methods used in this study.

Figure 6:

Methodological Approaches to the Medical Illustration Competency-Based Process Model

Research Objectives and Hypotheses	Medical Illustration Competency-Based Process Model	Method
	1. conduct a needs assessment	Research: No existance of MI competencies
	2. review literature a. professional practice b. educational practice	Literature review (Chapter 2)
(1) to identify competencies required of a professional medical illustrator	3. review data sources a. job descriptions b. existing curricula c. standards of practice 4. identify competencies a. consult content experts in the field b. from previous feedback c. from subspecialties of the field d. list performances deemed necessary from #3, a through c. e. design survey and Likert scale for quantifying responses	Focus group: Consisting of medical illustration experts to identify initial competency list for purpose of developing the survey instrument
	5. send test pilot to choice few 6. revise survey as per feedback from initial pilot	Modify survey instrument (from pilot feedback) via focus group
	7. send survey to (respondents from 1st pilot removed from pool) a. graduates b. practitioners c. educators - employers	Administer survey to active AMI members
There will be no significant difference H1: between males and females H2: of respondents of differing age H3: between new graduates and those experienced H4: among MI graduates from differing academic programs H5: among freelancers and non-freelancers regarding the perceived levels of achievement necessary for major competency groupings	8. analyze the survey responses a. confirm comprehensive competency list	Evaluate survey comments for competency omissions
(2) to analyze the level of achievement necessary for each competency by practicing, professional, medical illustrators	b. quantify competency importance by analyzing rated responses from surveys	Descriptive statistics, Factor analyses, and Analyses of Variance (ANOVAs)
	9. establish a level of learning (learning heirarchy) of competencies- through use of a scale	Used pass/fail (*-Alternative- Focus group of MI faculty determines scale)*
From Research qq 1 and 2 (3) to categorize and structure tasks into logical groupings for the purpose of initiating a model competency-based medical illustration curriculum	10. identify major themes from activities: arrange the activities, skills, and knowledge into broad groups	Statistical correlations among competencies
	11. sequence learning experiences: arrange subject matter in each group according to logical sequence and degree of difficulty	*Focus or small group determination: Consisting of medical illustration faculty. Individualized curriculum for students with varied backgrounds.*
	12. evaluate curriculum a. faculty review b. listening to students presently enrolled 1. written course reviews 2. periodic oral course evaluations c. student progress d. feedback from industry(recent graduates, MI employers) e. information sharing (other MI programs, accreditation and governing bodies, and related, competency-based healthcare professions).	*Faculty focus group, course evaluations by current students, surveys of recent graduates, surveys from MI employers*

The remainder of this chapter will be organized around the three research objectives set forth in the purpose of this study. The methodological approaches used to accomplish each objective will be described within the section for that research objective. A step-by-step process for each objective will be presented as illustrated in

Figure 6. Each of the twelve steps presented in the Medical Illustration Competency-Based Process Model will be described.

PROCEDURE FOR RESEARCH OBJECTIVE ONE: COMPETENCY IDENTIFICATION

The first part of the study followed steps one through seven of the Medical Illustration Competency-Based Process Model. This initial part of the study was designed to address the first purpose: to identify the competencies needed by practicing medical illustrators. The first step in this process was accomplished by identifying experts in the field of medical illustration. This was done through a purposive sample (judgment or expert choice) approach. An expert was identified as someone who was a practicing professional and yet had expertise and experience in medical illustration education. Additionally, these individuals had to be well-known in the profession and had to have membership within the Association of Medical Illustrators. Three individuals met these criteria. These experts were asked to develop an "initial" competency list from professional standards and expert judgment. Each expert was asked to review Katz's fifty-one item medical illustration, job function list (See Table 1), Stenstroms's list of instructional objectives for the Medical College of Georgia's competency-based education (CBE) program (Appendix G), and a generic job description and functions of the medical illustrator as described by the Association of Medical Illustrators (Appendix I).

Upon completion of their reviews, each expert was asked to participate in a focus group to establish competency items. The focus group took place at a centralized location, convenient for group members who volunteered their time. Focus group members were asked to present a comprehensive list of competencies from the data sources each had reviewed independently.

Table 1 provides the medical illustration job functions that were identified by Alice Katz (1996); each job function has a description that was formulated by focus groups of freelancers, medical illustrator supervisors, and employers and clients of institutional medical illustrators. This comprehensive list identifies functions relevant to the field of medical illustration including those used by experienced individuals in supervisory or managerial positions and those that come from years of professional experience.

Table 1: Medical Illustration Job Functions

FUNCTION ID	FUNCTION DESCRIPTION
ABSTRACT	Distills The Essence of Client's Message; Eliminates Extraneous Data
ALTER	Alters sketches or design based on client feedback
ANALYZE	Gathers information about job; conducts an analysis of client needs
ARTDIRECT	Develops and communicates concept for others to produce
BILL	Bills client after the fact
BUDGET	Develops budget and monitors expenditures/revenues
COMP	Refines sketches; produces comprehensives or scaled models
CONCEPT	Conceptualizes a solution
CONFLICT	Manages and resolves conflict
CONSULT	Gives consultation or advice
COOP	Cooperates with others on project(s)
COORD	Coordinates work of others on project
CRIT	Evaluates own and others art
DESIGN	Produces design for project
EDIT	Edits exhibit or brochure text, articles, and newsletters
ESTIM	Estimates cost and turnaround on a specific project
EVALUATE	Retroactive analysis, e.g., cost-benefit
FIRE	Fires personnel

GOAL	Sets goals
HIRE	Hires personnel
INTERACT	Interacts with clients, art buyers, or colleagues
INTERVIEW	Interviews for a position or a project
LEARN	Keeps abreast of new technology and knowledge; acquires new Knowledge & Skills
MONITOR	Monitors project(s) for quality, cost, timeliness, e.g., press & blue line checks
NEGOTIATE	Negotiates a contract (cost, time, copyright)) with client
ORGANIZE	Organizes data, tasks, work environment
PLAN	Develops business or strategic plan
POLICY	Establishes and/or follows policies and procedure
PRESENT	Presents papers and workshops
PRICE	Establishes price of products/services for the unit or business
PROCURE	Gets needed resources by any means
PRODUCE	Produces final art (renders, airbrushes, paints, sculpts, computer generates)
PROMOTE	Promotes business or organization
PROPOSE	Develops/delivers concept, budget, and plan for executing project
PURCHASE	Evaluates and purchases equipment
RECORD	Maintains records of labor, materials, etc.
REPORT	Writes and delivers written reports, articles, technical writing
REPRO	Prepares art for reproduction, e.g., sizing, flapping, trapping, peeling
RESEARCH	Researches/investigates topic, media, and audience for a specific project
REVIEW	Seeks client's review and approval
SCHEDULE	Schedules work activities and jobs, multitasking
SCRIPT	Creates concept, dialogue, and treatment for AV media
SELF	Self-management, e.g., stress control, creates balance, renews self
SKETCH	Produces preliminary sketches
SPECS	Prepares specs for vendors

STORYBD	Produces a storyboard to indicate sequence of content
SUPERVISE	Supervise/appraise staff
SYSTEM	Establishes systems for storage/ retrieval of data and things
TEACH	Trains staff or teaches students/interns
VISUALIZE	Visualizes imagery
WRITE	Writes contracts, correspondence, policies, procedures, etc.

The focus group of experts decided to use Katz's Function listing as a starting point for developing the comprehensive list of competencies. All fifty-one of Katz's (1996) functions were determined applicable for professional medical illustrators working in the field. However, Katz developed these functions as they relate to *practicing* medical illustrators, not those necessary for the *preparation* of MI students. Therefore, there were functions on her list that one could not expect a pupil to master without obtaining practical professional experience. These factor items (twenty-six business management functions) were concluded to be "advanced," since they fall outside the range of academic preparation. The focus group decided to collapse these functions into one heading called "business practices." In other words, twenty-six functions from Katz's original fifty-one were reduced from their original scope, and organized into one broad class named "business practices" so that students would have *exposure* to them without having to be *proficient* in them.

In some cases, focus group members identified ambiguous functions as they identified and organized competencies within functions. As a result, some competencies were expanded and other competencies were created. These newly created competencies were then incorporated into Katz's remaining twenty-five functions with other similar competencies. This process was continued until each focus group member was satisfied that each function was comprehensively represented by all competencies that pertained to it. The result was a list of ninety-nine competencies arranged under

twenty-seven function headings (which included twenty five of Katz's original fifty-one functions, as well as the newly created "business practices" function).

Table 2 presents the competencies that were developed by the experts based on Katz's functions. Katz's functions are presented in capitalized letters, followed by her original description in parentheses. The competency(ies), identified for each function by the experts and a brief description, are presented as bulleted entries within each function. The "advanced" competencies in the "business practices" function are shown separately at the end of the table.

Table 2: MI Functions and Competencies

FUNCTION (Katz's original description of her function)
- Competencies (description of competency derived from Katz's function)

ABSTRACT (Description: distills the essence of client's message)
- Verbal understanding-distills the essence of client's message verbally by explaining the problem and solution to others.
- Thumbnail sketch ─ distills the essence of client's message by creating a rough representational sketch of the client's message.
- Final drawing ─ distills the essence of client's message by creating a finished representational drawing of the client's message. Final presentation ─ distills the essence of client's message by creating a final, fully-realized representation of the client's message.

ALTER (Description: Alters sketches or design based on client feedback)
- Verbal understanding- verbally communicates the problem/solution based on additional communications with the client.
- Thumbnail sketch- Alters the rough representation of the illustrated solution based on communications with the client.
- Final Sketch- Alters the final representation of the illustrated solution based on communications with the client.

ANALYZE (Description: Gathers information about job; conducts an analysis of client needs)
- Consults expert personnel in the specialty related to the anatomy/procedure at hand.
- Obtains visual references that pertain to the problem at hand.
- Obtains textual references that pertain to the problem at hand.

- Verbal understanding- verbally articulates the problem/solution based on additional communications with the client.
- Cost analysis ─ Determines the cost based on the amount of time, materials/supplies, and out-sourced expenses needed to execute a project.
- Examine medium type based on cost, time, and output format via a written recommendation or proposal.

COMP (Description: Refines sketches, produces comps or scaled models)
- Final Drawing ─ Creates a detailed (finished) representation of the final product.
- Final preproduction mock-up ─ Able to note necessary production information to production staff.

CONCEPT (Description: Conceptualizes a solution)
- Verbal understanding- demonstrates understanding of concept by verbally explaining the problem and solution to others.

COOP (Description: Cooperates with others on projects)
- Collaboration ─ Able to work together via contributions of other professionals.
- Negotiation ─ Agrees upon work related factors such as cost, turnaround time, etc.
- Communicate ─ Uses appropriate terminology to effectively communicate with members of work-related disciplines.

COORD (Description: Coordinates work of others on project)
- Assign (resources/personnel) for desired outcome.
- Schedule ─ Assigns individuals to a production timeline.
- Delegates workloads to others to optimize efficiency.

CRIT (Description: Evaluates own and others art)
- Verbally explains the strength and weaknesses of the piece in terms of medium application (how medium was handled).
- Verbally explains the strength and weaknesses of the piece in terms of conveying the message (information).
- Medium choice type is appropriate for message

DESIGN (Description: Produces design for project)
- Designing with type: lettering/labeling/copy fitting for readability and layout
- Storyboarding/flowcharting/navigation mapping- visual representation of sequences and/or relationships among elements.
- Composition- Able to sketch layout for the project

ESTIM (Description: Estimates cost and turnaround on a specific project)
- Estimates cost based on turnaround time via verbal means.
- Estimates cost based on medium application via verbal means.

- Estimates cost based on materials needed via verbal means.
- Estimates cost of service bureau/out-service vendors via verbal means.

GOAL (Description: Sets goals)
- Verbally describe a desired outcome (proofs/proposals)
- Able to identify ideas the viewer is intended to gain.

INTERACT (Description: Interacts with clients, art buyers, or colleagues).
- Collaboration ─ Able to work together via contributions of other professionals.
- Negotiation- Mutually agrees upon work related factors such as cost, turnaround time, etc.
- Communicate ─ Uses appropriate terminology to effectively communicate with members of work-related disciplines.

LEARN (Description: Keeps abreast of new technology and knowledge; acquires new Knowledge & Skills)
- Acquire new technical skills.
- Attend workshops, seminars and meetings.
- Subscription to technical/professional publications.
- Membership in professional organizations.
- Networking with colleagues

MONITOR (Description: Monitors projects for quality, cost, timeliness, e.g., press & blue lines)
- Critique- Verbally evaluates the project for quality of information, use of aesthetics, and the degree to which product fulfills objective.
- Budget- Written assessment of cost effectiveness of production process.
- Schedule- Actual production timeline in terms of objectives.

ORGANIZE (Description: Organizes data, tasks, work environment)
- Archives completed work for retrieval
- Schedules work according to deadlines.
- Arranges work area to be efficient
- Catalogues morgue file for reuse in later projects
- Maintains accurate time log for time spent on projects
- Assign (resources/personnel) for desired outcome

PRODUCE (Description: Produces final art (renders, sculpts, computer generates))
- Produces final art according to contracts or agreements (renders, sculpts, computer generates)

PROPOSE (Description: Develops/delivers concept, budget, and plan for executing project)

- Verbally describe a desired outcome (proofs/proposals).
- Pictorially produces a solution to a visual problem.

REPRO (Description: Prepares art for reproduction, e.g., sizing, trapping)

- Prepares product assets for conversion to presentation media.

RESEARCH (Description: Researches/investigates topic, media, and audience for a specific project)

- Accesses expert personnel in the specialty related to the anatomy/procedure at hand.
- Acquires the appropriate textual content references to research the topic at hand.
- Reviews the visual reference material to expedite the initial creation phase.
- Acquire information from client regarding knowledge base of audience.

REVIEW (Description: Seeks client's review and approval)

- Feedback – Seeks client input for ultimate approval of product.

SCHEDULE (Description: Schedules work activities and jobs, multitasking)

- Meets deadlines.
- Delegates workloads to others to optimize efficiency.
- Coordinates changing schedules among product participants, including outside vendors.
- Orchestrates production schedules for concurrent projects.

SCRIPT (Description: Creates concept, dialogue, and treatment for AV media)

- Draft storyboards/flowcharts/navigation maps- show sequences between relationships among elements.
- Writes text to correspond with imagery.

SKETCH (Description: Produces preliminary sketches)

- Thumbnail sketch ─ demonstrates understanding of concept by producing a rough thumbnail sketch.
- Final Drawing ─ demonstrates understanding of concept by producing a final drawing.

SPECS (Description: Prepares specs for vendors)

- Prepares written information relevant to reproduction of product.

STORYBD (Description: Produces a storyboard to indicate sequence of content)

- Produces a storyboard to indicate sequence between or relationships among elements.

VISUALIZE (Description: Visualizes imagery)

- Able to generate multiple sketches/thumbnails to communicate a solution to a given problem.
- Thumbnail sketch ─ demonstrates understanding of concept by producing a rough thumbnail sketch.
- Final Drawing ─ demonstrates understanding of concept by producing a final drawing
- Final presentation ─ demonstrates understanding of concept by executing a finished, completed product.

BUSINESS PRACTICES (Description: Skills necessary to conduct ones self in business)

ARTDIRECT (Develops and communicates concept for others to produce)

- Exposure to the considerations with which art directors face

BILL (Bills client after the fact)

- Exposure to the principles of billing and cash flow

BUDGET (Develops budget and monitors expenditures/revenues)

- Exposure to budget concerns/philosophies related to service bureaus or running a small businesses

CONFLICT (Manages and resolves conflict)

- Exposure to management principles pertaining to conflict resolution

CONSULT (Gives consultation or advice)

- Exposure to communication techniques through role playing

EDIT (Edits exhibit or brochure text, articles, and newsletters)

- Exposure to writing techniques, proper grammar, and scholarly formats.

EVALUATE (Retroactive analysis, e.g., cost-benefit)

- Exposure to techniques comparing a goal to an outcome

FIRE (Fires personnel)

- Exposure to management principles pertaining to employment termination

GOAL (Sets Goals)

- Exposure to professional development skills

HIRE (Hires personnel)

- Exposure to management principles pertaining to employment and interview considerations

INTERVIEW (Interviews for a position or a project)

- Exposure to interviewing techniques and skills

NEGOTIATE (Negotiates a contract (cost, time, copyright)) with client.

- Exposure to negotiation techniques pertaining to cost, timeframes, and ownership/usage.

PLAN (Develops business or strategic plan)

- Exposure to considerations necessary for beginning a new business or furthering an existing one

POLICY (Establishes and/or follows policies and procedure)

- Exposure to management principles related to organizational structure and behavior

PRESENT (Presents papers and workshops)

- Exposure to presentation techniques and formats

PRICE (Establishes price of products/services for the unit or business)

- Exposure to pricing rates for freelance and service environments

PROCURE (Gets needed resources by any means)

- Exposure to practical approaches (case studies) for attaining resources/funds

PROMOTE (Promotes business or organization)

- Exposure to marketing/promotion philosophies/strategies for business

PURCHASE (Evaluates and purchases equipment)

- Exposure to purchasing considerations including needs analyses

RECORD (Maintains records of labor, materials, etc.)

- Exposure to management principles pertaining to record keeping

REPORT (Writes and delivers written reports, articles, technical writing)

- Exposure to writing formats necessary for preparing professional articles.

SELF (Self-management, e.g., stress control, creates balance, renews self)

- Exposure to professional skills

SUPERVISE (Supervise/appraise staff)

- Exposure to management principles pertaining to supervising and evaluating personnel.

SYSTEM (Establishes systems for storage/ retrieval of data and things)

- Exposure to various examples of work-related systems (management of assets, supplies, and information.)

TEACH (Trains staff or teaches students/interns)

- Exposure to basic principles of teaching.

WRITE (Writes contracts, correspondence, policies, procedures, etc.)

- Exposure to writing formats necessary for preparing professional documents

The competencies shown in Table 2 became the basis for the draft survey instrument. However, in creating the competency list, the focus group realized that certain competencies seemed redundant despite the fact that they originated from different functions. These competencies were either further defined to establish a more detailed meaning from similarly sounding competencies, or listed only once if the difference in meaning was not substantial. The result was a comprehensive list of eighty-nine competencies.

In order to quantify the level to which students should achieve a particular task/competency, a seven-point Likert scale was developed with a value of "1" denoting a minimum level of achievement and a value of "7" denoting a maximum level of achievement. Because all of the competencies that were included in the survey were pertinent to medical illustration, it was expected that survey responses would fall toward the higher end of the scale. It was hoped that the seven-point scale would be more able to distinguish among perceptions of greater achievement.

Two medical illustrators who were considered to be both proficient in illustration and experienced in the education of medical illustration students were asked to pilot test the draft survey. The purpose of the study was explained to them, and they were asked

to review the survey instrument to see whether the wording was clear and whether any competencies had been omitted. The only shortcoming identified by the pilot study respondents was "continuity of flow." Specifically, they reported that the survey took an inordinate amount of time to complete because respondents were asked to move from one action word to another too much. As a result, the competency/task statements were rearranged alphabetically according to the action word that began each statement. The resulting list of statements became the basis for the final survey instrument. It is shown in Table 3. The two individuals who took part in the pilot study were removed from the sample.

Table 3: Comprehensive list of competencies

1. Able to note necessary production information to production staff for a final preproduction mock-up.
2. Acquires information from client regarding knowledge base of audience.
3. Acquires new technical skills.
4. Acquires the appropriate textual content references to research the topic at hand.
5. Alters the final representation of the illustrated-solution-based on communications with the client.
6. Alters the rough representation of the illustrated-solution-based on communications with the client via thumbnail sketch.
7. Archives completed work for retrieval.
8. Arranges work area to be efficient.
9. Articulates verbal understanding of the problem/solution based on additional communications with the client.
10. Assigns resources/personnel for desired outcome.
11. Assigns individuals to a production timeline.
12. Attends workshops, seminars, and meetings.
13. Budgets the cost effectiveness of production process via written assessments.
14. Catalogues morgue file for reuse in later projects.
15. Chooses medium type that is appropriate for message.
16. Collaborates with other professionals.
17. Communicates using appropriate terminology to effectively communicate with members of work-related disciplines.

18. Composes sketch layouts for the project.
19. Consults expert personnel in the specialty related to the anatomy/procedure at hand.
20. Coordinates changing schedules among product participants, including outside vendors.
21. Creates a detailed (finished) representation of the final product.
22. Delegates workload to others to optimize efficiency.
23. Demonstrates understanding of concept by executing a finished, completed product.
24. Demonstrates understanding of concept by producing a final drawing.
25. Demonstrates understanding of concept by producing a rough thumbnail sketch.
26. Demonstrates understanding of concept by verbally explaining the problem and solution to others.
27. Describes verbally a desired outcome (proofs/proposals).
28. Designs with type (e.g. lettering/labeling/copy fitting) for readability and layout.
29. Determines the cost based on the amount of time, materials/supplies, and outsourced expenses needed to execute a project.
30. Distills the essence of client's message by creating a final, fully realized representation of the clients message.
31. Distills the essence of client's message by creating a finished representational drawing of the client's message.
32. Distills the essence of client's message by creating a rough representational thumbnail sketch of the client's message.
33. Distills the essence of client's message verbally by explaining the problem and solution to others.
34. Drafts storyboards/flowcharts/navigation maps (e.g. shows sequences between relationships among elements).
35. Estimates cost based on materials needed.
36. Estimates cost based on medium application.
37. Estimates cost based on turnaround time.
38. Estimates cost of service bureau/out-service vendors.
39. Evaluates the project verbally for quality of information, use of aesthetics, and the degree to which product fulfills objective.
40. Examines medium type based on cost, time, and output format via a written recommendation or proposal.
41. Explains verbally the strength and weaknesses of the piece in terms of conveying the message (information).

42. Explains verbally the strength and weaknesses of the piece in terms of medium application (how medium was handled).
43. Generates multiple sketches/thumbnails to communicate a solution to a given problem.
44. Has exposure to basic principles of teaching.
45. Has exposure to budget concerns/philosophies related to service bureaus or running a small business.
46. Has exposure to communication techniques through role-playing.
47. Has exposure to considerations necessary for beginning a new business or furthering an existing one.
48. Has exposure to interviewing techniques and skills.
49. Has exposure to management principles pertaining to conflict resolution.
50. Has exposure to management principles pertaining to employment and interview considerations.
51. Has exposure to management principles pertaining to employment termination.
52. Has exposure to management principles pertaining to record keeping.
53. Has exposure to management principles pertaining to supervising and evaluating personnel.
54. Has exposure to management principles related to organizational structure and behavior.
55. Has exposure to marketing/promotion philosophies/strategies for business.
56. Has exposure to negotiation techniques pertaining to cost, time frames, and ownership/usage.
57. Has exposure to practical approaches (case studies) for attaining resources/funds.
58. Has exposure to presentation techniques and formats.
59. Has exposure to pricing rates for freelance and service environments.
60. Has exposure to professional development skills.
61. Has exposure to purchasing considerations including needs analyses.
62. Has exposure to techniques comparing a goal to an outcome.
63. Has exposure to the considerations which art directors face.
64. Has exposure to the principles of billing and cash flow.
65. Has exposure to various examples of work-related systems (management of assets, supplies, and information).
66. Has exposure to writing formats necessary for preparing professional articles.
67. Has exposure to writing formats necessary for preparing professional documents.
68. Has exposure to writing techniques, proper grammar, and scholarly formats.
69. Has membership in professional organizations.

70. Identifies ideas the viewer is intended to gain.
71. Maintains accurate time log for time spent on projects.
72. Meets deadlines.
73. Negotiates/mutually agrees upon work-related factors such as cost, turnaround time, etc
74. Networks with colleagues.
75. Obtains textual references that pertain to the problem.
76. Obtains visual references that pertain to the problem.
77. Orchestrates production schedules for concurrent projects.
78. Prepares product assets for conversion to presentation media.
79. Prepares written information relevant to reproduction of product.
80. Produces a pictorial solution to a visual problem.
81. Produces a storyboard to indicate sequence between or relationships among elements.
82. Produces final art according to contracts or agreements (renders, sculpts, computer generates).
83. Reviews the visual reference material to expedite the initial creation phase.
84. Schedules production timeline in terms of objectives.
85. Schedules work according to deadlines.
86. Seeks client input (feedback) for ultimate approval of product.
87. Subscribes to technical/professional publications.
88. Uses storyboarding/flowcharting/navigation mapping for visual representation of sequences and/or relationships among elements.
89. Writes text to correspond with imagery.

Selection of Sample: Survey Participants

The survey was sent to those individuals listed in the Association of Medical Illustrators' (AMI) 2002-2003 membership database. The 740 members were an incomplete list of practicing medical illustrators at the time, since some medical illustrators are not AMI members. Only medical illustrators identified by addresses in the United States were chosen for this study. Further, the two individuals who pilot-tested the survey instrument were not included in the sample. This narrowed the number of participants from 740 to 678. Those participants included persons employed in small

medical education companies, Veterans' Administration hospitals, university teaching hospitals, state and private supported medical, dental and veterinary colleges, and private clinics, as well as freelance medical illustrators working independently for physicians, or pharmaceutical, publishing, medical instrument, and advertising companies. These demographics were not a complication of the sampling plan for this study because the purpose was to identify the competencies within the profession and establish expected levels of achievement.

Treatment of all participants was in accordance with the ethical standards of the American Psychological Association (APA, 1981). Respondents were informed in their recruitment letter (Appendix J) that their participation in the study was strictly voluntary and that their responses would remain confidential.

Materials

The study materials included a recruitment letter (Appendix J) and the Survey Form (Appendix K) composed of 89 items, each with a seven-point Likert scale, and a postage-paid return envelope. The 89 items, each a medical illustration competency, were scored according to the level of achievement necessary, as judged by the respondents. Respondents remained anonymous; however, each survey was marked with a number associated to the AMI membership list. This revealed which respondent had returned the survey information, and allowed for the possibility of subsequent mailings for those who had not yet responded. Those individuals who did not respond by the date indicated on the survey, received a reminder letter, then a follow-up letter with another enclosed survey, and finally, a phone call. Finally, a general notice was sent out to AMI members via the AMI ListServe, an electronic bulletin board about two weeks following the mass mailing (See Appendix L).

PROCEDURE FOR RESEARCH OBJECTIVE TWO: COMPETENCY QUANTIFICATION

This section pertains to how the second purpose of this study, analysis of levels of achievement for competencies and the associated hypotheses, were addressed statistically. Competency quantification is the process of assigning a numerical value to a competency survey item based on the cumulative ratings by respondents. Steps eight and nine of the Medical Illustration Competency-Based Process Model were designed to address this purpose. Various data analysis processes were carried out depending upon the intent of the research purpose or hypothesis.

Data Analysis

There were three data analysis techniques used in this study: Descriptive Statistics, Analyses of Variance, and Factor Analyses. All of the analyses were generated using the Statistical Analysis System (SAS) software package, version 6.12. Descriptive Statistics and the Analyses of Variance will be described in this section because they were used to address the second research objective for the study. Factor analysis will be discussed in the next section of this chapter.

Six hundred seventy-eight surveys were sent out to professional illustrators. Out of these, 142 surveys were returned [a response rate of 20.9%]. Not all of the remaining 142 survey forms were complete. However, all data were entered into the master file. The procedures are explained in the following text.

Descriptive Statistics

Summaries of the demographic data recorded on the survey were based upon the total sample size of 142 respondents who provided data. Frequency distributions for gender, age, percent time freelancing, years in the field, possession of masters degree and program attended were calculated.

In addition, specific competencies with the ten highest and lowest average Likert scores were identified. Average Likert scores and standard deviations were calculated for the eighty-nine competencies (See Appendix M).

Analysis of Variance (ANOVA)

To investigate differences among average scores for two or more criteria, ANOVA is the preferred statistical procedure. It is a structured mathematical procedure that uses the variation among responses "within" each criterion "to make quantitative judgments about potential differences between/among averages for each of the criteria in a demographic characteristic" (Free, 2006, conversation) The resulting critical statistic is an F ratio with an associated p-value. A p-value ≤ 0.05 was used to identify statistically significant differences.

In this study, the five hypotheses, all of which pertained to demographic characteristics, were tested using this technique. Each hypothesis stated that there would be "no difference" in perceived levels of achievement of competencies across the various demographic characteristic. The demographic characteristics tested included: sex, age, level of experience in the profession, percent time freelancing, and whether the respondent graduated from an accredited or non-accredited medical illustration program.

It would be impractical to consider individually all competencies to investigate potential differences among criteria within each of the demographic characteristics. Therefore, the hypotheses were tested using the four dimensions identified during the factor analysis that will be described in the next section. Only 117 of the responses were used in this analysis for reasons that will be described in the next section.

The nature of the testing of these hypotheses is shown in Table 4.

Table 4: Hypotheses

Hypothesis	Analysis of Variance Plan
H_1: There will be no significant difference between males and females regarding the perceived levels of achievement ascribed to major competency groupings.	Independent Variable: Gender -2 levels (males and females) Dependent Variable: Importance level of major competency groupings.
H_2: There will be no significant difference between respondents of differing age groups regarding the perceived levels of achievement ascribed to major competency groupings.	Independent Variable: Age - 7 levels (e.g., 20 to 29 yrs., 30 to 39 yrs., 40 to 49 yrs., 50 to 59 yrs., 60 to 69 yrs., 70 to 79 yrs., over 79 yrs.) Dependent Variable: Importance level of major competency groupings.
H_3: There will be no significant difference between new graduates and those experienced in the field regarding the perceived levels of achievement ascribed to major competency groupings.	Independent Variable: Time in career – 2 levels (e.g. new graduates, 1 to 5 years and experienced professionals, 6 plus years) Dependent Variable: Importance level of major competency groupings.
H_4: There will be no significant difference between professionals from accredited academic programs of medical illustration and those from non-accredited programs regarding the perceived levels of achievement ascribed to major competency groupings.	Independent Variable: Accredited program – 6 levels (e.g., Chicago, Johns Hopkins, MCG, Michigan, UT Dallas, non-accredited programs) Dependent Variable: Importance level of major competency groupings.
H_5: There will be no significant difference between professionals working in a freelance capacity and those who do not work in freelance regarding the perceived levels of achievement ascribed to major competency groupings	Independent Variable: Freelance – 2 levels (e.g., 0 to 20% time spent freelancing and 21 to 100% time spent freelancing) Dependent Variable: Importance level of major competency groupings.

PROCEDURE FOR RESEARCH OBJECTIVE THREE: COMPETENCY-BASED CURRICULUM CONSTRUCTION

The third part of the study pertained to step 10 of the Medical Illustration Competency-Based Process Model and provided the foundation for a competency-based curriculum in medical illustration education. Competency items were arranged, organized, and categorized into broad subject headings, or themes, for the purpose of structuring courses. This was done through factor analysis attempting to locate and identify correlated competencies. The Statistical Analysis System (SAS) software package, version 6.12, was again used to accomplish this research objective.

Factor Analyses

> Factor analysis is an objective, mathematical procedure that uses the correlation structure to achieve the following: (1) to determine how many "real" dimensions would exist among the 89 items if they were plotted in multi-dimensional space. (2) To identify clusters of items which are highly correlated within each cluster; these are called factors. (3) To identify dimensions that are actually single items that most respondents scored consistently. (4) By default, to identify the items that were scored in such a way that they did not provide positive information (M. Free, 2006, emeritus statistics professor, personal conversation).

Data for all 142 respondents were entered into the SAS program. Raw data for 89 items for all 142 respondents were printed out to identify missing data. Thirty respondents were recognized as being responsible for missing data; twenty-five were removed from this part of the analysis because they did not provide a sufficient number of responses. Five of the thirty respondents provided all but one or two responses for the 89 total items. In an attempt to utilize the maximum amount of available data, a decision was made to substitute the average score of the respondents who did respond for the respondent who did not. In all, of the 12,638 expected Likert scores [142

respondents x 89 correlated items], fewer than 3.5% substitutions were made. Therefore the factor analysis was carried out using the 117 "completed" surveys.

As indicated previously, all statistical analyses were carried out using the SAS data processing software [version 6.12]. The varimax rotation option was used as part of the factor analysis. This helped to identify the items that made the greatest contributions within each factor (cluster). A numerical value of $\geq$.48 was used to determine whether a competency was strong enough to be included in a particular factor. Typically a weight of $\geq$.50 is used as a threshold for determining this strength, but the lower threshold was chosen in this case because of the number of weights that fell $\geq$.49. The decision was made to use $\geq$.48 to include these weights in the analysis and to combat rounding issues.

Organizing all competencies with their descriptions within the various factors revealed an obvious, common theme for each factor. It is conventional to "name" each factor in a manner that contributes to the objectives of a project. These short names will be discussed further in the Chapter V.

Appendix N provides a detailed description of factor

MEDICAL ILLUSTRATION COMPETENCY-BASED MODEL STEPS NOT FOLLOWED FOR THIS STUDY

Establishing competency scales

Assigning levels of competency to each identified competency task is Step 9 of the Medical Illustration Competency-Based Process Model. The focus group felt strongly that minimum levels of competency should be determined by the administration of each academic program as this model is being implemented. As a result of this decision, establishing competency scales was not part of the methodology for this study.

Sequencing learning experiences and Curriculum evaluation

For the purposes of this study, no consideration was given to steps 11 or 12 of the Medical Illustration Competency-Based Model. These two steps were not addressed in this study because they pertain to a particular student's knowledge base and the evaluation of the curriculum being used. Since there were no students being evaluated as part of such a curriculum, and an actual, existing curriculum was not being evaluated, these two last steps of the MICBPM were not relevant to this study. However, these steps are recognized as important elements when implementing or following an actual Medical Illustration Competency-Based curriculum. Sequencing learning experiences (step 11), viewed from a competency based perspective, is dependent upon the unique abilities, background, and experiences of a given student. The focus group and the competency education literature state that individual learning experiences need to be established based on the unique characteristics of each student. Each student would need individualized learning experiences developed for his or her own particular knowledge bases.

Step 12, program evaluation, can only be executed after an actual academic competency based medical illustration program has been in practice for a given period of time. Again, this step, too, is recognized as an important element when implementing a Medical Illustration Competency-Based curriculum.

CONCLUSION

This chapter presented procedures for addressing research questions one, two, and three. Competencies were identified by expert medical illustrators in a focus group. A seven point Likert scale was designed and used with each of the competencies the focus group identified. This became the pilot survey instrument. As a result of the pilot test the survey items were redesigned. Six hundred seventy-eight surveys were sent out

to professional illustrators listed in the Association of Medical Illustrators' (AMI) 2002-2003 membership database. One hundred-fifty surveys were returned. Of these, one hundred forty-two were complete enough to be used in descriptive statistics and one hundred seventeen were complete enough to be used in the factor analysis and variance analyses. The next chapter will present the study's findings.

Chapter V

Findings

> "Give me a premise to stand on and I will deduce a world!" Archimedes (In Kaplan, 1964).

INTRODUCTION

In this chapter, the rates of return of the surveys are presented, along with demographic data. Demographic data included gender, age, number of years in the medical illustration field, the academic program from which the degree was awarded, possession of a Masters degree or certificate in medical illustration, and percentage of time per day spent freelancing.

The next section presents two tables of competencies arranged by the level of necessary achievement as identified by survey respondents. The ten highest and lowest rated competencies from the survey are included along with their average scores.

Factor analysis reduced the original data set of eighty-nine competencies to twenty-one "Major," "Minor," and "Potentially Useful" factors. Factors are presented in table format. The correlated competencies that make up each of the Major and Minor factors are described. Single dimension items, which are single competencies that were scored similarly by each respondent, are also presented.

The final section of this chapter presents findings to answer the study's five research hypotheses regarding sex, age, experience, percent time freelancing, and academic program affiliation, as described in Chapter IV.

DEMOGRAPHIC DATA: FREQUENCY DISTRIBUTION

Demographic data for sex, age, experience, school affiliation, possession of a Masters degree, and percent time freelancing, were based upon the total sample size of 142 respondents who provided complete data. These descriptive statistics are presented in the frequency distribution tables for each demographic variable.

Sex

Respondents were asked to indicate their gender. In this study, 58.5% of the respondents were female and 41.5% were male. All 142 respondents completed this question. Table 5 below presents a frequency distribution by sex.

Table 5: Frequency Distribution by Sex

Sex	Frequency	Percent
Female	83	58.5
Male	59	41.5
Total	142	100.0

Frequency missing: 0

Age

Respondents were asked to indicate their age, according to 10-year ranges. They could indicate 20-29, 30-39, 40-49, 50-59, 60-69, or 70-79. In this study, the majority of respondents (50 individuals) reported being in the 40-49 age group. This represented 35.7 percent of 140 total respondents. The 50-59 age group and the 30-39 age group represented 21.4% and 20.7% of the respondents respectively. The 20-29 age group represented 15%. Three individuals identified themselves with the 70-up age group; seven respondents fell within the 60-69 age group. These two groups were combined into a 60-up age group which represented 7.1% of all respondents. (See Table 6)

Table 6: Frequency Distribution by Age

Age	Frequency	Percent	Cumulative Frequency	Cumulative Percent
20-29	21	15.0	21	15.0
30-39	29	20.7	50	35.7
40-49	50	35.7	100	71.4
50-59	30	21.4	130	92.9
60 and up	10	7.1	140	100.0

Mean age: 41.6 years old
Median: 43.3
Frequency missing: 2

Experience: Number of Years in the Field

Respondents were asked to indicate the number of years they had worked in the medical illustration field. Responses ranged from one to sixty years of service. The highest percentage of respondents fell within the 2-5 years category. (See Table 7) Medical illustrators who had worked in the field for five years or less made up 26 percent of total respondents. Medical illustrators who had worked in the field for ten years or less made up 41 percent of total respondents. Illustrators working in the field 11-20 years made up 30.2 percent of the respondents. Illustrators working in medical illustration for more than twenty years comprised 29.1 percent of respondents.

Table 7: Frequency Distribution of Number of Years in the Field

Years in field	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	8	5.8	8	5.8
2-5	28	20.1	36	25.9
6-10	21	15.1	57	41.0
11-15	18	12.9	75	54.0
16-20	24	17.3	99	71.2
21-25	19	13.7	118	84.9
26-30	11	7.9	129	92.8
31-35	7	5.4	136	98.2
36-45	2	1.4	138	99.6
46-60	1	0.7	139	100.0

Frequency missing: 3

The frequency distribution presented in Table 7 shows that using one year in the field was too restrictive (N=8 at 5.87 percent) to provide meaningful comparisons. For this reason, new graduates in this study were defined by having five or less years of professional experience. Hypothesis #3 regarding how new graduates versus experienced professionals perceive necessary levels of achievement of various competencies was investigated with this definition. This analysis will be discussed in greater detail later in the next chapter.

School Affiliation

Every graduate-level U.S. medical illustration program was represented by at least one respondent to the survey. Out of 142 respondents, 113 indicated the program they attended. Nine respondents indicated they had either a degree or a certificate, but did not indicate the particular program to which they were affiliated. One hundred-four respondents indicated they attended accredited academic programs; the remaining nine

attended non-accredited programs. Only programs that awarded masters degrees or certificates in MI are shown in Table 8 below; respondents who indicated they worked in medical illustration but had not earned a degree or certificate in medical illustration are not included in the table. Programs are presented in the order of number of respondents. The first five medical illustration programs listed in Table 8 are the only accredited graduate-level programs in the United States.

Table 8: School Affiliation

School Program	N
Medical College of Georgia	31
University of Illinois at Chicago	24
Johns Hopkins School of Medicine	18
University of Texas Southwestern Medical Center at Dallas	16
University of Michigan	15
Rochester Institute of Technology	3
Colorado State	2
Cleveland Institute of Art	2
Northern Illinois	1
University of Missouri	1

N=113

Certificate or Masters Degree

Approximately 75 percent (106) of respondents indicated that they had earned a Masters degree in medical illustration. Roughly 25% (33) had not. Of these, 12 individuals reported that although they had not earned a Masters degree, they had earned a certificate in medical illustration. Twenty individuals indicated that they had earned neither a certificate nor a Masters degree. One respondent indicated that he had not

earned a Masters degree, but failed to indicate whether he had earned a certificate. Three respondents did not answer the question. (See Table 9)

Table 9: Frequency Distribution by Certificate or Masters Degree

Earned Masters Degree	Earned Certificate	Frequency	Percent	Cumulative Percent
No	Yes	12	8.6	8.6
No	No	20	14.4	23.0
No	?	1	0.7	23.7
Total No		33	23.7	23.7
Total Yes		106	76.2	100.0

Frequency missing: 3

Percent Time Freelancing

Respondents were asked to indicate their percentage of time spent freelancing. Of the 142 respondents in this study, 56 (40.3%) indicated that all of their time was spent freelancing. Conversely, seventeen respondents (12.2%) answered that none of their time consisted of freelance work. Of those respondents who indicated that they engaged in some freelance activities, 122 (87.8%) reported that some portion of their time (at least 5 percent) was spent in freelance activity. Sixty-two (44.6%) responded that half of their work time was freelance, and 47 (33.8%) indicated that a quarter or less of their time was spent on freelance work. Three respondents did not answer this question. (See Table 10)

Table 10: Frequency Distribution by Percent of Time Freelancing

% Time Freelancing	Frequency	Percent	Cumulative Frequency	Cumulative Percent
100	56	40.32	56	40.3
90	1	0.72	57	41.0
80	1	0.72	58	41.8
60	1	0.72	59	42.5
55	1	0.72	60	43.2
50	2	1.44	62	44.6
40	4	2.88	66	47.5
35	1	0.72	67	48.2
30	8	5.76	75	54.0
25	2	1.44	77	55.4
20	9	6.48	86	61.9
15	5	3.60	91	65.5
10	18	12.96	109	78.5
5	13	9.36	122	87.8
0	17	12.24	139	100.0

Frequency missing: 3

SELECTED COMPETENCIES

Mean scores on the seven-point Likert scale were calculated for each of the 89 competencies in the survey instrument. One hundred-seventeen respondents provided surveys that were complete enough to be included in this analysis. The competencies with the highest mean scores are shown in Table 11 in rank order. The means for these ten competencies averaged between 6.80 and 6.12. Attention to deadlines (questions 72, 85, and 73) and understanding client needs (questions 82, 86, 80, 5, 23, and 9) accounted for the largest number of these competencies. Appendix M provides the means and standard deviations for all 89 survey items.

Table 11: Competencies with the 10 Highest Likert Score Averages

Rank	Survey number	Description	Mean
1	72	Meets deadlines.	6.80
2	82	Produces final art according to contracts or agreements (renders, sculpts, computer generates).	6.50
3	86	Seeks client input (feedback) for ultimate approval of product.	6.41
4	85	Schedules work according to deadlines.	6.32
5	80	Produces a pictorial solution to a visual problem.	6.26
6	5	Alters the final representation of the illustrated solution based on communications with the client.	6.21
7	73	Negotiates/mutually agrees upon work related factors such as cost, turnaround time, etc	6.20
8	23	Demonstrates understanding of concept by executing a finished, completed product.	6.19
9	9	Articulates verbal understanding of the problem/solution based on additional communications with the client.	6.14
10	76	Obtains visual references that pertain to the problem at hand.	6.12

N= 117

The competencies that had the lowest mean scores are shown in Table 12 in reverse rank order. The means for these competencies were between 4.26 and 3.62. Nine of the ten lowest ranked competencies were derived from the "Business Practices" function. Of these, role-playing techniques, and management-related principles were ranked as lower-valued competencies.

Table 12: Competencies with the 10 Lowest Likert Score Averages

Rank	Survey number	Description	Mean
89	51	Has exposure to management principles pertaining to employment termination.	3.62
88	46	Has exposure to communication techniques through role-playing.	3.76
87	53	Has exposure to management principles pertaining to supervising and evaluating personnel.	3.84
86	54	Has exposure to management principles related to organizational structure and behavior.	3.86
85	66	Has exposure to writing formats necessary for preparing professional articles.	3.86
84	50	Has exposure to management principles pertaining to employment and interview considerations.	3.92
83	62	Has exposure to techniques comparing a goal to an outcome.	4.09
82	61	Has exposure to purchasing considerations including needs analyses.	4.17
81	65	Has exposure to various examples of work-related systems (management of assets, supplies, and information).	4.20
80	14	Catalogues morgue file for reuse in later projects.	4.26

N= 117

As was mentioned earlier, it was expected that responses would fall on the high end of the Likert scale because all of the competencies were intended to be pertinent to medical illustration. The mean score of the ten lowest ranked competencies were between 3.6 and 4.3, toward the neutral part of the seven-point Likert scale.

FACTOR ANALYSIS

In order to identify broader categories of subject matter for a medical illustration curriculum, correlations between the 89 competencies were calculated based on the 117 complete survey responses and a factor analysis was carried out. The Factor Analysis process with the associated principle components analysis and varimax rotation is described in Appendix N. Factor analysis found 21 factor/dimensions based on 76 of the

competencies. (Thirteen of the competencies were found to add little to the analysis and were eliminated from the analysis.) A dimension is defined as independent variables derived from the principle components phase of factor analysis. Table 13 shows the amount of variance explained by principle component analysis for each of the 21 dimensions.

Table 13: From the Principle Components Analysis

Dimension	Eigenvalue	Variance accounted for:	
		Percent	Cumulative
1	22.59	25.4	25.4
2	7.13	8.0	33.4
3	4.61	5.2	38.6
4	4.24	4.8	43.3
5	3.31	3.7	47.1
6	2.84	3.2	50.2
7	2.57	2.9	53.1
8	2.36	2.7	55.8
9	2.14	2.4	58.2
10	2.05	2.3	60.5
11	2.01	2.3	62.8
12	1.89	2.1	64.9
13	1.73	2.0	66.8
14	1.59	1.8	68.6
15	1.48	1.7	70.3
16	1.40	1.6	71.8
17	1.23	1.4	73.2
18	1.18	1.3	74.5
19	1.10	1.2	75.8
20	1.07	1.2	77.0
21	1.02	1.1	78.1

Clustering of Competencies

Fourteen of the dimensions consisted of clusters of highly correlated competencies; seven were based on single competencies. These organizational structures are presented in Tables 14 and 15. The dimensions were categorized as Major

Factors, Minor Factors and potentially useful single competencies. These categories will be explained in detail later in this chapter.

Tables 14 and 15 present an overview of the factors and dimensions generated from the factor analysis. Table 14 gives an overview of how the 89 competencies clustered during the analysis. Table 15 shows the number of competencies in each of the factors. The factors are ranked in the order of the amount of the variance explained.

Table 14: Clustering of Competencies Resulting from Factor Analysis

Organized Structure	Number of Structures	Number of Total Items
Major Factors	4	39
Minor Factors	10	30
Single Competencies	7	7
Competencies eliminated		13

Table 15: Rank Order Listing of All Real Factors

Factor Classification	Factor	Total Competencies Within Factor
Major Factor	**1**	**14**
	2	**11**
	3	**8**
	4	**6**
Minor Factor	5	4
	6	3
	7	4
	8	4
	9	3
	10	3
	11	3
	12	2
	*18	2
	*21	2

Note* Minor Factors #18 and #21 are out of sequence. Each was ranked accordingly in the mathematical factor analysis but appear in Table 15 because each included two competencies.

Major Factors

Factors were identified by their respective eigenvalues and the amount of variance each accounted for. Factors, associated with the largest eigenvalues and containing five or more competencies were called Major Factors. Four Major Factors were identified using these criteria. Major Factors accounted for 43.3% of the total variance in the data set and included 39 competencies.

Factor 1: Management

Factor 1 included 14 highly correlated competencies. All fourteen competencies are reported in Table 16. Examining the topics in each of the competencies, a general theme emerged. All of the competencies were related to management-oriented topics. Nine were "Business practices," four concerned "Coordination," and one dealt with "Schedule." This factor was named "Management."

Table 16: Factor 1 – Management

Survey number	Survey statement	Weight	Mean	Standard deviation
53	Has exposure to management principles pertaining to supervising and evaluating personnel.	0.817	3.84	1.90
11	Assigns individuals to a production timeline.	0.808	4.44	1.67
51	Has exposure to management principles pertaining to employment termination.	0.804	3.62	1.86
50	Has exposure to management principles pertaining to employment and interview considerations.	0.758	3.91	1.77
54	Has exposure to management principles related to organizational structure and behavior.	0.746	3.85	1.79
20	Coordinates changing schedules among product participants, including outside vendors.	0.733	4.51	1.64
10	Assigns resources/personnel for desired outcome.	0.682	4.74	1.54
22	Delegates workload to others to optimize efficiency	0.670	4.46	1.63
49	Has exposure to management principles pertaining to conflict resolution.	0.670	4.31	1.83
62	Has exposure to techniques comparing a goal to an outcome.	0.552	4.09	1.75
65	Has exposure to various examples of work-related systems (management of assets, supplies, and information).	0.550	4.20	1.73
48	Has exposure to interviewing techniques and skills	0.532	4.55	1.68
1	Able to note necessary production information to production staff for a final preproduction mock-up	0.510	4.50	1.63
61	Has exposure to purchasing considerations including needs analyses.	0.510	4.17	1.74

Factor 2: Business Practices

Factor 2 included 11 highly correlated competencies. All 11 were found in the "business practice" function. The competencies in Factor 2 differed from those in Factor 1 in that they pertained to running a business with particular concern for considerations external to the organization. These considerations included promoting, negotiating, procuring, presenting, pricing and billing. Table 17 shows the competencies included in this factor. It was named "Business Practices."

Table 17: Factor 2 – Business Practices

Survey number	Survey statement	Weight	Mean	Standard deviation
56	Has exposure to negotiation techniques pertaining to cost, timeframes, and ownership/usage.	0.788	5.70	1.50
55	Has exposure to marketing/promotion philosophies/strategies for business.	0.771	5.22	1.57
59	Has exposure to pricing rates for freelance and service environments.	0.751	5.91	1.37
52	Has exposure to management principles pertaining to record keeping.	0.720	4.56	1.64
64	Has exposure to the principles of billing and cash flow.	0.693	5.01	1.59
60	Has exposure to professional development skills.	0.630	5.49	1.48
63	Has exposure to the considerations with which art directors face	0.626	4.82	1.52
57	Has exposure to practical approaches (case studies) for attaining resources/funds.	0.580	4.54	1.74
45	Has exposure to budget concerns/philosophies related to service bureaus or running a small business.	0.550	5.24	1.54
47	Has exposure to considerations necessary for beginning a new business or furthering an existing one.	0.543	5.08	1.66
58	Has exposure to presentation techniques and formats.	0.525	5.42	1.52

Factor 3: Product Creation

Eight highly correlated competencies made up the components of Factor 3. The emerging theme was associated with a strong understanding of the visual problem and its solutions. Both visual and verbal evidence of this understanding were indicated with words like "generates," "explaining," "composes," "demonstrates," and "produces." These competencies illustrated the fundamental considerations for the creation of a visual product. The factor was named "Product Creation." Table 18 shows the competencies included in this factor.

Table 18: Factor 3 – Product Creation

Survey number	Survey statement	Weight	Mean	Standard deviation
25	Demonstrates understanding of concept by producing a rough thumbnail sketch.	0.838	5.68	1.43
32	Has exposure to negotiation techniques pertaining to cost, timeframes, and ownership/usage.	0.755	5.54	1.39
43	Generates multiple sketches/thumbnails to communicate a solution to a given problem.	0.652	5.51	1.40
18	Composes sketch layouts for the project.	0.625	6.01	1.16
6	Alters the rough representation of the illustrated solution based on communications with the client via thumbnail sketch.	0.590	6.04	1.28
26	Demonstrates understanding of concept by verbally explaining the problem and solution to others.	0.556	5.40	1.36
33	Distills the essence of client's message, verbally, by explaining the problem and solution to others.	0.537	5.02	1.60
24	Demonstrates understanding of concept by producing a final drawing.	0.519	6.07	1.24

Factor 4: Determining Cost of Production

Pricing and cost considerations were the major themes of Factor 4. Four of the six competencies involved were derived from estimating the cost for a given project based on materials needed, as well as the time and medium used for project completion. The remaining two competencies dealt with the same pricing issues but from an analysis viewpoint, not through one of estimation. Table 19 shows the competencies included in this factor. It was named "Determining Cost of Production."

Table 19: Factor 4 –Determining Cost of Production

Survey number	Survey statement	Weight	Mean	Standard deviation
36	Estimates cost based on medium application.	0.838	5.07	1.67
35	Estimates cost based on materials needed.	0.826	4.83	1.76
38	Estimates cost of service bureau/out-service vendors.	0.738	5.09	1.63
37	Estimates cost based on turnaround time.	0.654	5.55	1.41
29	Determines the cost based on the amount of time, materials/supplies, and outsourced expenses needed to execute a project.	0.570	5.73	1.37
40	Examines medium type based on cost, time, and output format via a written recommendation or proposal.	0.554	4.57	1.96

Minor Factors

Minor Factors were identified by smaller eigenvalues. Ten Minor Factors were identified in the factor analysis based on 30 additional competencies. One characteristic of Minor Factors was that each included fewer competencies.

Factor 5: Product Preparation

Factor 5, the strongest of the ten minor factors, pertained to the preparation of final work product. The specific competencies in this factor related to preparatory activities, such as storyboard creation and foundational sequences that prepare the end product. They portrayed a thought process necessary for the ultimate creation of the work product. Table 20 shows the competencies included in this factor. It was named "Product Preparation."

Table 20: Factor 5 – Product Preparation

Survey number	Survey statement	Weight	Mean	Standard deviation
88	Uses storyboarding/flowcharting/navigation mapping for visual representation of sequences and/or relationships among elements.	0.837	4.83	1.62
81	Produces a storyboard to indicate sequence between or relationships among elements.	0.813	4.91	1.72
34	Drafts storyboards/flowcharts/navigation maps. (e.g. shows sequences between relationships among elements).	0.808	4.83	1.60
89	Writes text to correspond with imagery.	0.486	4.53	1.76

Factor 6: Product Assessment

Explanation of the proposed illustration and the final product made up the three correlated competencies included in Factor 6. They included a quality control element pertaining to how well the medium was handled in addition to how well the message of the illustration was conveyed. Analysis of the medium chosen to best portray the illustration's intended message was also included in this factor in terms of time, cost and usage. Table 21 shows the competencies included in this factor. It was called "Product Assessment."

Table 21: Factor 6 – Product Assessment

Survey number	Survey statement	Weight	Mean	Standard deviation
41	Explains verbally the strength and weaknesses of the piece in terms of conveying the message (information).	0.782	5.09	1.53
42	Explains verbally the strength and weaknesses of the piece in terms of medium application (how medium was handled).	0.753	4.57	1.61
39	Evaluates the project verbally for quality of information, use of aesthetics, and the degree to which product fulfills objective	0.576	5.26	1.46

Factor 7: Professional Growth

Factor 7 was the only factor in which all the competencies came from only one function. All four competencies came directly from the "Learn" function. This factor demonstrated the importance of keeping up with the changes occurring within the field, establishing and maintaining professional membership status, and networking with colleagues. Table 22 shows the competencies included in this factor. It was named "Professional Growth."

Table 22: Factor 7 – Professional Growth

Survey number	Survey statement	Weight	Mean	Standard deviation
69	Has membership in professional organizations.	0.836	5.18	1.54
87	Subscribes to technical/professional publications.	0.670	4.62	1.50
74	Networks with colleagues.	0.560	5.15	1.50
12	Attends workshops, seminars, and meetings.	0.520	4.57	1.40

Factor 8: Contract Completion

The competencies that made up Factor 8 all apply to meeting obligations agreed upon by the client and the medical illustrator. Deadlines pertained to three of the four competencies in this factor. Achieving client approval was the other competency. Taken together, client approval, and meeting established deadlines point to a commitment theme. Competency #82 sums up this factor best, "Produces final art according to contracts or agreements (renders, sculpts, computer generates)." Table 23 shows the four competencies involved in this factor. It was named "Contract Completion."

Table 23: Factor 8 – Contract Completion

Survey number	Survey statement	Weight	Mean	Standard deviation
82	Produces final art according to contracts or agreements (renders, sculpts, computer generates).	0.755	6.50	.98
72	Meets deadlines.	0.667	6.79	.68
85	Schedules work according to deadlines.	0.661	6.32	1.03
86	Seeks client input (feedback) for ultimate approval of product.	0.535	6.41	.90

Factor 9: Reference Acquisition

The three competencies in Factor 9 all dealt with the acquisition of reference material, both written and visual, to begin a visual solution to a problem. "Research" and "analysis" were the only two functions that contributed to this factor. Table 24 shows the competencies included in this factor. It was named "Reference Acquisition.

Table 24: Factor 9 – Reference Acquisition

Survey number	Survey statement	Weight	Mean	Standard deviation
75	Obtains textual references that pertain to the problem at hand.	0.795	5.78	1.29
76	Obtains visual references that pertain to the problem at hand.	0.782	6.12	1.04
4	Acquires the appropriate textual content references to research the topic at hand.	0.770	6.05	1.07

Factor 10: Product Feedback

Similar to the theme in Factor 5, Factor 10 related to a final work product. Whereas Factor 5 dealt with product preparation, Factor 10 deals with product feedback. The three items within this factor pertained to the creation of a final work product, final drawing, or sketch through evidence of a thorough understanding of the client's intended message. Table 25 below shows the competencies included in this factor. It was named "Product Feedback."

Table 25: Factor 10 – Product Feedback

Survey number	Survey statement	Weight	Mean	Standard deviation
23	Demonstrates understanding of concept by executing a finished, completed product.	0.749	6.19	1.39
30	Distills the essence of client's message by creating a final, fully-realized representation of the client's message.	0.710	6.04	1.30
31	Distills the essence of client's message by creating a finished representational drawing of the client's message.	0.505	5.96	1.23

Factor 11: Organizational Skills

Factor 11 contained three highly correlated competencies that all related to organizational skills. Key verbs like "arranges," orchestrates," and "schedules" fell within this factor. Table 26 shows the competencies in this factor. It was named "Organizational Skills."

Table 26: Factor 11 – Organizational Skills

Survey number	Survey statement	Weight	Mean	Standard deviation
8	Arranges work area to be efficient.	0.670	4.81	1.38
77	Orchestrates production schedules for concurrent projects.	0.654	5.73	1.25
84	Schedules production timeline in terms of objectives.	0.649	5.41	1.33

Factor 12: Text Usage

Factor 12's two correlated competencies described working with text both in a design sense as well as in the traditional writing and usage sense. These competencies can be addressed in the writing of a contract, proposal, or in an assignment where type and lettering are required. Table 27 shows the competencies in this factor. It was named "Text Usage."

Table 27: Factor 12 – Text Usage

Survey number	Survey statement	Weight	Mean	Standard deviation
68	Has exposure to writing techniques, proper grammar, and scholarly formats.	0.660	5.26	1.57
28	Designs with type (e.g. lettering/labeling/copy fitting) for readability and layout.	0.589	5.04	1.47

Factor 18: Future Professional Readiness

The two competencies in Factor 18 dealt with the medical illustrator's preparedness for future projects in terms of both professional skill and organization of previous project research/sketches. Table 28 shows the competencies in this factor. It was named "Future Professional Readiness."

Table 28: Factor 18 – Future Professional Readiness

Survey number	Survey statement	Weight	Mean	Standard deviation
3	Acquires new technical skills.	0.776	5.93	1.06
7	Archives completed work for retrieval.	0.580	5.44	1.43

Note: As mentioned previously, there was a sequential break in the Factor numbering system here. This factor was ranked 18th because of the amount of variation it accounted for. However it contained two competencies.

Factor 21: Artistic Execution

Factor 21 was ranked lowest among the multi-competency factors as noted above. The two competencies in Factor 21 dealt with the medical illustrator's choice of medium for a given project and the end product. Table 29 shows the two competencies in this factor. It was named "Artistic Execution."

Table 29: Factor 21 – Artistic Execution

Survey number	Survey statement	Weight	Mean	Standard deviation
15	Chooses medium type that is appropriate for message.	0.515	5.71	1.47
21	Creates a detailed (finished) representation of the final product.	0.485	5.84	1.46

Note: As mentioned previously, there was a sequential break in the Factor numbering system here. This factor was ranked 21st because of the amount of variation it accounted for. However, it contained two competencies**.**

Potentially Useful Single-Competencies

Seven competencies were scored similarly by many respondents. They were not correlated with any other competency item and, therefore, were not considered factors. Table 30 below presents these seven competencies in the order they were identified in the factor analysis.

Please note that dimensions 18 and 21 are not included in Table 30, because they contained two correlated competencies and, as such, were considered factors, not dimensions.

Table 30: Potentially Useful Single Competencies

Single Dimension	Survey statement	Weight	Mean	Standard deviation
13	44. Has exposure to basic principles of teaching.	0.604	4.68	1.69
14	71. Maintains accurate time log for time spent on projects.	0.700	5.32	1.46
15	16. Collaborates with other professionals.	0.732	5.16	1.37
16	80. Produces a pictorial solution to a visual problem.	0.655	6.26	1.02
17	17. Communicates using appropriate terminology to effectively communicate with members of work-related disciplines.	0.709	5.94	.97
19	2. Acquires information from client regarding knowledge base of audience.	0.762	5.91	1.17
20	14. Catalogues morgue file for reuse in later projects.	0.750	4.26	1.78

INVESTIGATION OF DEMOGRAPHICS BY MAJOR FACTORS

As mentioned in Chapter I, it was hypothesized that there would be no difference in the perceived levels of achievement in the competencies identified in this study across five demographic characteristics: gender, age, level of professional experience, percent time freelancing, and whether the respondent graduated from an accredited or non-accredited medical illustration program. As described in Table 4 in Chapter IV, Analysis of Variance was used to test these hypotheses. These analyses were carried out only on the competencies in the four Major Factors: Management, Business Practices, Product Creation, and Determining Cost of Production.

Respondents' average scores were calculated for each of the four factors within each of the demographic characteristics as shown in the following tables. The analysis of variance procedure was used to investigate potential difference in the average scores across the groups in each of the five demographic variables. Least squares means were used because they account for the unequal group sizes. Only the 117 respondents who were included in the factor analysis were included in this analysis.

Gender

No statistically significant differences ($p<.05$) were found across gender groups for any of the four Major factors. There were not even any clear trends in the mean scores by gender across the Major factors. As shown in Table 31, Hypothesis #1 was found to be true. No significant differences were found between male and females regarding the competency levels thought to be necessary for medical illustrators in the four Major Factors identified in this study.

Table 31: Means for Sex and Major Factors

Factor	Male (N=49)	Female (N=68)	F-ratio	p Value*
1	4.48	4.00	.09	0.7649
2	5.31	5.27	.03	0.8713
3	5.60	5.82	1.23	0.2700
4	5.29	5.37	.08	0.7770

*p value is based upon the least squares means (LSM) from the analysis of variance.

Age

There were no statistically significant differences ($p \leq .05$) across age groups for any of the four factors. Hypothesis #2 was found to be true. No significant differences were found across age groups regarding the competency levels thought to be necessary for medical illustrators in the four Major Factors identified in this study

Table 32: Means by Age Group for the Major Factors

Factor	20 -29 (N=18)	30-39 (N=25)	40-49 (N=39)	50-59 (N=25)	60-up (N=9)	F-ratio	p Value*
1	4.53	4.41	4.15	4.21	4.89	.70	0.5906
2	5.38	5.17	5.20	5.44	5.25	.28	0.8929
3	5.91	5.68	5.60	5.52	5.85	.33	0.8539
4	5.42	5.55	5.04	5.20	5.44	.57	0.6815

*p value is based upon the least squares means (LSM) from the analysis of variance.

Time in Career

The respondents were divided into two groups; group one had 0 to 5 years of experience (new graduates) in the profession and group two had 6 or more years of professional experience. No statistically significant differences were found between the two groups for any of the four Major factors. Interestingly, medical illustrators with less experience had higher average scores in all four Major Factors, but they were not significantly higher. As shown in Table 33, Hypothesis #3 was found to be true. No

significant differences were found between new graduates and those experienced professionals regarding the competency levels thought to be necessary for medical illustrators in the four Major Factors identified in this study.

Table 33: Means for Time in Career and Major Factors

Factor	1 to 5 years (N=34)	6 + years (N=82)	F-ratio	p Value*
1	4.54	4.33	.30	0.5827
2	5.54	5.04	2.35	0.1281
3	5.76	5.67	.09	0.7656
4	5.38	5.28	.06	0.8060

*p value is based upon the least squares means (LSM) from the analysis of variance.

Program Accreditation

Differences according to whether a respondent's medical illustration program was accredited were not found to be statistically significant for any of the Major Factors. Respondents from non-accredited programs did tend to think that slightly higher levels of achievement should be necessary in the competencies in the Major factors, but these differences were not significant. As shown in Table 34, Hypothesis #4 was found to be true. There was no significant difference in the responses from graduates from accredited medical illustration programs as compared with those from graduates from non-accredited programs in the four Major Factors identified in this study.

Table 34: Means for School Accreditation and Major Factors

Factor	Accredited (N=88)	Nonaccred (N=28)	F-ratio	p Value
1	4.32	4.56	.62	0.4340
2	5.25	5.32	.07	0.7867
3	5.67	5.75	.11	0.7445
4	5.07	5.59	2.87	0.0934

*p value is based upon the least squares means (LSM) from the analysis of variance.

Time Spent Freelancing

Respondents were divided into two groups: those in group one spent 0 to 20% of their time freelancing (non-freelancers); and those in group two spent 21 to 100% of their time freelancing (freelancers). The groups were found to be statistically different in Factor 2, Business Practices. The freelancers felt that the competencies in this factor were more important than their non-freelancing colleagues. No statistically significant differences were found between the two groups in the other three Major Factors. As shown in Table 35, Hypothesis #5 was found to be true, except for Business Practices.

Table 35: Means for Time Freelancing and Major Factors

Factor	0 to 20% (N=55)	21 to 100% (N=61)	F-ratio	p Value*
1	4.66	4.21	3.26	0.0739
2	4.95	5.62	9.96	0.0021
3	5.59	5.84	1.71	0.1934
4	5.25	5.41	.44	0.5069

*p value is based upon the least squares means (LSM) from the analysis of variance.

CONCLUSION

The findings in this study indicated that demographic characteristics did not generally influence the perceived level of achievement needed for medical illustration competencies. Factor analysis reduced the original data set of eighty-nine competencies to twenty-one variables, including "Major," "Minor," and "Potentially Useful" categories. Factors were identified by their respective eigenvalues and the amount of variance each accounted for. Four Major Factors accounted for 43.3% of the total variance in the data set and included 39 competencies. Ten Minor Factors were identified by smaller eigenvalues and accounted for 30 additional competencies. Seven competencies were found to be scored similarly by many respondents and were classified as single-item dimensions, or potentially useful competencies. These three classifications accounted for seventy-six of the eighty-nine competencies.

The next chapter will suggest curricular organization based on the statistical classification of the competencies. Curricular themes will be identified based on the factor analysis findings. Finally, suggestions for future research will be discussed.

Chapter VI

Discussion, Recommendations, and Conclusions

Tom Jones, medical illustrator and visual educator, states:

> [C]ommunication, as it applies to the field of medicine, is no longer the simple routine business that it used to be. It has become an art, or science if you will, requiring many new materials, new techniques, and even new concepts of learning. The design and production of many of the multi-sensory media involved as well as their method of use, is the concern of the medical illustrator. It is an area of responsibility which is rapidly expanding and taking on new significance in medical education. (Jones, 1948, p. 1-13)

These words clearly point to medical illustration's role in both medical communication and education. What is most interesting is that this passage was written in 1948, more than 50 years ago! His words are more poignant today than they were when they were first written.

DISCUSSION

The purpose of this study was:

1. To identify all of the current tasks (competencies) required of a professional medical illustrator.
2. To analyze the necessary level of achievement assigned to each competency by practicing, professional medical illustrators.
3. To organize competencies as curricular themes for the development of a model, modern day, academic medical illustration program.

Additional objectives of this study were:

1. To analyze the differences and/or similarities of responses by respondents of differing genders, ages, professional time in the field, levels of freelancing, and accreditation affiliations.
2. To assist educational administrators of medical illustration graduate departments in determining which curricular elements should be deleted from, remain within, or be adopted into a two-year program of study.
3. To assist in the articulation of school and work by helping to align educational training and professional job tasks.
4. To identify future competencies for future practice based upon the current competencies identified for contemporary practice.
5. To assist accreditation and certification entities in establishing guidelines and standards for medical illustration education programs.

Each of the three primary research objectives has been accomplished and information has been garnered to address the five additional objectives mentioned above. The literature review presented various ideas about general curricula, competency based education tenets, and specific studies in the biomedical communications and medical illustration fields. The literature provided both a foundation and a framework from which contemporary definitions of competency-based education and medical illustration were established. A comprehensive list of competencies was developed by a panel of experts in the field of medical illustration (purpose #1). A survey was then developed and administered to practicing, professional medical illustrators with the intent of rating their perspectives on the named competencies. This survey incorporated eighty-nine competencies that had been deemed basic and fundamental to the medical illustration field. Surveys were distributed to all the active U. S. members (N=678) listed in the 2002-03 membership directory of the

Association of Medical Illustrators (AMI). One hundred forty-two individuals responded to the survey, a 20.9% response rate, and were deemed complete enough to be included in statistical analyses. An average score was calculated for each competency based on the seven-point Likert scale used in the survey instrument (purpose #2).

Factor analysis was performed to determine whether competencies could be grouped into themes that might impact a medical illustration curriculum. Twenty-one useful dimensions were found. Four Major Factors were identified: "Management," "Business Practices," "Product Creation," and "Determining Cost of Production." They included 39 of the 89 competencies. Ten Minor Factors were also identified. They included 30 more competencies. Seven competencies were found to be not sufficiently related to others to be included in factors, but they accounted for enough variance to be included as Potentially Useful. The remaining 13 competencies were found not to belong to any factor, nor were they found to be potentially useful as single items. They were dropped.

As alluded to, the final part of the factor analysis process involved naming the Major and Minor Factors based on common themes found in the competencies clustered in each. These themes and names will be discussed in the next section of this Chapter. Suggested curricular constructs will be presented.

It was originally hypothesized that there would be no difference in the perceived levels of achievement in the competencies identified in this study across five demographic characteristics: gender, age, level of professional experience, percent time freelancing, and whether the respondent graduated from an accredited or non-accredited medical illustration program. Analysis of Variance was used to test these hypotheses in each of the four Major Factors. No statistically significant differences were found among the least square mean scores of any of the demographic groups, except between

freelancers and non-freelancers in the Business Practice factor. With this one minor exception, no significant differences in the competency levels thought to be necessary for medical illustrators in the four Major Factors were found by gender, age, time in profession, percent time freelancing, or whether the program they had graduated from was accredited or not.

The competencies and themes that were identified were derived from the Medical Illustration Competency-Based Process Model (MICBPM). The following section describes the model and discusses its use in this study.

DISCUSSION OF THE MEDICAL ILLUSTRATION COMPETENCY-BASED PROCESS MODEL

The Medical Illustration Competency-Based Process Model (MICBPM) was developed to be used as a methodological tool. Specifically, it was designed to assist academic administrators establish a competency-based curriculum. In this study, steps from the MICBPM were followed to address the research objectives: identify, rate, and finally arrange medical illustration competencies for a competency-based curriculum. The success of this study, as evidenced by meeting these research objectives, is due in large part to the design of the model. The MICBPM, which was created by assimilating models identified in the biocommunications literature, contains various steps which were essential to this study. One important step, was the literature review that provided the framework for identifying the competencies. It provided biocommunications-related concerns and methodological examples from similar research.

Identification of medical illustration competencies was successful for a number of reasons. First, the demographic variables analyzed in this study were generally

found not to have a statistically significant impact on the competencies. The inference is that the respondents scored the competencies based solely on their perceived importance. Additionally, definite clusters of competencies -- or factors-- were found to exist and were named according to their themes.

The MICBPM is easy to follow and logical in sequence. It provided a comprehensive approach to address the objectives in this study. The model allows for flexibility to address each of its twelve steps. Two of the MICBPM steps were designed to establish achievement scales and provide feedback for a medical illustration competency-based curriculum. These steps were not addressed in this study; however, they would be important considerations in the development of a medical illustration competency-based curriculum. The following section discusses the major factors and associated themes found in this study.

DISCUSSION OF MAJOR FACTORS

Finding no meaningful differences, and few suggested trends, across demographic groups is very positive information for this study. It indicates that the factors identified are not dependent upon demographic criteria. It can be inferred that the scores for each competency by respondents in this study indicate solely that particular competency's importance, regardless of the demographic characteristics of the respondent. This inference strengthens the finding that factors exist and can be classified. Table 36 shows a summary for the Major Factors identified and is presented to facilitate the following discussion.

Table 36: Summary of Major Factors

Factor Classification	Factor	Factor Name	Total Competencies Within Factor
Major Factor	**1**	Management	**14**
	2	Business Practices	**11**
	3	Product Creation	**8**
	4	Determining Cost of Production	**6**

The Major "Business" Factors

Three business-related factors are included in the Major Factor category: determining or estimating costs, exposure to management principles and the practical considerations pertaining to running or starting a small business are all components within these three factors. Nine of the lowest ranked competencies were derived from the "Business" function. This is an interesting finding because the first major factor, "Management," contained fourteen competencies, nine of which originated from the same "Business Function." What would cause some business-related competencies to be identified as least important while others clustered as the first major factor? It is possible that this result was present because of the freelance aspect of respondents' work days. A large percentage of respondents, approximately 45%, stated that 20% or less of their time was spent freelancing. These illustrators, because of the relatively small amount of time spent freelancing, could be classified as salaried illustrators, and not as freelancers. A statistical significance was identified between freelancers and non freelancers in Factor 2. The freelancers thought that the competencies in this Factor were more important than did non-freelancers. Upon closer inspection of the competencies contained in Factor 2, components of business practices, such as: promoting, pricing, and budgeting, emerged. Salaried illustrators do not have to deal with many of the business, or management responsibilities, as freelancers do. In large institutions or companies that employ medical illustrators, many of the administrative

tasks are carried out by separate departments. In comparison, freelancers are responsible for all aspects of illustration and its related business dealings, such as accounting, budgeting, purchasing, and scheduling, and therefore think that these competencies are more important. The difference in responses between freelancers and non-freelancers for the Business Practice function, may pertain to the administrative aspects associated, or not associated, with their jobs.

Another explanation for the discrepancy in competencies derived from the "Business Practices" function might pertain to administrative or management responsibilities. Respondents holding management positions would potentially have different responses to competency statements pertaining to supervising, evaluating, employment termination, assigning individuals to timelines, interviewing considerations, delegating workloads, and conflict resolution as opposed to freelancers, or illustrators not holding management positions. Future studies could be done to address this issue, as discussed later in this chapter.

Major Factor 4 dealt with determining the cost of production. Six highly correlated competencies pertaining to estimating cost clustered to make up this factor. The fact that there were so many highly correlated competencies relating to cost estimation may have resulted from the (freelance and management) demographics, described previously.

Another interesting point regarding the Major Factors is that not one of the ten highest ranking competencies was included in any of the four Major Factors. Conversely, six of the highest ranked competencies were included in Minor Factors. One other competency from this list was included in the single-item, "possibly useful" dimensions. The conclusion from this is that strength comes from relationships between competencies rather than from single competencies. This is also apparent from the

percent of variance accounted for by factors as compared with individual competencies. This should be a major consideration when designing a competency-based curriculum, as will be discussed further.

Product Creation

Creation of a product is the fundamental objective for all medical illustration activities. Product Creation was identified as one of the four Major Factors. The competencies presented in this study were rated by practicing, professional medical illustrators according to how they perceived each competency's necessary level of achievement. To assure a curriculum is relevant and beneficial, competencies should be taught through a hands-on approach to real-world illustration projects. Students should demonstrate competence by producing illustrations or visual products for assignments taken from real world, professional projects. Using actual, professional practice as a foundation for academic study should be included in the curriculum as an ongoing process for the entire time the student is enrolled in the degree program. This approach would adequately prepare students for the experiences they will eventually encounter in the real-world. However, based on the student's prior experience with producing illustrations, varying amounts of personalized modifications should be implemented to challenge him/her to identify and strengthen areas of weakness: this is a tenet of competency-based education.

A final illustration critique is one suggested way to test for competence. Critique of student illustrations in a group setting will help determine whether assignment objectives have been met. Feedback from students, professors, and experts in a given medical specialty or illustration technique would generate a constructive dialogue and determine whether competence has been achieved. Specific constraints of the project-

pertaining to contract, budget, timeframe, and audience- would be addressed to assist in this determination.

DISCUSSION OF MINOR FACTORS AND SINGLE-ITEM DIMENSIONS

Essentially, all of the Minor factors were ancillary to the themes that emerged from the Major Factors. If Major functions dealt with paramount medical illustration purposes such as 1) producing a visual solution to an assignment and 2) the business activities required to do so, then Minor Factors provided the secondary, or supportive, elements. Table 37 shows a summary of the minor factors and is presented to facilitate the following discussion.

Table 37: Summary of Minor Factors

Factor Classification	Factor	Factor Name	Total Competencies Within Factor
Minor Factor	5	Product Preparation	4
	6	Product Assessment	3
	7	Professional Growth	4
	8	Contract Completion	4
	9	Reference Acquisition	3
	10	Product Feedback	3
	11	Organizational Skills	3
	12	Text Usage	2
	18	Future Professional Readiness	2
	21	Artistic Execution	2

Three of the Major Factors, "Management," "Business Practices," and "Determining Cost of Production," related to the business of medical illustration. Minor Factor 8, "Contract Completion," contained four competencies, all of which were represented on the ten highest scored competencies list. This point illustrates the importance of variance accounted for by a factor. One might expect that a factor with four very highly rated competencies would be a Major Factor-- but Factor 8 accounted for less than three percent of the variance. (See Table 13 in Chapter V.)

The end product, an illustration or visual depiction of a project, is the ultimate goal for a medical illustrator. This was identified in Major Factor 3, "Product Creation." Ancillary components to the creation of a product were found in the Minor Factor categories too. These Minor factors were: "Reference Acquisition" (research material garnered to prepare for the assignment), "Product Preparation" (supplies and resources required to begin work), "Product Feedback" (ongoing dialogue with the client regarding needs and product evolution), and "Product Assessment" (critique of how well a product met its intended objective). Additionally, Minor Factor 12 "Text Usage," and Minor Factor 21 "Artistic Execution" are ancillary to the Major Factor 3 "Product Creation" theme because text usage is a concern for a final illustration or visual project. Further, artistic execution, by definition, describes how a product is created.

Minor Factor 7, Professional Growth, dealt with how illustrators conduct themselves in professional settings. Related to this factor was Minor Factor 18, "Future Professional Readiness." Minor Factor 18 had to do with acquiring new professional skills and maintaining a database of completed work/research that may be used again.

Finally, Minor Factor 11 was identified as "Organizational Skills." These competencies referred to conducting oneself in an efficient, professional, and business-like manner in order to meet deadlines, prioritize job tasks, and keep an organized work area.

Single-Item Dimensions were supportive of each theme identified in this study. Table 38 shows the seven single dimension items that were supportive of the Major and Minor factors which could be used in the structure of a competency-based medical illustration curriculum.

Table 38: Potentially Useful Single Competencies

Single Dimension	Survey statement
13	Has exposure to basic principles of teaching.
14	Maintains accurate time log for time spent on projects.
15	Collaborates with other professionals.
16	Produces a pictorial solution to a visual problem.
17	Communicates using appropriate terminology to effectively communicate with members of work-related disciplines.
19	Acquires information from client regarding knowledge base of audience.
20	Catalogues morgue file for reuse in later projects.

As was mentioned, Minor Factor #8, "Contract Completion," was supportive of the three business-related Major factors. Minor Factors 5, 6, 9, 10, 12, and 21 were ancillary to Major Factor #3's "Product Creation" theme. Similarly, many single dimensions supported both the major and minor factor themes. For example, Dimension #16, "producing a solution to a visual problem," seems to relate to Major Factor 3 "Product Creation" but it was not found to be correlated with the other competencies. However, Dimension #16 was found to be scored similarly by respondents and had a weight ≥ 0.48 and its eigenvalue was greater than 1.00. Therefore, as a result of its weight and eigenvalue, it became a dimension, and therefore, became an important contribution to the data. Each of these single dimension items helped complete the themes or topics that identified the competencies required of a professional medical illustrator.

MEDICAL ILLUSTRATION THEMES FOR A COMPETENCY-BASED CURRICULUM

All seventy-six competencies contained in the twenty-one function/dimensions were found to be important as related to the necessary achievement levels as perceived by the survey respondents. Accordingly, it can be concluded that all seventy-six competencies should be contained in a competency-based medical illustration curriculum. These competencies can and should be grouped within appropriate courses.

The Major and Minor factor headings identified in this study could be structured as courses. The competencies that make up each factor should remain within the course thus derived. However, additional competencies could be included from factors with a related theme and from the single dimension competencies. Including many related competencies would ensure that all competencies are adequately addressed, competencies identified as the most important are repeated more often than lesser valued competencies, and courses are sufficiently complete in subject matter. It is suggested that this scheme be used to develop each academic course in a competency-based medical illustration curriculum.

As was mentioned earlier, medical illustration program administrators and instructors are encouraged to develop program specific competency scales. That is, the minimum levels of achievement in each competency that graduates should demonstrate should be determined by the administration of a particular academic program. Each academic program employing a competency-based curriculum could have its own unique scale for competencies, or a variety of scale structures for certain competency groupings.

The Business of Medical Illustration

The factor themes that emerged dealt largely with the business of medical illustration. Four factors, including three major and one minor factor, made up the business related factors. The four business related factors comprised 51% of the competencies (39/76) that were scored similarly or present within factors. This finding is important for the medical illustration curriculum. A large part of the curriculum should focus on the business aspects of medical illustration. Students should be well versed in all of the business and management aspects of their profession. A business course could be developed which included all of the highly correlated business

competencies. As was mentioned in Chapter 4, however, some of the business-related competencies were considered advanced because they fall outside the range of academic preparation. These are competencies that one would not expect a pupil to master without obtaining practical professional experience. These competencies are described as being applicable to professional practitioners holding management positions. Students should be exposed to these competencies but not necessarily expected to be proficient in them during their academic programs.

Producing Illustrations

Seven factors; one major and six minor, pertained to the process of creating an artistic product. These factors, in the order they occur in the production process, included "Reference Acquisition," Product Preparation," "Product Creation," "Artistic Execution," "Text Usage," "Product Feedback," and "Product Assessment." These seven factors included 25 of the 76 (32%) that survived the factor analysis. Their importance cannot be overlooked. A curriculum needs to address the competencies contained within each of these factors as part of a continuum to assist in the development of the student's understanding of the entire production process.

This continuum need not always be the focus for student assignments. Initially, first year students could be introduced to the production process by addressing each of the seven factors. Each factor is important and could be addressed as a distinct unit. Different student assignments could be structured to address particular process-related factors throughout a course. For example, exploring or learning various reference sources -- e.g. MedLine or WebMD -- could be the focus of a particular assignment. Students could be asked to provide different illustration examples from distinctly different sources for a given assignment on an anatomical region or surgical procedure. Another possibility could be creating two very different illustrations for one surgical

procedure. The intended audience for each assignment could be different, thereby forcing the student to think about the surgical steps that should be included or omitted from the surgical storyboard. These two examples illustrate how a factor pertaining to one part of the production process could become the focus of a student assignment. This study found that certain competencies were important in order for a medical illustrator to be effective. More importantly, certain competencies were found to be associated with each other. This suggests that medical illustration education is better when related competencies are taught together. A curriculum structured with associated competencies as distinct units is the basis of a medical illustration competency-based model. Since the creation of a product is the fundamental objective for all medical illustration activities, those activities associated with product creation should be taught together.

Aspects of Professionalism

Factors 7 and 18, "Professional Growth" and "Future Professional Readiness," respectively, referred to conducting oneself in an efficient, professional, and businesslike manner in order to meet deadlines, prioritize job tasks, and keep an organized work area. These skills can be addressed academically as a student moves through the phases of creating a visual product. Students should be encouraged to become members of professional organizations-- the Association of Medical Illustrators, for example-- while they are in school. Clean, legible, and accurate illustrations should be expected by instructors, and illustrations should be evaluated according to the degree of professionalism. Of paramount importance, as suggested by the highest rated competency (See Table 11), is that work should never be late and deadlines should always be met. The skills associated with these factors can be incorporated into every illustration assignment insuring that students learn their importance. Highly rated

competencies should be incorporated repeatedly into a competency based curriculum to insure that the skills are mastered.

RECOMMENDATIONS: FUTURE RESEARCH

Further studies based on the competencies identified in this research should be carried out. However, the 13 competencies that were dropped because they were not included in any of the Major or Minor factors, or because they did not qualify as 'potentially useful" single items, should be excluded. Studies could focus on a small number of competencies from each factor, as well as the single dimension competencies.

This study also suggests other future research topics. One might investigate how respondents who hold management positions rank business related competencies as compared with respondents who do not have managerial responsibilities. The results of such an investigation might provide additional insight into why there were such vastly differing views regarding competencies that pertained to the business of medical illustration. A second possible research study might look at how similar the administrators of academic programs are in how they perceive the value of competencies/factors identified in this study.

This study identified the achievement level necessary for a given function, not how often a particular competency was performed. Another useful study would analyze the frequency with which particular competencies are performed by professional medical illustrators. A study that attempted to meet this objective would require a different survey format than the one used in this study. Nevertheless, it would be interesting to analyze how frequently the competencies identified in this study are performed.

Another possible research study might investigate "time in career" as a significant demographic characteristic with the frequency in which particular

competencies are performed. A greater population of "new graduates," defined by less time in the field than was used in this study, could prove more useful in potential future studies, particularly when compared with the frequency that certain specific medical illustration tasks are done.

Finally, as medical, technological, production, and communication fields evolve, it will be crucial for educational leaders within medical illustration to re-identify the necessary competencies for those employed in the industry. The comprehensive list of competencies identified in this study should be reevaluated periodically by those working in the field. If necessary achievement levels of specific competencies change enough, their interrelationships could also change. As a result, the themes derived from those correlations, i.e. the underlying factors, might also change. If these themes serve as the backbone of competency-based MI curricula, a complete restructuring of those curricula could be required. Therefore, reevaluation of MI competency items should become an ongoing process.

CONCLUSION

This research project was carried out to identify competencies for the professional medical illustrator and to identify necessary levels of achievement for each. Curricular themes were established by organizing competencies into factors, or clusters of highly correlated competencies. There have been no known attempts to determine whether the content of existing MI curricula is providing the necessary knowledge and skills of the medical illustration professional. It is the researcher's hope that this study, with its extensive literature review, the list of competencies developed, and the analysis of functions indicating curricula themes, will suggest ways to bring the training programs for medical illustrators into closer concert with the needs of individuals working in biomedical communications. This study has also provided a well organized

structure for a long list of correlated competencies, provided by medical illustrators themselves. Another hope stemming from this study is that educational administrators working in MI training programs will have accessible, current information with which to structure and restructure their curricula. It is also hoped that the governing bodies for MI program accreditation, such as the Accreditation Review Committee for the Medical Illustrator (ARC-MI) and the Commission on Accreditation of Allied Health Education Programs (CAAHEP), will use the list of competencies developed in this study.

This study provided data potentially useful to all entities interested in the preparedness of medical illustration professionals. The study's competency list and the structure produced by the factor analysis of those competencies should prove helpful in establishing and assessing MI curricula and planning for future changes. Curricula can be structured according to the factor-themes identified in this study. Highly ranking competencies can be emphasized within a curriculum to assure that students attain the necessary level of achievement. Use of this study's MI Process model, could make administrators aware of changing competencies required in the workplace and allow for the necessary curricula adjustments to reflect these changes.

Appendices

APPENDIX A: MEDICAL ILLUSTRATION AS A CAREER

MEDICAL ILLUSTRATION

...AS A CAREER

The Association of Medical Illustrators

1819 Peachtree Street, NE
Suite 712
Atlanta, Georgia 30309

CONTINUING EDUCATION

Medical illustration is a field of continual growth. Medical research is embedded in nearly every medical illustration assignment, sometimes requiring learning to use medical instrumentation, doing one's own cadaver dissections, organizing computer searches or studying relevant medical articles.

More formal continuing education is available through the Association of Medical Illustrators (AMI). Continuing education credits are offered for workshops presented at the AMI's annual meeting and at AMI-sponsored regional meetings throughout the United States. The AMI also offers a certification program in which medical illustrators can, through a series of examinations and coursework, demonstrate their proficiency in various aspects of the profession. The annual AMI meeting also provides the opportunity for medical artists to display their best pieces of medical art in the largest exhibit devoted to medical art in the world. The AMI also publishes a bimonthly newsletter; offers extensive job placement services; and copublishes *The Journal of Biocommunication*, a quarterly academic journal.

ADVANCEMENT

Some medical illustrators specialize in a particular facet of medicine, such as forensic reconstruction, ophthalmological surgery, medical-legal presentations or the making of prostheses, often accumulating considerable recognition for their knowledge and abilities in that particular area. Other illustrators become integral parts of medical research teams, sometimes appearing as co-author on books and articles on which they contributed. Illustrators with an interest in teaching may join the faculty of one of the graduate programs in medical illustration. Experienced medical illustrators may also begin their own businesses, head a group of illustrators or become a director of an audiovisual department.

SALARY

Earnings vary significantly according to 1) the experience and ability of the artist, 2) the type of work, and 3) the area of the country where one works. The average starting salary in an institutional setting in the United States for a graduate of an accredited school is around $25,000 a year plus fringe benefits. Experienced salaried illustrators usually earn between $35,000 and $60,000 a year. Administrators and faculty members generally earn somewhat more, with a few earning in excess of $90,000 a year. Salaried illustrators often supplement their income with freelance work.

Freelance artists generally have set prices for particular kinds of art, although some charge by the hour. Although the earnings of freelance medical illustrators are more erratic than those of salaried illustrators, the highest earnings are generally made by a relatively few freelance artists whose art and professionalism keep them in constant demand.

In addition to earnings from a salary or freelance projects, some medical artists have royalty and re-use arrangements with publishers and clients that can provide an additional and sometimes significant source of income.

For more information, please phone or write:

The Association of Medical Illustrators
1819 Peachtree Street, NE, Suite 712
Atlanta, Georgia 30309
Telephone 404-350-7900
Telefax 404-351-3348

Printed on recycled paper

What is a "Medical Illustrator"?

A medical illustrator is a professional artist with extensive training in medicine and science who creates visual material to help record and disseminate medical, biological and related knowledge. Medical illustrators not only produce such material but function as consultants and administrators within the field of biocommunication.

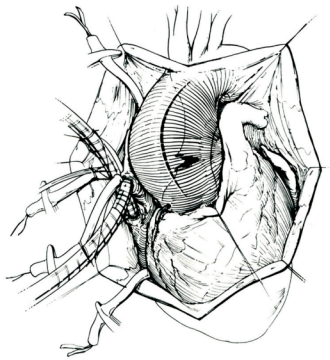
Nature of Work

Medical illustrations appear in medical textbooks, medical advertisements, professional journals, instructional videotapes and films, computer-assisted learning programs, exhibits, lecture presentations, general magazines and programs for television. Although the majority of medical illustrations are for print and projection media, medical illustrators also work in three dimensions, creating anatomical teaching models, models for simulated medical procedures and prosthetic parts for patients.

Skills Required

The field is most rewarding for those who enjoy and have some natural ability in both art and science. Because of the variety of assignments, medical illustrators must be accomplished in a wide range of art techniques, including drawing, painting and modeling techniques, as well as the basic concepts and techniques involved in the production of commercial and graphic art. A strong foundation in the basic sciences is necessary to enable the illustrator to understand and conceptualize, for example, complex neurochemical and neuroanatomical relationships. Strong organizational skills that can be utilized in distilling complex information into visuals that can teach are also essential, as is an ability to visualize relationships in three dimensions. Writing, research and computer skills are also valuable.

Cover: Timothy H. Phelps, a board-certified medical illustrator and Associate Professor of Art as Applied to Medicine at Johns Hopkins University, surrounds himself with medical art and a selection of the tools used to create medical art.



Pen-and-ink illustration by Carol Larson for journal article by E. Stanley Crawford, M.D., on total aorta replacement. The series was awarded the 1991 Russell Drake Award of Excellence for Medical Line.

Education

The majority of medical illustrators in the United States have a master's degree from an accredited graduate program in medical illustration. There are currently five accredited programs in the United States, each accepting between 3 and 12 students each year.

High school students contemplating medical illustration as a career should take a college preparatory program with as much emphasis on art and science as possible.

In college, students should concentrate on art, biology and the humanities. Art courses should include drawing, advanced life drawing, painting, color theory, advertising design, illustration, computer graphics and photography. In the sciences, students should include general biology or zoology, vertebrate anatomy, embryology, physiology, chemistry and histology. The science courses must be of the caliber required for medical school.

Admission requirements vary from program to program. In general, a bachelors degree with a major in art and a minor in the biological sciences, or a major in science with a minor in art is preferred. In addition, a portfolio of artwork and a personal interview are generally required.

Graduate programs in medical illustration are two to three years in length. The following courses (or their equivalents) are offered by each accredited program:

Medical Science Courses:

- Human gross anatomy
- Pathology
- Histology/microanatomy
- Human physiology
- Embryology
- Neuroanatomy

Art and Theory Courses:

- Anatomical drawing (from dissections)
- Illustration techniques (including pen and ink, watercolor, carbon dust, gouache, acrylic, airbrush, color pencil)
- Surgical illustration (from observations of surgery and consultations with surgeons)
- Graphic techniques
- Medical computer graphics
- Instructional design and technology
- Photography
- Motion media production
- Three-dimensional models and exhibits
- Management and business practices
- Professional ethics

Each program also offers elective courses. Examples include advanced surgical illustration, advanced computer and video graphics, ophthalmological illustration, endoscopic illustration, medical statistics, pharmacology, patient prosthetics, animation, script writing and veterinary illustration.

In addition to satisfactory completion of all coursework, most programs require an original master's thesis and a formal portfolio review for graduation.

Employment

Many medical illustrators are employed in medical schools and large medical centers that have teaching and research programs. Other medical artists are employed by hospitals, clinics, dental schools or schools of veterinary medicine. Some institutional medical illustrators work alone, whereas others are part of large multimedia departments.

Other medical illustrators choose to target specific markets such as medical publishers, pharmaceutical companies, advertising agencies, physicians or attorneys. Some work independently on a freelance basis; others set up small companies designed to provide illustration services to their various targeted markets.

The employment outlook for medical illustrators is generally good. This is in part due to the relatively few medical illustrators who graduate each year, and in part due to ongoing medical research that continually reveals new treatments and technologies that require medical illustrations. In addition, a growing demand by patients to better understand their own bodies and medical options has expanded the need for medical illustrations aimed at nonmedical individuals, and increased need for medical illustrations and models to educate juries during courtroom presentations has expanded the medical-legal subspecialty of medical illustration.

APPENDIX B: U.S. ACCREDITED MEDICAL ILLUSTRATION PROGRAMS

ACCREDITED SCHOOL PROGRAMS

The Association of Medical Illustrators (AMI) developed the first set of education standards for accreditation and began accrediting programs of medical illustration in 1967. In 1987 these standards were modified to comply with the standards of the Committee on Allied Health Education and Accreditation (CAHEA) of the American Medical Association (AMA). The resulting *Essentials for an Accredited Educational Program for the Medical Illustrator* were jointly adopted by the AMI and the AMA. In October 1992, the AMA announced plans to discontinue sponsorship of programmatic accreditation for allied health education. The Acreditation Review Committee for the Medical Illustrator (ARC-MI) and the AMI Board of Governors voted in 1993 to join CAHEA's successor accrediting agency, the Commission on Accreditation of Allied Health Education Programs (CAAHEP). The *Essentials* are revised periodically to reflect changes in the field, and accredited programs are reviewed every 5 to 8 years to verify compliance with the *Essentials*.

Request for general information on the accreditation process and/or application for accreditation of a program should be directed to:

L M. Detmer
Executive Director (CAAHEP)
Commission on Accreditation of
Allied Health Education Programs
515 North State St., Suite 7530
Chicago, IL 60610-4377
(312)464-4623 Fax (312)464-5830
Email:75767.1444@compuserve.com

The following are the currently accredited school programs:

GEORGIA (706)721-3266
Graduate Program in Medical Illustration
School of Graduate Studies
The Medical College of Georgia
Augusta, GA 30912-0300
Fax (706)721-7855
(M.S. degree - 2 year curriculum)

ILLINOIS (312)996-7337
Department of Biomedical Visualization
School Biomedical & Health Info. Science
College of Associated Health Professions
University of Illinois at Chicago
1919 W. Taylor St., Room 213, M/C 527
Fax (312)996-8342
Email: aakatz@uic.edu
(M.A.M.S. degree - 2 year curriculum)

MARYLAND (410)955-3213
Department of Art as Applied to Medicine
The Johns Hopkins School of Medicine
1830 E. Monument St., Suite 7000
Baltimore, MD 21205-2100
Fax (410)955-1085
Email: glees@welchlink.welch.jhu.edu
(M.A. degree - 2 year curriculum)

MICHIGAN (313)747-1669
M.F.A. Program in Medical & Biological
Illustration, School of Art & Design
The University of Michigan
2000 Bonisteel Blvd., Rm. 1075
Ann Arbor, MI 48109-2069
Fax (313)936-0469
Email: stdenis@umich.edu
(M.F.A. degree - 5 consecutive semesters)

TEXAS (214)648-4699
Biomedical Communications Graduate Prgm.
Dept. of Biomedical Communications
The University of Texas
Southwestern Medical Center at Dallas
Graduate Program/Exchange Park
5323 Harry Hines Blvd.
Dallas, TX 75235-8881
Fax (214)648-5353
(M.A. degree - 2 year curriculum)

TORONTO * (416)978-2659
Division of Biomedical Communications
Department of Surgery
Faculty of Medicine
University of Toronto
Medical Sciences Bldg., Rm 235
1King's College Circle
Toronto, Ontario, M5S 1A8 Canada
Fax (416)978-6891
Email: l.wilson.pauwels@utoronto.ca
(M.Sc. degree - 2 year curriculum)

*CAAHEP does not accredit programs outside of the United States and its territories. The University of Toronto program recieved an Award of Recognition in 1993 from the Accreditation Review Committee for the Medical Illustrator (ARC-MI) for its demonstration of compliance with the standards for accreditation in the US.

Additional information on any school may be obtained by writing to the program director.

APPENDIX C: MEDICAL ILLUSTRATION ESSENTIAL AND GUIDELINES

Medical Illustrator

Essentials and Guidelines

for an Accredited Educational Program for the Medical Illustrator

Essentials initially adopted in 1987; revised in 1992

Adopted by the
Association of Medical Illustrators
American Medical Association

The Committee on Allied Health Education and Accreditation (CAHEA) accredits programs upon the recommendation of the Accreditation Review Committee for the Medical Illustrator (ARC-MI).

These **Essentials** are the minimum standards of quality used in accrediting programs that prepare individuals to enter the profession of medical illustration. The extent to which a program complies with these standards determines its accreditation status; the **Essentials** therefore constitute the minimum requirements to which an accredited program is held accountable. **Essentials** are printed in regular typeface in outline form.

The Guidelines accompanying the **Essentials** provide examples intended to assist in interpreting the **Essentials**. Guidelines are printed in italic typeface in narrative form.

Sections I and III of these Essentials are common to all educational programs accredited by CAHEA. Section II contains a description of the profession and the specific requirements for preparing medical illustrators.

Preamble

Objective

The Association of Medical Illustrators (AMI) and the American Medical Association (AMA) cooperate to establish, maintain and promote appropriate standards of quality for educational programs in medical illustration and to provide recognition for educational programs which meet or exceed the minimum standards outlined in these **Essentials**. Lists of accredited programs are published for the information of students, employers, educational institutions and agencies, and the public.

These standards are to be used for the development, evaluation, and self-analysis of medical illustration programs. On-site review teams assist in the evaluation of a program's relative compliance with the **Essentials**.

Interdisciplinary visual arts curricula with a premedical illustration orientation are recognized within the field of visual arts rather than as a part of allied health. Such curricula do not fall under the purview of CAHEA accreditation.

Section I: General Requirements for Accreditation

A. Sponsorship

1. The **sponsoring institution and affiliates,** if any, must be accredited by recognized agencies or meet equivalent standards.

2. Sponsoring institutions must be authorized under applicable law or other acceptable authority to provide a program of post-secondary education.

3. In programs where academic, studio, and clinical phases are provided in two or more institutions, responsibilities for program administration, instruction, supervision, and other functions of the sponsoring institutions and of each affiliate must be clearly documented as a formal affiliation agreement or memorandum of understanding.

4. Accredited educational programs may be established in

a. medical schools

b. schools of allied health

c. health science centers

d. graduate schools

e. other institutions or consortia which meet comparable standards for education in medical illustration.

A consortium of any or several of the above may constitute appropriate sponsorship.

5. The sponsoring institution assumes primary responsibility for student admission, curriculum planning, selection of course content, coordination of classroom teaching and supervised clinical practice, appointment of faculty, receiving and processing applications for admission, and granting the certificate or degree documenting satisfactory completion of the educational program. The sponsoring institution shall also be responsible for providing assurance that the practice activities assigned to students in a clinical setting are appropriate to the program.

B. Resources

1. Personnel

a. Program Director
The program must have adequate leadership and management. This official shall possess the necessary qualifications to perform the functions identified in the documented job description.

The program official should be sufficiently free from service and other non-educational responsibilities to fulfill the educational and administrative responsibilities indicated below.

(1) Responsibilities

The director of the educational program shall be responsible for the organization, administration, continuous review, planning, development, and general effectiveness of the program.

(2) Qualifications

The program director shall be an accomplished and competent medical illustrator and shall have appropriate experience in educational design.

b. Faculty and Instructional Staff

(1) Responsibilities

In each location where a student is assigned for didactic or supervised practice instruction there must be a qualified individual designated to provide that supervision and related frequent assessments of the student's progress in achieving acceptable program requirements.

Opportunities should be assured for program faculty to participate in and contribute to instructional and program policies.

(2) Qualifications

The faculty and instructors must be knowledgeable in course content and effective in teaching their assigned subjects.

Curricula vitae and examples of work should be on file for all and available on request.

c. Number
There shall be sufficient faculty to provide students with adequate attention, instruction and supervised practice to acquire the knowledge and competence needed for entry to the occupation.

d. Clerical and support staff
Adequate clerical and other support staff shall be available.

e. Professional development
Programs shall encourage program staff and faculty to pursue continuing professional growth, to assure that program faculty and officials can fulfill their responsibilities.

Examples include medical illustration practice, curriculum design, instructional methodology and teaching techniques.

2. Financial resources

Financial resources to operate an educational program shall be ensured to fulfill obligations to matriculating and enrolled students.

3. Physical resources

a. Facilities
Adequate classrooms, laboratories, clinical and other facilities, and administrative offices shall be provided for students, program staff, and faculty.

b. Equipment and supplies
Appropriate and sufficient equipment, supplies, and storage space shall be provided for student use and for teaching the didactic and supervised medical illustration practical experience. Instructional aids, such as clinical materials, reference materials, art files, instruments, and demonstration and other multimedia materials, when required by the types of learning delineated for either the didactic or supervised practical experiences. Clinical subjects, specimens, records and related reference materials, computer hardware and software, and audio and visual resources shall be available in sufficient number and quality to enhance student learning.

Both didactic educational and medical illustration service activities should be able to function concurrently, with appropriate modern equipment. It is not necessary to duplicate all equipment. However, classes or laboratory learning experiences should

not be jeopardized due to equipment or space needs for medical illustration service activities.

c. Library
Students shall have ready access in time and location to an adequate supply of current books, journals, periodicals and other reference materials related to the curriculum.

In addition to the institution's main library there should be an up-to-date departmental library available to the students with adequate references for illustrative needs.

d. Medical illustration service unit
A medical illustration service unit must be readily accessible to the program to provide opportunity for student observation and practical experience.

C. Students

1. Admission policies and procedures
Admission of students, including advanced placement, shall be made in accordance with clearly defined and published practices of the institution. Any specific academic and technical standards required for admission to the program shall also be clearly defined and published and readily accessible to prospective students and the public.

If the program admits any students on the basis of ability to benefit, then it must employ appropriate methods, such as a preadmission test or evaluation, for determining that such students are in fact capable of benefiting from the training or education offered. Policies regarding advanced placement, transfer of credit, and credit for experiential learning shall be readily accessible to prospective students. Requirements for previous education or work experience shall also be provided and readily accessible.

2. Evaluation of students
Criteria for successful completion of each segment of the curriculum and for graduation shall be given in advance to each student. Evaluation methods (systems) shall include content related to the objectives and competencies described in the curriculum for both didactic and supervised clinical education components. They shall be employed frequently enough to provide students and program officials with timely indications of the students' progress and academic standing and to serve as a reliable indicator of the effectiveness of course design and instruction.

3. Health
The program officials shall establish a procedure for determining that the applicants' or students' health will permit them to meet the written technical standards of the program. Students must be informed of and have access to the health care services provided to other students of the institution.

4. Guidance
Guidance shall be available to assist students in understanding course content and in observing program policies and practices and to provide counseling or referral for problems that may interfere with the students' progress through the program.

D. Operational Policies

1. Fair practices

a. Announcements and advertising must accurately reflect the program offered.

b. Student and faculty recruitment and student admission and faculty employment practices shall be non-discriminatory with respect to race, color, creed, sex, age, disabling conditions (handicaps), and national origin.

c. Academic credit and costs to the student shall be accurately stated, published and made known to all applicants.

d. The program or sponsoring institution shall have a defined and published policy and procedure for processing student and faculty grievances.

e. Policies and processes for student withdrawal and for refunds of tuition and fees shall be published and made known to all applicants.

f. Policies and processes by which students may perform service work while enrolled in the program must be published and made known to all concerned in order to avoid practices in which students are substituted for regular staff. Students may not take the responsibility or the place of qualified staff. However, after demonstrating proficiency, students may be permitted to undertake certain defined activities with appropriate supervision and direction. Students may be employed in the field of study outside regular educational hours, provided the work does not interfere with regular academic responsibilities. The work must be non-compulsory, paid, and subject to standard employee policies.

Section 1
continued

g. The health and safety of patients, students, and faculty associated with the educational activities of the students must be adequately safeguarded.

h. A program admitting students on the basis of ability to benefit must publicize its objectives, assessment measures, and means of evaluating ability to benefit.

2. Student records
Satisfactory records shall be maintained for student admission, attendance, and evaluation. Grades and credits for courses shall be recorded on the student transcript and permanently maintained by the sponsoring institution in a safe and accessible location.

Student transcripts should be retained in a safe and accessible location, in the event that the program or the sponsoring institution is discontinued.

E. Program Evaluation

The program must have a continuing system for reviewing the effectiveness of the educational program especially as measured by student achievement and must prepare timely self-study reports to aid the staff, the sponsoring institution and the accrediting agencies in assessing program qualities and needs.

1. Outcomes
Programs shall routinely secure sufficient qualitative and quantitative information regarding the program graduates to demonstrate an ongoing evaluation of outcomes consistent with the graduate competencies specified by the educational program.

The manner in which programs comply with this criterion may vary. However, there should be timely efforts made to document the data and analysis provided. These sources of data may include, but should not be limited to, surveys of graduates and employers on such matters as employment settings, type and scope of practice, salary, job satisfaction, education and skills sufficiently and inadequately addressed in the educational program; interviews with program graduates and employers of graduates; and data on the evaluation of student performance on the national certifying examination and other nationally recognized standardized tests.

2. Results of ongoing program evaluation
The results of ongoing evaluation must be appropriately reflected in the curriculum and other dimensions of the program. In particular, the program must systematically use the information obtained in its evaluation to foster student achievement.

Program evaluation should be a continuing systematic process with internal and external curriculum validation in consultation with employers, faculty, preceptors, students and graduates, with follow-up studies of their employment and national examination performance. Other dimensions of the program merit consideration as well, such as the admission criteria and process, curriculum design and content.

Section II: Requirements for Medical Illustration Education

Description of the Profession

The field of medical illustration encompasses the transfer of knowledge in the biomedical sciences through visual communications. Medical illustrators are skilled artists who communicate both known and conceptual scientific, medical and biological information in visual media, eg, print, film, television, computer graphics, electronic imaging, exhibits, three dimensional models and prosthetics, in support of specific education, research, patient care and public relations objectives.

Medical illustrators are qualified by advanced academic education, practical and professional clinical experience in medical and biological sciences, in media techniques, and in theories related to communication, learning and management. They are knowledgeable regarding professional ethics and business practices. They are qualified to serve as designer, producer, director, and or consultant in the development of instructional, informational, and or promotional materials appropriate for an intended audience. Conceptualizing, designing, sketching, storyboarding, illustrating and modeling are the processes included in creating a final product. Medical illustrators prepare visual media from direct observation and description of biological, medical and surgical procedures, processes, and phenomena. They plan and produce a variety of presentations from the simple to the complex.

Medical illustrators work cooperatively with other biocommunications specialists and subject matter experts to create visual representations of scientific concepts and statistical data. Their clients include health care professionals, research and clinical scientists, art directors, publishers, and lawyers.

A. Curriculum

1. Description of the program
Faculty and students shall be provided with a clear description of the program and its content, including learning goals, course objectives, supervised clinical practice assignments and competencies required for graduation.

2. Medical illustration programs must stress the professional competencies required of a practicing medical illustrator. Educational programs in medical illustration are required to develop core curricula to satisfy these competencies as well as their own stated objectives. Schools may develop programs for the medical illustration generalist or the medical illustration specialist, with concentration in one more areas.

3. The curriculum must be designed on an advanced degree model and ordinarily require two (2) full academic years, though its length may vary. Further, the curriculum must be comprehensive and at an advanced level and instruction must follow a plan which documents:

a. Appropriate learning experiences and curriculum sequencing to develop the competencies necessary for entry into the profession. The curriculum must provide adequate and appropriate instructional materials, classroom presentation, discussion, demonstrations, supervised practice, and clinical experiences.

b. Clearly written course syllabi, which describe learning objectives and competencies to be achieved for both didactic and supervised studio and clinical education components.

c. Periodic evaluation of students to assess their knowledge, problem identification and problem solving skills, and their psychomotor and clinical competencies.

The sponsoring institution may present learning experiences through time frames and methods appropriate to its mission and objectives.

B. Required Competencies

The medical illustration graduate must be capable of translating complex anatomical, physiological, scientific and biomedical information and methods into visual forms that facilitate comprehension. Further, the graduate must execute these professional competencies in an ethical and businesslike manner. [See II A, Description of the Profession]

1. All **basic science instruction** should be comprehensive and above basic survey-type.

a. Human gross anatomy
Lecture, demonstration, and student dissection of the human cadaver taught by anatomy or cell biology faculty at the medical or graduate school level.

b. Pathology
Lecture, demonstration, and laboratory which includes fresh as well as fixed specimens.

c. Histology/microanatomy
Lecture, demonstration, and laboratory which encompass human cellular structure and organization.

d. Human physiology
Lecture, laboratory, and discussion of the basic physiological principles of organ systems and their interrelationships.

e. Embryology
Lecture, demonstration, and laboratory in embryologic development.

f. Neuroanatomy
Lecture, demonstration, and laboratory which includes microscopic and gross specimens.

2. The following laboratory, studio and theoretical content areas are strongly recommended:

a. Anatomical drawing
Graphic representation of gross anatomy from a variety of sources: dissections of human cadaver, medical imaging technology, cross sections of the body, et cetera.

b. Illustration techniques
Experience in a variety of art techniques and media and their appropriate application to specific scientific and medical subject matter.

c. Human surgical drawings
Renderings of surgical procedures based on operating room observations and consultations with surgeons; the study of the techniques of surgery and common surgical procedures.

d. Graphics principles
and techniques for the preparation of artwork for print and non-print media, e.g. slides, motion picture, television, film strips, overhead transparencies, and computers.

e. Medical computer graphics

Section II
continued

f. Instructional design and technology
Include elements of learning theory, pedagogical and presentation techniques, evaluation and writing for media and print publication, and the production of computer tutorials.

g. Photography
Uses of cameras, lighting, emulsions, darkroom procedure, (black-and-white and color), and photography of patients, specimens, flat copy and surgical procedures.

h. Motion media production

i. Three-dimensional materials and methods and/or exhibit plan, design, construction and budgeting.

j. Management and business practices

k. Professional ethics

3. Thesis, research project and/or final exhibit

C. Elective Courses or Seminars

Curricula must offer a variety of elective subjects in addition to the required areas of study identified in **Essential II C** above.

Appropriate examples include:

1. Illustration

a. Life drawing

b. Biological illustration

c. Ophthalmic illustration

d. Endoscopic illustration

e. Advanced medical and surgical illustration

f. Advanced graphics including computer and video graphics

2. Three-dimensional art

a. Materials and methods

b. Medical sculpture and models

c. Prosthetics

3. Communications art

a. Advanced biomedical photography

b. Advanced television and motion photography

c. Animation for film and or TV

d. Script writing

4. Instructional design and development

a. Survey of current audiovisual products

b. Media production, distribution and utilization

5. Science elective

a. Surgical techniques

b. Neuroanatomy

c. Medical statistics

d. Genetics

e. Veterinary anatomy and physiology

f. Dental and oral anatomy

g. Pharmacology

6. Externships

Section III: Maintaining and Administering Accreditaton

A. Program and Sponsoring Institution Responsibilities

1. Applying for accreditation

The accreditation review process conducted by the Committee on Allied Health Education and Accreditation (CAHEA) can be initiated only at the written request of the chief executive officer or an officially designated representative of the sponsoring institution.

This process is initiated by requesting an application form from and returning it to the

Division of Allied Health Education and Accreditation
American Medical Association
515 North State Street
Chicago, Illinois 60610

2. Administrative requirements for maintaining accreditation

To maintain accreditation, the following actions are required:

a. The program must submit a Self-Study Report or a required progress report within a reasonable period of time, as determined by the review committee.

b. The program must agree to a reasonable site visit date near the end of the period for which accreditation was awarded.

c. The program must inform the Accreditation Review Committee for the Medical

Illustrator (ARC-MI) within a reasonable period of time of changes in required program personnel.

d. The sponsoring institution must inform CAHEA and the review committee of its intent to transfer program sponsorship, in accord with CAHEA policy.

e. The program and the sponsor institution must pay review committee fees within a reasonable period of time, as determined by the review committee.

f. The sponsoring institution must promptly inform CAHEA and the review committee of any adverse decision affecting its accreditation or other specialty recognition status.

Failure to meet these administrative requirements for maintaining accreditation may lead to being placed on probation and ultimately to having accreditation withdrawn.

3. Withdrawal

An institution sponsoring a program may voluntarily withdraw from the CAHEA accreditation system at any time.

B. CAHEA and Review Committee Responsibilities

1. Administering the Accreditation Review Process

a. At the written request of the chief executive officer or other officially designated representative, CAHEA and the Accreditation Review Committee for the Medical Illustrator (ARC-MI) assess an applicant program's relative compliance with the Essentials.

The accreditation review process includes an on-site evaluation of the program. If the performance of a site visit team is unacceptable, the institution may request a second site visit.

Before the Accreditation Review Committee for the Medical Illustrator (ARC-MI) transmits its accreditation recommendation to CAHEA, the sponsoring institution is given an opportunity to comment in writing on the report of the site visit team and to correct factual errors.

b. Before recommending Probationary Accreditation to CAHEA, the Accreditation Review Committee for the Medical Illustrator (ARC-MI) provides the sponsoring institution with an opportunity to respond in writing to the cited deficiencies in the program's relative compliance with the Essentials. The Accreditation Review Committee for the Medical Illustrator (ARC-MI) reconsideration of a recommendation for Probationary Accreditation is based on conditions existing when the review committee arrived at its recommendation to CAHEA and on subsequent documented evidence of corrected deficiencies provided by the applicant.

c. CAHEA awards of Probationary Accreditation are final and are not subject to appeal.

2. Withholding or Withdrawing Accreditation

a. Before recommending to CAHEA that accreditation be withheld or withdrawn, the review committee provides the sponsoring institution with an opportunity to request reconsideration. CAHEA decisions to withhold or withdraw accreditation may be appealed. A copy of 5.600 CAHEA Appeals Procedures for Withholding or Withdrawing Accreditation is enclosed with the letter notifying the sponsoring institution of one of these actions. When accreditation is withheld or withdrawn, the sponsoring institution's chief executive officer is provided with a clear statement of each deficiency and is informed that the institution may apply for accreditation whenever the program is believed to be in compliance with the Essentials.

b. All students who have successfully completed a program granted any accreditation status at any point during their enrollment are regarded as graduates of a CAHEA-accredited program.

3. Inactive Programs

a. The sponsoring institution may request inactive status for a program that does not enroll students for up to two years. The program and its sponsoring institution must continue to pay required annual fees.

b. Should a program be inactive for two years and not be reactivated, it will be considered discontinued and accreditation will be withdrawn.

APPENDIX D: COMMISSION ON ACCREDITATION OF ALLIED HEALTH EDUCATION PROGRAMS: STANDARDS AND GUIDELINES FOR AN ACCREDITED EDUCATIONAL PROGRAM FOR THE MEDICAL ILLUSTRATOR

Commission on Accreditation of Allied Health Education Programs

Standards and Guidelines

for an Accredited Educational Program for the Medical Illustrator

Essentials/Standards initially adopted in 1987

REVISED IN 1992, 1998, AND 2003 BY THE

Association of Medical Illustrators

Commission on Accreditation of Allied Health Education Programs

The Commission on Accreditation of Allied Health Education Programs (CAAHEP) accredits programs upon the recommendation of the Accreditation Review Committee for the Medical Illustrator (ARC-MI).

These accreditation **Standards** are the minimum standards of quality used in accrediting programs that prepare individuals to enter the medical illustration profession. The accreditation **Standards** therefore constitute the minimum requirements to which an accredited program is held accountable.

Standards are printed in regular typeface in outline form. *Guidelines* are printed in italic typeface in narrative form.

Preamble

The Commission on Accreditation of Allied Health Education Programs (CAAHEP) and the Association of Medical Illustrators cooperate to establish, maintain and promote appropriate standards of quality for educational programs in medical illustration, and to provide recognition for educational programs that meet or exceed the minimum standards outlined in these accreditation **Standards**. Lists of accredited programs are published for the information of students, employers, educational institutions and agencies, and the public.

These standards are to be used for the development, evaluation, and self-analysis of medical illustration programs. On-site review teams assist in the evaluation of a program's relative compliance with the accreditation **Standards**.

Description of the Profession

Medical illustrators specialize in the visual display and communication of scientific information. Their graduate level training in science, art and communications enables them to understand and visualize scientific data and concepts. They create visuals and design communication to teach medical professionals as well as the general public. The accredited programs prepare students for a career in academic or research health science centers, industry, or consulting. As members of the health career profession with strong communication skills, medical illustrators work closely with clients to interpret their needs and create visual solutions through effective problem solving.

I. Sponsorship

A. Sponsoring Institution

A sponsoring institution must be at least one of the following:

1. A post-secondary, academic institution accredited by an institutional accrediting agency that is recognized by the U.S. Department of Education, and authorized under applicable law or other acceptable authority to provide a post-secondary program, which awards a minimum of a master's degree at the completion of the program.

2. A foreign post-secondary academic institution acceptable to CAAHEP that is authorized under applicable law or other acceptable authority to provide a post-secondary program, which awards a minimum of a master's degree at the completion of the program.

B. Consortium Sponsor

1. A consortium sponsor is an entity consisting of two or more members that exists for the purpose of operating an educational program. In such instances, at least one of the members of the consortium must meet the requirements of a sponsoring educational institution as described in I.A.

2. The responsibilities of each member of the consortium must be clearly documented as a formal affiliation agreement or memorandum of understanding, which includes governance and lines of authority.

C. Responsibilities of the Sponsor

The Sponsor must assure that the provisions of these *Standards* are met.

II. Program Goals

A. Program Goals and Outcomes

There must be a written statement of the program's goals and learning domains consistent with and responsive to the demonstrated needs and expectations of the various communities of interest served by the educational program. The communities of interest that are served by the program include, but are not limited to, students, graduates, faculty, sponsor administration, employers, physicians, the public, and nationally accepted standards of roles and functions.

Program-specific statements of goals and learning domains provide the basis for program planning, implementation, and evaluation. Such goals and learning domains must be compatible with both the mission of the sponsoring institution(s) and the expectations of the communities of interest. Goals and learning domains are based upon the substantiated needs of health care providers and employers, and the educational needs of the students served by the educational program.

B. Appropriateness of Goals and Learning Domains

The program must regularly assess its goals and learning domains. Program personnel must identify and respond to changes in the needs and/or expectations of its communities of interest. An advisory committee, which is representative of these communities of interest, must be designated and charged with the responsibility of meeting at least annually, to assist program and sponsoring institutional personnel in formulating and periodically revising appropriate goals and learning domains, monitoring needs and expectations, and ensuring program responsiveness to change.

The annual advisory committee meeting need not be face-to-face but can be accomplished by a conference call. Contact, with the advisory committee members, can be maintained by telephone and digital correspondence.

C. Minimum Expectations

The program must have the following goal defining minimum expectations: "To prepare competent entry-level medical illustrators in the cognitive (knowledge), psychomotor (skills), and affective (behavior) learning domains."

Programs adopting educational goals beyond entry-level competence must clearly delineate this intent and provide evidence that all students have achieved the identified basic competencies prior to entry into the field.

Nothing in this standard restricts programs from formulating goals beyond entry-level competence.

III. Resources

A. Type and Amount

Program resources must be sufficient to ensure the achievement of the program's goals and outcomes. Resources include, but are not limited to: faculty, clerical/support staff, curriculum, finances, offices, classroom/laboratory facilities, ancillary student facilities, clinical affiliations, equipment/supplies, computer resources, instructional reference materials, and faculty/staff continuing education.

B. Personnel

The sponsor must appoint sufficient faculty and staff with the necessary qualifications to perform the functions identified in documented job descriptions and to achieve the program's stated goals and outcomes.

1. Program Director

The program director must have a full time academic appointment.

a. Responsibilities

The director must be responsible for the organization, administration, continuous review, planning, development, and general effectiveness of the program.

b. Qualifications

The director must possess a master's degree, and must be a certified medical illustrator. The director must be a competent medical illustrator and have appropriate experience in education. He/she must possess the necessary qualifications to perform the functions identified in the documented job description.

Desirable that the director have a doctoral degree.

2. Didactic faculty (full- and part-time)
a. Responsibilities
Didactic faculty must be responsible for teaching each course assigned by the program director, evaluating students and reporting their progress as required by the sponsoring institution, and cooperating with the program director in periodic review and revision of course materials. Didactic faculty must maintain appropriate expertise and competencies through continuing professional development.

b. Qualifications
Didactic faculty must be knowledgeable in course content, effective in teaching their assigned subjects, and must meet the standards defined by the sponsor.

3. Clinical faculty (if applicable)
a. Responsibilities
Clinical faculty must be knowledgeable of the program goals, clinical objectives, and clinical evaluation system. Clinical faculty must provide students with appropriate and adequate clinical supervision and must evaluate student clinical competence.

b. Qualifications
A clinical faculty must be knowledgeable and effective in teaching the subjects assigned.

C. Curriculum

The curriculum must ensure the achievement of program goals and learning domains. Instruction must be an appropriate sequence of classroom, laboratory, and clinical activities. Instruction must be based on clearly written course syllabi describing learning goals, course objectives, and competencies required for graduation.

The curriculum must be designed at a master's degree level and must demonstrate compliance with the latest edition of *The Standards and Competencies for an Entry-Level Medical Illustrator* approved by ARC-MI and the Association of Medical Illustrator's Council on Education and Board of Governors.

D. Resource Assessment

The program must, at least annually, assess the appropriateness and effectiveness of the resources described in these standards. The results of resource assessment must be the basis for ongoing planning and appropriate change. An action plan must be developed when deficiencies are identified in the program resources. Implementation of the action plan must be documented and results measured by ongoing resource assessment.

IV. Student and Graduate (Outcomes) Evaluation/ Assessment

A. Student Evaluation

1. Frequency and Purpose

Evaluation of students must be conducted on a recurrent basis and with sufficient frequency to provide both the students and program faculty with valid and timely indications of the students' progress toward and achievement of the competencies and learning domains stated in the curriculum.

2. Documentation
Records of student evaluation must be maintained in sufficient detail to document learning progress and achievements.

B. Outcomes Assessment

1. Outcomes Assessment
The program must periodically assess its effectiveness in achieving its stated goals and learning domains. The results of this evaluation must be reflected in the review and timely revision of the program.

"Assessing effectiveness" is done through evaluation systems such as graduate performance measures, employer and graduate satisfaction, job (positive) placement, and attrition.

Graduate performance measures may include comprehensive examinations, clinical faculty evaluations, student portfolios and projects, and graduate scholarly output and professional achievements. Programmatic summative measures, if used, should contribute to assessing effectiveness in specific learning domains. "Positive Placement" means that the graduate is employed full or part-time in a related field, and/or continuing his/her education, and/or serving in the military.

2. Outcomes Reporting
The program must periodically submit its goal(s), learning domains, evaluation systems (including type, cut score, validity, and reliability), outcomes, analysis of the outcomes and an appropriate action plan based on the analysis.

V. Fair Practices

A. Publications and Disclosure

1. Announcements, catalogs, publications, and advertising must accurately reflect the program offered.

2. At least the following shall be made known to all applicants and students: the sponsor's institutional and programmatic accreditation status as well as the name, address and phone number of the accrediting agencies; admissions policies and practices; policies on advanced placement, transfer of credits, and credits for experiential learning; number of credits required for completion of the program; tuition/fees and other costs required to complete the program; policies and processes for withdrawal and for refunds of tuition/fees.

3. At least the following shall be made known to all students: academic calendar, student grievance procedure, criteria for successful completion of each segment of the curriculum and graduation, and policies and processes by which students may perform clinical work while enrolled in the program.

B. Lawful and Non-discriminatory Practices
All activities associated with the program, including student and faculty recruitment, student admission, and faculty employment practices, must be non-discriminatory and in accord with federal and state statutes, rules, and regulations. There shall be a faculty grievance procedure made known to all paid faculty.

C. Safeguards
The health and safety of patients, students, and faculty associated with the educational activities of the students must be adequately safeguarded**.**

All activities required in the program must be educational and students must not be substituted for staff.

For example, the program must ensure adequate ventilation, ergonomic equipment, and appropriate immunizations to protect from exposure to pathogens.

D. Student Records

Satisfactory records must be maintained for student admission, advisement, counseling, and evaluation. Grades and credits for courses must be recorded on the student transcript and permanently maintained by the sponsor in a safe and accessible location.

E. Substantive Change

The sponsor must report substantive change(s) as described in Appendix [below] to CAAHEP/ARC-MI in a timely manner. Additional substantive changes to be reported to ARC-MI within the time limits prescribed include:
1) Program resources, including budget/soft funds, scholarship support, personnel, resources, and space;
2) Degree granted at completion of program;
3) Admission process and procedures;
4) Admission target number or admission rate;
5) Attrition and graduation rates;
6) Program length;
7) Curriculum, including department-wide changes made in other departments;
8) Mechanisms for communicating student standing within the program.

F. Agreements

There shall be a formal affiliation agreement or memorandum of understanding between the sponsor and all other entities that participate in the education of the students describing the relationship, role, and responsibilities between the sponsor and that entity.

~~Appendix A~~

APPLICATION, MAINTENANCE AND ADMINISTRATION OF ACCREDITATION

A. Program and Sponsor Responsibilities

1. **Applying for Initial Accreditation**

a. The chief executive officer or an officially designated representative of the sponsor completes a "Request for Accreditation Services" form and returns it to:

CAAHEP
Attention: ARC-MI
35 East Wacker Drive, Suite 1970
Chicago, IL 60601

The "Request for Accreditation Services" form can be obtained from the CAAHEP website at www.caahep.org.

Note: There is **no** CAAHEP fee when applying for accreditation services; however, individual committees on accreditation may have an application fee.

b. The program undergoes a comprehensive review, which includes a written self-study report and an on-site review.

The self-study instructions and report form are available from the ARC-MI. The on-site review will be scheduled in cooperation with the program and once the self-study report has been completed, submitted, and accepted by the ARC-MI.

2. Applying for Continuing Accreditation

a. Upon written notice from the ARC-MI, the chief executive officer or an officially designated representative of the sponsor completes a "Request for Accreditation Services" form, and returns it to:

CAAHEP
Attention: ARC-MI
35 East Wacker Drive, Suite 1970
Chicago, IL 60601

b. The program may undergo a comprehensive review in accordance with the policies and procedures of the ARC-MI.

If it is determined that there were significant concerns with the on-site review, the sponsor may request a second site visit with a different team.

After the on-site review team submits a report of its findings, the sponsor is-provided the opportunity to comment in writing and to correct factual errors prior to the ARC-MI forwarding a recommendation to CAAHEP.

3. Administrative Requirements for Maintaining Accreditation

a. The program must inform the ARC-MI and CAAHEP within a reasonable period of time (as defined by the ARC-MI and CAAHEP policies) of changes in chief executive officer, dean of health professions or equivalent position, and required program personnel.

b. The sponsor must inform CAAHEP and the ARC-MI of its intent to transfer program sponsorship. To begin the process for a Transfer of Sponsorship, the current sponsor must submit a letter (signed by the CEO or designated individual) to CAAHEP and the ARC-MI that it is relinquishing its sponsorship of the program. Additionally, the new sponsor must submit a "Request for Transfer of Sponsorship Services" form. The ARC-MI has the discretion of requesting a new self-study report with or without an on-site review. Applying for a transfer of sponsorship does not guarantee that the transfer of accreditation will be granted.

c. The sponsor must promptly inform CAAHEP and the ARC-MI of any adverse decision affecting its accreditation by recognized institutional accrediting agencies and/or state agencies (or their equivalent).

d. Comprehensive reviews are scheduled by the ARC-MI in accordance with its policies and procedures. The time between comprehensive reviews is determined by the ARC-MI and based on the program's on-going compliance with the **Standards**, however, all programs must undergo a comprehensive review at least once every ten years.

e. The program and the sponsor must pay ARC-MI and CAAHEP fees within a reasonable period of time, as determined by the ARC-MI and CAAHEP respectively.

f. The sponsor must file all reports in a timely manner (self-study report, progress reports, annual reports, etc.) in accordance with ARC-MI policy.

g. The sponsor must agree to a reasonable on-site review date that provides sufficient time for CAAHEP to act on a ARC-MI accreditation recommendation prior to the "next comprehensive review" period, which was designated by CAAHEP at the time of its last accreditation action, or a reasonable date otherwise designated by the ARC-MI.

Failure to meet any of the aforementioned administrative requirements may lead to administrative probation and ultimately to the withdrawal of accreditation. CAAHEP will immediately rescind administrative probation once all administrative deficiencies have been rectified.

4. Voluntary Withdrawal of a CAAHEP- Accredited Program

Voluntary withdrawal of accreditation from CAAHEP may be requested at any time by the Chief Executive Officer or an officially designated representative of the sponsor writing to CAAHEP indicating: the last date of student enrollment, the desired effective date of the voluntary withdrawal, and the location where all records will be kept for students who have completed the program.

5. Requesting Inactive Status of a CAAHEP- Accredited Program

Inactive status may be requested from CAAHEP at any time by the Chief Executive Officer or an officially designated representative of the sponsor writing to CAAHEP indicating the desired date to become inactive. No students can be enrolled or matriculated in the program at any time during the time period in which the program is on inactive status. The maximum period for inactive status is two years. The sponsor must continue to pay all required fees to the ARC-MI and CAAHEP to maintain its accreditation status.

To reactivate the program the Chief Executive Officer or an officially designated representative of the sponsor must notify CAAHEP of its intent to do so in writing to both CAAHEP and the ARC-MI. The sponsor will be notified by the ARC-MI of additional requirements, if any, that must be met to restore active status.

If the sponsor has not notified CAAHEP of its intent to re-activate a program by the end of the two-year period, CAAHEP will consider this a "Voluntary Withdrawal of Accreditation."

B. CAAHEP and Committee on Accreditation Responsibilities – Accreditation Recommendation Process

1. After a program has had the opportunity to comment in writing and to correct factual errors on the on-site review report, the ARC-MI forwards a status of public recognition recommendation to the CAAHEP Board of Directors. The recommendation may be for any of the following statuses: initial accreditation, continuing accreditation, transfer of sponsorship, probationary accreditation, withhold accreditation, or withdraw accreditation.

The decision of the CAAHEP Board of Directors is provided in writing to the sponsor immediately following the CAAHEP meeting at which the program was reviewed and voted upon.

2. Before the ARC-MI forwards a recommendation to CAAHEP that a program be placed on probationary accreditation, the sponsor must have the opportunity to request reconsideration of that recommendation or to request voluntary withdrawal of accreditation. The ARC-MI reconsideration of a recommendation for probationary accreditation must be based on conditions existing both when the committee arrived at its recommendation as well as on subsequent documented evidence of corrected deficiencies provided by the sponsor.

The CAAHEP Board of Directors' decision to confer probationary accreditation is not subject to appeal.

3. Before the ARC-MI forwards a recommendation to CAAHEP that a program's accreditation be withdrawn or that accreditation be withheld, the sponsor must have the opportunity to request reconsideration of the recommendation, or to request voluntary withdrawal of accreditation or withdrawal of the accreditation application, whichever is applicable. The ARC-MI reconsideration of a recommendation of withdraw or withhold accreditation must be based on conditions existing both when the [committee on accreditation] arrived at its recommendation as well as on subsequent documented evidence of corrected deficiencies provided by the sponsor.

The CAAHEP Board of Directors' decision to withdraw or withhold accreditation may be appealed. A copy of the CAAHEP "Appeal of Adverse Accreditation Actions" is enclosed with the CAAHEP letter notifying the sponsor of either of these actions.

At the completion of due process, when accreditation is withheld or withdrawn, the sponsor's Chief Executive Officer is provided with a statement of each deficiency. Programs are eligible to re-apply for accreditation once the sponsor believes that the program is in compliance with the accreditation **Standards**.

Any student who completes a program that was accredited by CAAHEP at any time during his/her matriculation is deemed by CAAHEP to be a graduate of a CAAHEP-accredited program.

CAAHEP Accreditation

The Accreditation Review Committee for the Medical Illustrator (ARC-MI)

Sponsored by

The Association of Medical Illustrators

Recognized by

The Commission on Accreditation of Allied Health Education Programs

Guide for the Self-Study Process

and Format for the Report

(This Self-Study Guide and Format are based on the2003 edition of the Standards and Guidelines for an Accredited Program for the Medical Illustrator.)

Form III.C.2.

Entry-level Competencies

Competency	Curriculum Course(s) where Competency is Covered
C.1. Basic Science Competencies	
1. Graduates must have advanced level knowledge in one (or more) branches of the life sciences.	
C.2. Cognitive Competencies	
2.a. Graduates must demonstrate visualization skills	

2.a.1. Visualize structures, processes, and concepts that are not visible to the human eye, or that may not be visual, based on previous in depth study of the subject.	
2.a.2. Visualize objects in 3-dimension, perspective, cross-section, cut-away, sequence, and/or from different viewpoints.	
2.a.3. Solve visual communication problems using graphic conventions.	
2.b. Graduates must demonstrate analytical thinking skills	
2.b.1. Formulate meaningful questions	
2.b.2. Break down problems or complex tasks into manageable parts.	
2.b.3. Analyze relationships among the parts of a problem or situation.	
2.b.4. Set priorities for tasks in order of importance	
2.b.5. Anticipate obstacles and think ahead about next steps.	
2.c. Graduates must demonstrate conceptual thinking skills.	
2.c.1. Identify key or underlying issues in complex communication situations.	
2.c.2. Use creative, conceptual, or inductive reasoning in generating solutions to visual communication problems	

C.3. Research Competencies	
3. Graduates must know how to contribute to knowledge in the field through research.	
3.1. Review and critically appraise the literature on a topic.	
3.2. Formulate a statement of purpose or hypothesis for a proposed research project.	
3.3. Apply critical thinking, time management, and organizational skills in the conduct of research.	
3.4. Collect and organize data and resource information.	
3.5. Assess data to formulate a result.	
3.6. Report the research findings in an oral presentation and in writing using accepted scientific style.	
C.4. Applied Design and Production Competencies	
4.a. Graduates must be able to produce accurate and convincing representations of life science subject matter.	
4.a.1. Research content by reviewing the literature, doing dissections, using imaging modalities, making photographic references, attending surgery, consulting with subject matter experts, etc.	
4.a.2 Apply principles of measurement, proportion, and perspective.	
4.b. Graduates must be able to organize and graphically design information to maintain viewer attention and clearly convey a message.	
4.b.1. Abstract and distill the essence of a message.	
4.b.2. Tailor information and visual approach to the audience.	
4.b.3. Orient the viewer.	
4.b.4. Control the focus of viewing.	

4.b.5. Use color for viewer appeal, emphasis, balance, and/or mood.	
4.b.6. Use a sequence of images to tell a story.	
4.b.7. Combine textual and pictorial information into a unified message.	
4.b.8. Use motion to communicate and create structures that require X,Y,Z axes.	
4.c. Graduates must develop skill sets in traditional and digital media as needed to produce visual representations of life science structures and processes for print, video, Internet, CD-ROM, or DVD format.	
C.5. Instructional Design Competencies	
5. Graduates must be able to design and produce effective educational materials that satisfy the needs of the learner as well as the client.	
5.1. Elicit and assess client and learner needs.	
5.2. Analyze and arrange content to enhance learning.	
5.3. Tailor information and visual approach to learner.	
5.4. Select an appropriate medium and method of delivery.	
5.5. Assess learner and client satisfaction with the finished product.	
5.6. Apply relevant research findings from education, communication, and visual perception.	
C.6. Communication Competencies	
6. Graduates must be able to communicate with clients, subject matter experts, co-workers, superiors, and subordinates in oral and written form.	
6.1 Question clients until their communication needs are understood.	

6.2. Consult with subject matter experts until the content is fully understood.	
6.3. Use a process of formative feedback, followed by modifications.	
6.4. Work cooperatively with others on team projects.	
6.5. Make oral presentations to clients and colleagues.	
6.6 Apply appropriate writing skills to business correspondence, contracts, proposals, reports, scripts, and/or articles for publication.	
C.7. Professional and Ethical Competencies	
7. Graduates must be aware of professional and ethical conduct emphasized in the Association of medical Illustrators' Code of Ethics.	
7.1. Use appropriate conduct in special situations like the operating room, autopsy, dissection, and patient examination.	
7.2. Use professional conduct in relations with clients and colleagues.	
7.3. Maintain confidentiality when it applies to the privacy rights of patients, clients, and colleagues.	
7.4. Create accurate, original visual imagery.	
7.5. Do not plagiarize others' work.	
7.6. Credit others for their ideas and original imagery.	
7.7. Understand own personal strengths and weaknesses.	
7.8. Learn from own experiences and improve performance.	
C.8. Business and Management Competencies	
8. Graduates must be aware of sound business and management practices as emphasized in the Association of Medical Illustrators' Guidelines for Fair Practice.	

8.1. Estimate project costs and time.	
8.2. Develop and maintain an organized production schedule and budget for a variety of projects.	
8.3. Manage resources, such as, time, equipment, and supplies.	
8.4. Use written agreements with clients, employers, agents, authors, and publishers.	
8.5. Interpret and apply copyright laws.	
8.6. Register copyright of created works.	
8.7. Negotiate with clients for services rendered.	
8.8. Keep accurate business records for planning and tax purposes.	
8.9. Know how to market/promote a business or unit.	
8.10. Know what is required to set up a sole proprietorship or a partnership.	

oversees scheduling of interviews between potential employers and members seeking employment.

AMI Resume Service. Resumes of members actively seeking employment who fit the criteria specified by a prospective employer are available through the Association.

AMI Sourcebook. This biennial full-color publication features the work of more than 150 freelance medical illustrators, along with pertinent biographical information.

BPA-AMI Hotline. A special phone line plays a continuous tape with descriptions of available positions in the field of medical illustration.

Job Notices. Job notices are regularly mailed to the entire AMI membership. Job notices may also be posted in the *AMI News.*

Speaker Service. The AMI maintains a list of qualified speakers with expertise in specific areas of biomedical communication.

Subscriptions. Subscriptions and standing orders are available for *AMI News*, *The Journal for Biocommunication*, and the *AMI Sourcebook.* The *AMI News* accepts advertisements.

In addition, the AMI provides procedures for addressing legal and ethical conflicts, is active in promoting artists' rights, and works closely with other organizations in the United States and abroad to promote the sharing of ideas and technologies in the field of biomedical communication.

For more information, please phone or write:

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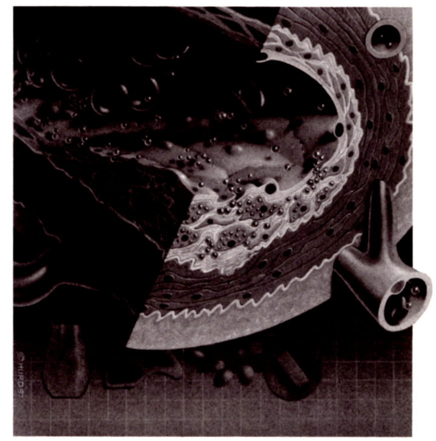


of Medical Illustrators

The Association of Medical Illustrators (AMI), formed in 1945, is a professional membership association whose primary purpose is to promote excellence within the field of medical illustration. As such, the Association's energies are focused into three basic areas:

1. To encourage high academic and professional standards

Accreditation. The Council of Allied Health Education Accreditation (CAHEA), in conjunction with the AMI, has established academic guidelines and accreditation procedures for graduate programs in medical illustration. Currently there are six accredited programs in the United States.

Certification. The AMI certification program, available for eligible members and nonmembers, consists of written and practical examinations and a series of courses and workshops approved for continuing education credits.

The AMI Code of Ethics. Adherence to the AMI's Code of Ethics is required of all AMI members.

Cover art: "Hypercholesterolemia," by Jane Hurd. Full-color art prepared for the cover of American Family Physician *magazine. Copyright 1987 Jane Hurd.*

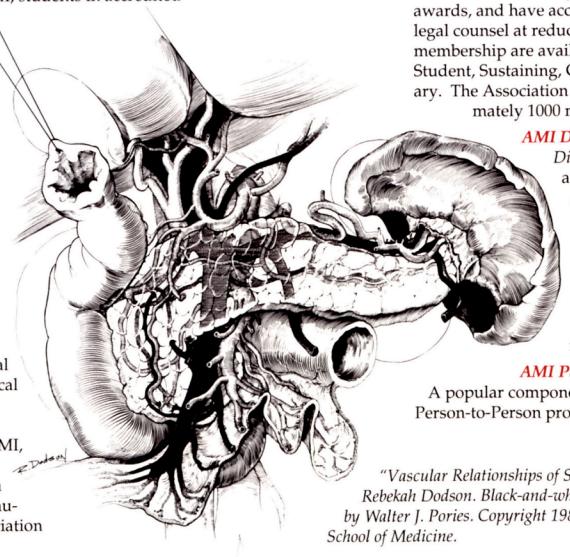
2. To provide educational opportunities

Financial Support. Funds for scholarships and educational projects in the health sciences are made available through the Vesalius Trust for Visual Communication in the Health Sciences, a nonprofit public foundation established by the AMI. All donations are fully tax-deductible.

Annual Meeting. The annual meeting constitutes the AMI's largest on-going educational project. The meeting includes continuing education workshops; concurrent presentations and panels on all aspects of the profession; hands-on demonstrations of the newest technology; and the largest salon in the world devoted to medical art. Approximately 500 individuals attend the annual meeting each year.

AMI Summer Internship Program. Administered through the AMI, students in accredited programs are matched with preceptor sites for work-related experience.

Educational Publications. The AMI publishes a bimonthly newsletter, *AMI News*, which features new technologies and addresses various practical and philosophical concerns of its members. In addition, the AMI, in conjunction with the Health Sciences Communications Association and the Association of Biomedical Communications Directors, publishes the quarterly academic journal, *The Journal of Biocommunication*.



"Vascular Relationships of Splanchnic Anatomy," by Rebekah Dodson. Black-and-white art prepared for a book by Walter J. Pories. Copyright 1987 East Carolina University School of Medicine.

3. To offer practical services in support of the profession

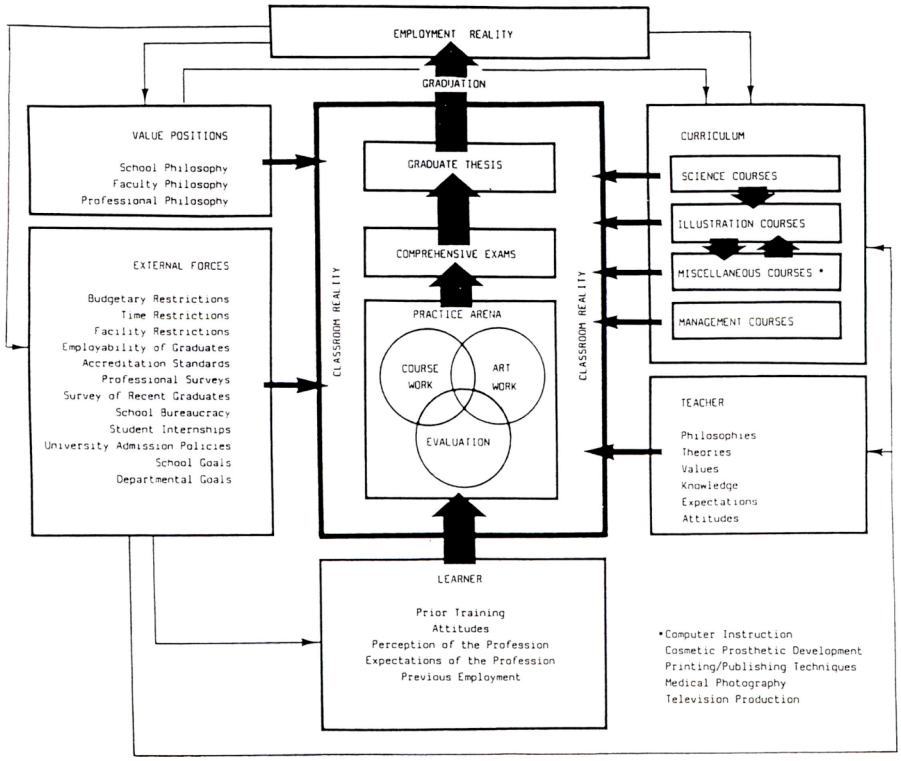
Membership. Membership in the AMI offers numerous benefits, including subscriptions to the *AMI News* and *The Journal of Biocommunication*, access to various job referral services, the opportunity to display artwork in the annual salon and to advertise in the *AMI Sourcebook*, reduced prices for AMI publications, and reduced fees for the annual meeting. Members are also eligible for numerous art, literary, achievement, and service awards, and have access to group insurance and legal counsel at reduced rates. Six types of membership are available: Active, Associate, Student, Sustaining, Contributing, and Honorary. The Association currently has approximately 1000 members.

AMI Directory. The *AMI Directory* is updated annually and lists all Active and Associate members, alphabetically and geographically.

AMI Label Service. This service supplies a set of self-adhesive, zip-coded labels of the entire AMI membership.

AMI Person-to-Person Service. A popular component of the annual meeting, Person-to-Person provides facilities and

APPENDIX F: PROGRAM IMPACT FACTORS



McGaghie W. C., et al (1966) as cited in Stenstrom 1987.

APPENDIX G: STENSTROM'S COMPETENCY BASED CURRICULUM

MCG Medical Illustration Curriculum

I. Utilize basic communication skills

[This section provides an overview of broad, current curricular theory, lends rationale for the variety and validity of perspectives, definitions, and purposes of curriculum]

A) Receive & interpret information from:
   1. tactile stimuli
      a. "real material"
      b. reproductions
   2. visual stimuli:
      a. in written language
      b. in graphic symbols
      c. in observed actions & subjects
   3. auditory stimuli (listening & "really hearing")
      a. oral directions
      b. oral descriptions
      c. personal narrations

B) Transmit information through:
   1. visual stimuli
      a. write
      b. illustrate graphically (draw)
   2. auditory stimuli (listening & "really hearing")
      a. orally - make live presentation
      b. produce audio tapes
   3. tactile stimuli
      a. models (still)
      b. prosthetics
   4. kinesthetic stimuli
      a. stimulators
      b. models (motion)

C) Utilize interpersonal communication skills with:
   1. clients/employers
   2. employees
   3. peers (team planning, joint projects)
   4. related production staff (graphic artists, photographers, printers, programmers, medical writers)

II. Utilize basic instructional technology skills

A) Define purpose of instruction
B) Identify target audience
C) Determine visual treatment
   1. Select communication media that are appropriate for intended use
      a. Describe the major physical and functional characteristics of each of the following visual communication media:
         1) Print Media
         2) Projected Media - Still
            a) 2x2 projection
            b) overhead projection

c) filmstrip projection

3) Projected Media - Motion
   a) live
      (1) 16mm projection
      (2) 8mm projection
   b) animation
      (1) 16mm projection
      (2) 8mm projection

4) Electronic
   a) computer
      (1) live
      (2) animation
   b) television - closed circuit
      (1) live
      (2) animation

5) Exhibit
   a) professional meetings
   b) public relations
   c) courtroom

6) Models

b. Identify advantages and disadvantages of each medium listed in "a" above.
   1) for producing software
   2) for using software
   3) for using hardware

c. Estimate production costs of software for each of these media
   1) labor
   2) materials
   3) equipment

d. Determine appropriate communication medium
   1) based on behavioral objective(s)
      a) when visual information is not necessary
         (1) textbook
         (2) journal
         (3) programmed text
         (4) monograph
         (5) lecture
      b) when visual information is necessary
         (1) still
         (2) motion
         (3) electronic
         (4) multisensory
            (a) visual-tactile
               ((1)) models
               ((2)) exhibits
            (b) audio-visual
               ((1)) slide-tape
               ((2)) sound/movie
               ((3)) television
               ((4)) film strip/sound
   2) based on size of viewing group
      a) individual learning
      b) small group learning
      c) large group learning

d) multi-groups - single geographic location
e) multi-groups - many geographic location

2. Select illustration style appropriate for audience, time factor, cost and medium of communication
3. Select b & w or color

D. Check library sources for redundancy
1. A-V catalog
2. AVLINE
3. Bibliographical Search

E. Write behavioral objectives
F. Organize informational (write script)
G. Storyboard ("thumbnail")
1. list several types ("thumbnails")
2. placement of credits at beginning

H. Create appropriate graphic information
I. Establish criteria for successful performance (terminal behavior)
J. Develop a means for evaluating performance (test)

III. Interpret in visual form a client's information

A. Determine form of visual (art, photo, etc.)
B. Create and Design Visual information that meets stated objectives
1. Establish objective of the visual info (with client)
2. Gather information necessary to create the visual information
a. Utilize personal knowledge to create the image (prerequisite knowledge, curricular experience, extra-curricular experience - ((internships, meetings, others))
b. Utilize other resources including:
1) subject specialists
2) library resources
a) identify helpful personnel
b) utilize computer search
c) use card catalogue
d) use written information
e) use visual information
(1) pictures in books
(a) artwork
(b) photography
(2) a-v materials
3) the operating room
4) autopsies
5) anatomical specimens
a) fresh
b) preserved
6) cadavers
7) anatomical models
8) "quickly" models (self-produced)
9) personal reference file ("morgue")
10) client sketches
11) photographs
a) use cameras
(1) 35mm
(2) Polaroid
(3) 4 x 5

b) process b & w film
(1) Kodalith
(2) pan
c) print b & w prints
(1) line
(2) tone

3) Develop/create sketches that synthesize information
a. synthesize essential info into loose visual form ("thumbnails")
b. create sketches of synthesized information that:
1) incorporate essential content (specified objective)
a) scientific information
(1) accurate structural features
(2) dynamic response of tissues
(3) explicit surface textures
b) technical aspects
(1) leader lines
(2) labels
(3) symbols and terminology
2) incorporate art principles
3) comply with limiting factors
a) target audience
b) budget
c) production time
(1) illustrator's
(2) producer's
d) communication medium
(1) format
(a) single use
(b) multiple use
(2) viewing time
c. ascertain correctness of sketches
1) clarity of information
2) scientific accuracy (expert's input)
3) spelling accuracy
4) meets stated objective
5) art principles
6) meets client's expectations (approval)

4) Create finished sketches - (ready for transfer)
a. incorporate necessary revisions/corrections of sketch
b. refine and/or redraw sketch
1) draw with exactness
a) correct/refine proportions
b) minor changes in placement/composition
2) plan shading, modeling, etc. (considering final art medium)
3) plan placement of labels and leader lines
c. clean up sketch for transfer

5) Transfer sketch to final rendering surface
a. prepare rendering surface
1) by mounting
a) artwork and photographs
(1) by photomount
(2) rubber cement/slipsheet
(3) 2-sided adhesive sheets

2) by preparing surface (erase with pink pearle, etc.)

b. use various transfer methods

1) backlit tracing
2) carbon paper impression
3) double transfer
4) projected image transfer
    a) artograph
    b) 2x2 slide
    c) overhead

C. Render the medical artwork

1. Utilize art techniques

a. 2-D illustration techniques

1) in Line
    a) for publication
    b) for projection
    c) for display
        (1) electronic
            (a) TV
            (b) computer
        (2) exhibit
2) in Tone
    a) for publication
    b) for projection
    c) for display
3) in Flat Color
    a) for publication
    b) for projection
    c) for display
4) in Full Color
    a) for publication
    b) for projection
    c) for display
5) in Combinations (mixed media)
    a) for publication
    b) for projection
    c) for display

b. graphic arts techniques

1) add flat color(s) to artwork
    a) in studio
        (1) color sheets (adhesive backing)
        (2) Color-Aid sheets
        (3) Bourges Colotone
    b) at printers
        (1) designate color areas on mechanical
        (2) write directions for percentage of specific colors
2) add tonal patterns to artwork
    a) in studio
        (1) zipatone, etc., adhesive sheets
        (2) Craft-tint materials
    b) at printers
        (1) designate tone areas on mechanical
        (2) write directions for benday
3) add lettering to artwork

a) Leroy
b) printed sheets of letters
c) cold type copy
(1) wax backing
(2) rubber cement backing
d) labeling instructions to printer

c. 3-D illustration techniques
1) to sculpt models
2) to create exhibits

2. Utilize art materials
a. 2-D material
1) for applied arts
a) media
(1) line
(a) flexible pen and ink
(b) tech pen and ink
(c) brush and ink
(d) carbon or litho pencil (or coquille)
(2) tone
carbon dust charcoal (b,w)
plastic pencil pastel (b, w)
graphite w. c. wash ink wash
(3) flat color
cel vinyl colored paper
tempera designers colors
acrylic (on film)
(4) full color
watercolor gouache/designers colors
acrylics Dr. Martin's dyes
pastels felt pens
pastel pencils
b) surfaces
(line:) Bristol board (flat color:) acetate
vellum (back painting)
Plasti-vellum illustration board
scratch board mat board
acetate
coquille board
(tone:) Color-Aid paper
(full color:)
illustration board
illustration board
medical stipple board
pastel paper
Vidalon
mat board
Bruning paper
wet acetate
charcoal paper
Anjax board
Video-media paper
2) graphic arts materials
a) adhesive films (Zipatone, Bourges, etc.)

(1) flat colors
(2) patterns
(3) % screens

b) pressure sensitive materials
(1) press type
(2) subjects/designs
(3) symbols
(4) tapes - colors
(5) image and transfer patterns

c) Craftint boards

d) acetates
(1) Bourges
(2) overlay sheets
(3) rubylith/amberlith

b. 3-D material

1) for models and prosthetics

a) for modeling (or permanent originals)

clay	Plexiglas sheets
wax	Modoclay
	Sculpy
	Sculpmetal
	soft-sculpture materials

b) for casting molds

plaster	dental alginate
RTV Silicones	dental stone
latex	moulage

c) for reproduction casts (final)

plaster	wax
paper mache	polyvinyl choride
Bioplastic	RTV
methyl methacrylate	
polyurethane	

d) for finishing
jeweler's rouge
sandpaper

2) for exhibit design and construction
graph paper
Styrofoam boards
foam core
gator board
lumber supplies
hardware
electrical supplies
A-V options
3-D letters
mounting supplies

3. Utilize Equipment and Instruments

a. 2-D instruments

airbrush	t-square	ruling pens
mat cutter	triangles, curves, templates, etc.	
x-acto knife	lettering devices (Leroy)	
electric eraser	ink compass	

b. 2-D equipment

pos I	Diazo	Photomount

compugraphic technifax artograph
varitype silk screen items paper cutter
phototypositer light box
3-M color key - console lab sonic cleaner, etc.

c. 3-D instruments
sculpting tools
buffer
refining tools
dental drill

d. 3-D equipment
oven
jigsaw
band saw
carpentry tools
etc.

IV. Prepare camera-ready copy for printing (photomechanical reproduction)

A. Single illustrations
B. Series of illustrations
C. Full-page layouts (art and type)
1. spec. type
2. copyfit
3. scale illustrations
4. directions to printer

V. Produce software for specified communication media

A. Projection media
1. Still media
a. Produce 2x2 slides
1. copywork
a) b & w
b) full color
c) duplicating slides on special equipment
2. process film
a) b & w
b) diazo
3) mounting
4) finishing
a) thumb spotting
b) taping - framing
c) opaquing
d) labeling the mount
b. Produce overheads
1) copy
2) process
3) mount
c. Prepare slides for commercial processing as a filmstrip
2. Produce a short, simple animated motion picture
a. create artwork
b. photograph artwork
B. Narrate an audio-tape to use with a slide series or direct a narration
C. Coordinate production and assemble components of a slide-tape unit
D. Produce an exhibit - (in model form)

VI. Describe the reproduction process and acceptable quality of reproduction of specified visual communication media

A. Print
   1. commercial
      a. letterpress
      b. offset
      c. gravure
      d. silk screen
   2. in-house
      a. mimeograph
      b. xerox
      c. multi-lith (paper plates)
      d. silk screen

B. Motion Pictures
   1. live - describe production sequence
   2. animation
      a. describe sequencing of events in developing an animated film
      b. describe special camera and set-up used for shooting animation

C. Television

D. Computers

E. Identify acceptable quality of production media (software) or appropriately designate required corrections
   1. photographic prints
      a. black and white
         1) line
         2) tone
      b. color
   2. photographic slides
      a. black and white
         1) line
         2) tone
      b. color
      c. diazo
   3. overhead projectuals
   4. TV graphics
   5. motion picture graphics
   6. animation graphics
   7. exhibits
   8. printed galleys/proof
      a. illustrations
         1) line
         2) tone
         3) flat color
         4) 4-color process
      b. typography - use of proof readers remarks
      c. layout

VII. Develop and manage a medical illustration service

A. Institutional
   1. Develop a unit
      a. identify needs expectations
         1) institution-wide
            a) present

b) past
2) within unit
a) present
b) future
b. identify functions of unit
c. design a unit
1) Develop
a) purpose, goals and objectives
b) policies - priorities, methods of financing, fees
c) procedures - work flow, forms design, charge system, job descriptions, salary ranges, competitive bids
2 List necessary facilities
a) space
b) furniture
c) equipment
d) supplies
(1) office
(2) art
d. estimate costs of the unit
1) setting-up costs
2) annual budget
e. employ personnel
1) publicize position
2) screen applicants
3) interview applicants
4) hiring and orientation

2. Manage a unit
a. Publicize
b. Manage personnel
c. Manage the work flow
d. maintain
1) inventory
2) equipment ("regular check-ups")
e. administer budget
1) income
2) expenditures
a) salaries
b) travel
c) equipment
d) supplies
3) record keeping
4) projections
f. Write reports
1) annual report
2) justifications
a) personnel evaluation
b) raises
c) new positions
d) equipment
e) travel
g. Address future needs
1) grants
2) cont. ed.

a) in service
b) professional associations
(1) meetings
(2) publications
c) post-graduate
d) individual research

B. Freelance
1. Studio set-up
a. furniture
b. equipment
c. supplies
1) office
2) art
2. Location
a. geographical region
b. local
1) in home
2) separate studio
3. Determination of Fee structure
4. Finding markets
5. Portfolio preparation
6. Describe necessary personality traits
a. assertive
b. confident
c. patient
d. self-motivated
e. works alone
7. Address future professional growth
a. continuing education
1) adult education
2) post-graduate education
b. professional associations
1) seminars
2) workshops
8. Set financial goals
9. Set professional goals
10. Business aspects
a. taxes
b. billing procedures
c. payment policies
d. insurance- include liability

VIII. Seek employment in an appropriate manner
A. Institutional
1. presenting qualifications
a. letter writing
1) application
2) inquiry
b. write c.v.
c. assemble portfolio
2. Interview
a. dress
b. personal appearance
c. conduct

1) listening
2) grammar
3) punctuality
4) manners
5) personal habits
6) attitude

d. conversation

B. Freelance
1. initial contact
2. assemble portfolio
3. appointment to show portfolio
4. follow-up

IX. Work within the parameters of the profession

A. Code of Ethics
B. Code of Fair Practice
C. Rules of Conduct:
1. in the O.R.
2. in the autopsy room
3. in the dissection lab
4. in the patient examination room

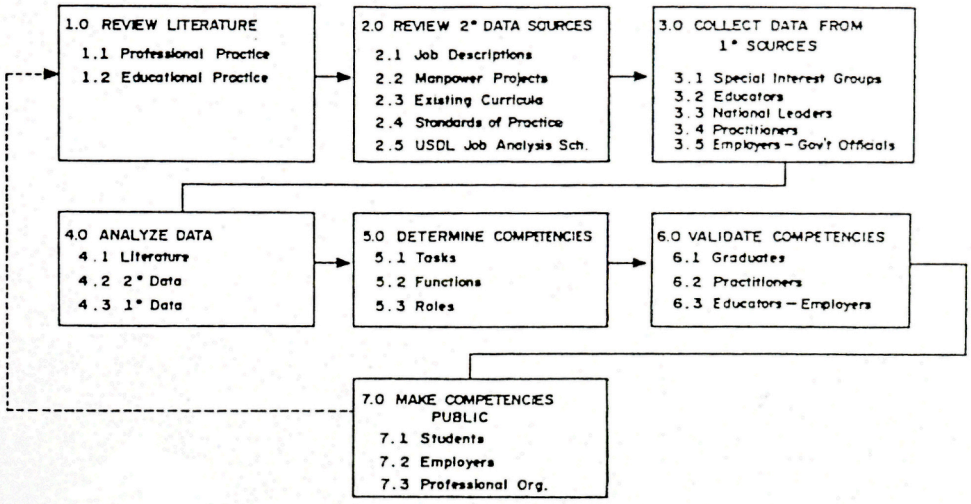
D. Essential legal information
1. Copyright
a. institutional
b. freelance
2. Contracts
a. copyright
b. ownership of original
c. co-authorship
d. re-use privilege/payment
e. deadlines
f. termination clauses
g. form of payment
1) "work for hire" (standard contract)
2) negotiated contract
a) per piece
b) per total job
c) royalty
h. fee charging policies
i. corrections/additions
3. patient release form
4. privacy of information
5. privileged information

E. Methods of professional advancement/enrichment
1. Meetings
2. Workshops
3. college credit courses
4. private art lesson/correspondence courses
5. untutored individual effort/experimentation

APPENDIX H: PROCESS MODEL

FIGURE 1

PROCESS MODEL FOR
DEVELOPING COMPETENCIES IN
ALLIED HEALTH FIELDS



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APPENDIX I: GENERIC JOB DESCRIPTIONS FOR THE MEDICAL ILLUSTRATOR

(Association of Medical Illustrators)

Job Description and Functions of the Medical Illustrator

Description of the Profession

The field of medical illustration encompasses the transfer of knowledge in the biomedical sciences through visual communications. Medical illustrators are skilled artists who communicate both known and conceptual scientific, medical and biological information in visual media, e.g. print, film television, computer graphics, electronic imaging, exhibits, three-dimensional models and prosthetics, in support of specific education, research, patient care and public relations objectives.

Medical illustrators are qualified by advanced academic education, practical and professional clinical experience in medical and biological sciences, in media techniques, and in theories related to communication, learning, and management. They are knowledgeable regarding professional ethics, and business practices. They are qualified to serve as designer, producer, director, and or consultant in the development of instructional, informational, and or promotional materials appropriate for an intended audience. Conceptualizing designing, sketching, storyboarding, illustrating and modeling are the processes included in creating a final product. Medical illustrators prepare visual media from direct observation and description of biological, medical and surgical procedures, processes and phenomena. They plan and produce a variety of presentations from the simple to the complex.

Medical illustrators work cooperatively with other biocommunications specialists and subject matter experts to create visual representations of scientific concepts and statistical data. Their clients include health care professionals, research and clinical scientists, art directors, publishers, and lawyers.

Generic Job Description:

Produce illustrations of anatomy, histology, pathology, surgical and other treatment procedures for varied markets (advertising editorial, publishing, educational, and medical legal) and purposes (informational, instructional, and promotional) based on client consultation OR observation, cadaver dissection, etc.

Design and produce graphic materials incorporating the elements of typography, illustration, layout, comprehensives, and page layout software for use in posters, brochures, newsletters, advertisements, stationary, logos, etc.

Design and produce permanent and temporary exhibits and posters for professional meetings, patient-education, public relations and courtroom demonstrative evidence.

Prepare instructional materials by developing objectives and preparing scripts, storyboards, evaluation instruments and visuals for audiovisual media, videotape productions, interactive media, etc. Manage either a private business or instructional unit.

APPENDIX J: RECRUITMENT FORM

Andrew F. Pecoraro, M.S.
317 New Bedford Rd
South Belmar, NJ 07719

732/681-0194
apec@bellatlantic.net

February 19, 2003

Dear Colleague:

I am in the process of conducting a study to identify the particular job tasks used by practicing medical illustrators. I want to determine job-task importance by looking at levels of achievement necessary for specific competency items, or tasks. What I plan to do is evaluate medical illustration job tasks in terms of their perceived importance by working illustrators. The feedback will prove useful to those institutions that train medical illustration students. It is hoped that by bridging the needs of the medical illustration workplace environment with academic training, a reduction of on-the-job-training for new graduates will occur.

In order to carry out this study, I am asking you for help. I have selected you, a member of the Association of Medical Illustrators, to help me quantify job-task importance. To assist me, will you please fill out the enclosed survey, returning it to me in the stamped envelope supplied by May 8, 2003. To assure anonymity, DO NOT place your name on the survey. The time it will take to fill out the survey is relatively minimal and your input is *greatly* needed. As all of the job tasks listed in the survey have been identified as important to medical illustration I am asking you to help determine (quantify) the degree to which tasks are important to *your* job by being acutely sensitive to varying degrees of importance of particular job tasks.

Again, I want to thank you for your participation. As a member of the Association of Medical Illustrators, I am sure you know important medical illustration training is and how quickly our industry is changing. We, as professionals, must evaluate our profession and provide feedback; your professional input is greatly needed.

Sincerely,
Andy Pecoraro, MS

APPENDIX K: SURVEY FORM

SURVEY OF MEDICAL ILLUSTRATION FUNCTIONS AND COMPETENCIES

The following Medical Illustration (MI) job tasks were derived from a comprehensive list of MI job functions. These tasks are used by experienced individuals in supervisory/managerial positions or come from years of professional MI experience. The purpose of the survey is to determine which functions/competencies are critical, and not so critical, in preparing MI students for the professional world.

INSTRUCTIONS:
Based on your experiences, please rate each of the following on a scale from (1) a minimum level of achievement necessary to (7) a maximum level of achievement necessary. In other words, please indicate, for each function/competency, what level of achievement is necessary to be successful in the field of MI.

Please **circle** your responses. If you make a mistake, please place an "X" through the incorrect response and circle the correct one.

	Minimum						***Maximum***
Able to note necessary production information to production staff for a final preproduction mock-up.	1	2	3	4	5	6	7
Acquires information from client regarding knowledge base of audience.	1	2	3	4	5	6	7
Acquires new technical skills.	1	2	3	4	5	6	7
Acquires the appropriate textual content references to research the topic at hand.	1	2	3	4	5	6	7
Alters the final representation of the illustrated solution based on communications with the client.	1	2	3	4	5	6	7
Alters the rough representation of the illustrated solution based on communications with the client via thumbnail sketch.	1	2	3	4	5	6	7
Archives completed work for retrieval.	1	2	3	4	5	6	7
Arranges work area to be efficient.	1	2	3	4	5	6	7

	Minimum						***Maximum***
Articulates verbal understanding of the problem/solution based on additional communications with the client.	1	2	3	4	5	6	7
Assigns resources/personnel for desired outcome.	1	2	3	4	5	6	7
Assigns individuals to a production timeline.	1	2	3	4	5	6	7
Attends workshops, seminars, and meetings.	1	2	3	4	5	6	7
Budgets the cost effectiveness of production process via written assessments.	1	2	3	4	5	6	7
Catalogues morgue file for reuse in later projects.	1	2	3	4	5	6	7
Chooses medium type that is appropriate for message.	1	2	3	4	5	6	7
Collaborates with other professionals.	1	2	3	4	5	6	7
Communicates using appropriate terminology to effectively communicate with members of work-related disciplines.	1	2	3	4	5	6	7
Composes sketch layouts for the project.	1	2	3	4	5	6	7
Consults expert personnel in the specialty related to the anatomy/procedure at hand.	1	2	3	4	5	6	7
Coordinates changing schedules among product participants, including outside vendors.	1	2	3	4	5	6	7
Creates a detailed (finished) representation of the final product.	1	2	3	4	5	6	7
Delegates workload to others to optimize efficiency.	1	2	3	4	5	6	7
Demonstrates understanding of concept by executing a finished, completed product.	1	2	3	4	5	6	7
Demonstrates understanding of concept by producing a final drawing.	1	2	3	4	5	6	7

	Minimum						***Maximum***
Demonstrates understanding of concept by producing a rough thumbnail sketch.	1	2	3	4	5	6	7
Demonstrates understanding of concept by verbally explaining the problem and solution to others.	1	2	3	4	5	6	7
Describes verbally a desired outcome (proofs/proposals).	1	2	3	4	5	6	7
Designs with type. (e.g. lettering/labeling/copyfitting) for readability and layout.	1	2	3	4	5	6	7
Determines the cost based on the amount of time, materials/supplies, and out-sourced expenses needed to execute a project.	1	2	3	4	5	6	7
Distills the essence of client's message by creating a final, fully-realized representation of the client's message.	1	2	3	4	5	6	7
Distills the essence of client's message by creating a finished representational drawing of the client's message.	1	2	3	4	5	6	7
Distills the essence of client's message by creating a rough representational thumbnail sketch of the client's message.	1	2	3	4	5	6	7
Distills the essence of client's message, verbally, by explaining the problem and solution to others.	1	2	3	4	5	6	7
Drafts storyboards/flowcharts/navigation maps. (e.g. shows sequences between relationships among elements).	1	2	3	4	5	6	7
Estimates cost based on materials needed.	1	2	3	4	5	6	7
Estimates cost based on medium application.	1	2	3	4	5	6	7
Estimates cost based on turn-around time.	1	2	3	4	5	6	7
Estimates cost of service bureau/out-service vendors.	1	2	3	4	5	6	7
Evaluates the project verbally for quality of information, use of aesthetics, and the degree to which product fulfills objective.	1	2	3	4	5	6	7

	Minimum						***Maximum***
Examines medium type based on cost, time, and output format via a written recommendation or proposal.	1	2	3	4	5	6	7
Explains verbally the strength and weaknesses of the piece in terms of conveying the message (information).	1	2	3	4	5	6	7
Explains verbally the strength and weaknesses of the piece in terms of medium application (how medium was handled).	1	2	3	4	5	6	7
Generates multiple sketches/thumbnails to communicate a solution to a given problem.	1	2	3	4	5	6	7
Has exposure to basic principles of teaching.	1	2	3	4	5	6	7
Has exposure to budget concerns/philosophies related to service bureaus or running a small business.	1	2	3	4	5	6	7
Has exposure to communication techniques through role-playing.	1	2	3	4	5	6	7
Has exposure to considerations necessary for beginning a new business or furthering an existing one.	1	2	3	4	5	6	7
Has exposure to interviewing techniques and skills.	1	2	3	4	5	6	7
Has exposure to management principles pertaining to conflict resolution.	1	2	3	4	5	6	7
Has exposure to management principles pertaining to employment and interview considerations.	1	2	3	4	5	6	7
Has exposure to management principles pertaining to employment termination.	1	2	3	4	5	6	7
Has exposure to management principles pertaining to record keeping.	1	2	3	4	5	6	7
Has exposure to management principles pertaining to supervising and evaluating personnel.	1	2	3	4	5	6	7
Has exposure to management principles related to organizational structure and behavior.	1	2	3	4	5	6	7

	Minimum						***Maximum***
Has exposure to marketing/promotion philosophies/strategies for business.	1	2	3	4	5	6	7
Has exposure to negotiation techniques pertaining to cost, timeframes, and ownership/usage.	1	2	3	4	5	6	7
Has exposure to practical approaches (case studies) for attaining resources/funds.	1	2	3	4	5	6	7
Has exposure to presentation techniques and formats.	1	2	3	4	5	6	7
Has exposure to pricing rates for freelance and service environments.	1	2	3	4	5	6	7
Has exposure to professional development skills.	1	2	3	4	5	6	7
Has exposure to purchasing considerations including needs analyses.	1	2	3	4	5	6	7
Has exposure to techniques comparing a goal to an outcome.	1	2	3	4	5	6	7
Has exposure to the considerations with which art directors face	1	2	3	4	5	6	7
Has exposure to the principles of billing and cash flow.	1	2	3	4	5	6	7
Has exposure to various examples of work-related systems (management of assets, supplies, and information).	1	2	3	4	5	6	7
Has exposure to writing formats necessary for preparing professional articles.	1	2	3	4	5	6	7
Has exposure to writing formats necessary for preparing professional documents.	1	2	3	4	5	6	7
Has exposure to writing techniques, proper grammar, and scholarly formats.	1	2	3	4	5	6	7
Has membership in professional organizations.	1	2	3	4	5	6	7

	Minimum						***Maximum***
Identifies ideas the viewer is intended to gain.	1	2	3	4	5	6	7
Maintains accurate time log for time spent on projects.	1	2	3	4	5	6	7
Meets deadlines.	1	2	3	4	5	6	7
Negotiates/ Mutually agrees upon work related factors such as cost, turn-around time, etc.	1	2	3	4	5	6	7
Networks with colleagues.	1	2	3	4	5	6	7
Obtains textual references that pertain to the problem at hand.	1	2	3	4	5	6	7
Obtains visual references that pertain to the problem at hand.	1	2	3	4	5	6	7
Orchestrates production schedules for concurrent projects.	1	2	3	4	5	6	7
Prepares product assets for conversion to presentation media.	1	2	3	4	5	6	7
Prepares written information relevant to reproduction of product.	1	2	3	4	5	6	7
Produces a pictorial solution to a visual problem.	1	2	3	4	5	6	7
Produces a storyboard to indicate sequence between or relationships among elements.	1	2	3	4	5	6	7
Produces final art according to contracts or agreements (renders, sculpts, computer generates).	1	2	3	4	5	6	7
Reviews the visual reference material to expedite the initial creation phase.	1	2	3	4	5	6	7
Schedules production timeline in terms of objectives.	1	2	3	4	5	6	7

	Minimum						*Maximum*
Schedules work according to deadlines.	1	2	3	4	5	6	7
Seeks client input (feedback) for ultimate approval of product.	1	2	3	4	5	6	7
Subscribes to technical/professional publications.	1	2	3	4	5	6	7
Uses storyboarding/flowcharting/navigation mapping for visual representation of sequences and/or relationships among elements.	1	2	3	4	5	6	7
Writes text to correspond with imagery.	1	2	3	4	5	6	7

Comments:

Respondent Information

1. GENDER (CIRCLE ONE): MALE FEMALE

2. AGE (CIRCLE ONE): 20-29 30-39 40-49 50-59 60-69 70-79

3. Indicate percentage of time spent freelancing _____
(Example: 20%)

4. Indicate number of years in the medical illustration field _____

5. INDICATE YOUR UNDERGRADUATE DEGREE AND MAJOR ____

(Example: BS, biology)

6. DO YOU HAVE A MASTERS DEGREE IN MEDICAL ILLUSTRATION (CIRCLE ONE)? YES NO

7. If not, do you have a certificate in medical illustration (circle one)? Yes No

8. If you possess a masters degree, from what program did you graduate? _____
_____

9. In what state do you currently work?_____

10. Please identify one market that best describes the area of medical illustration in which you work (Example: Medical-legal)_____

APPENDIX L: FOLLOW-UP "REMINDER" LETTER

Hi everyone-

Some of you may have received a survey in the mail within the last week. I have received many back but I still need to get a bit more. To foster returns I am turning to listserve to give a gentle reminder and further explain to anyone who is contemplating mailing back a response. First, a little background- I am a medical illustration graduate (1993) from the Medical College of Georgia. I am a practicing medical illustrator and have been for the last 10 years.

Currently, I am completing a doctoral degree from the University of Texas at Austin in Educational Administration. As part of that degree requirement, I must conduct a study; my primary interest is in medical illustration education. Bill Stenstrom, Elizabeth Roselius, Carrie Dilorenzo and I (through many focus group sessions) identified tasks (competencies) that practicing medical illustrators do on a daily basis. These very specific tasks were derived from broad areas of competencies that Alice Katz identified in her dissertation-study through focus groups with MIs and professionals associated to our field. Essentially I am furthering her study.

My hope is that by analyzing what professional illustrators are doing in their varied everyday work-lives, the graduate programs may be able to use this information and better streamline their programs to present the information to students that is recognized as "very important". I would like to see MI academia better aligned with the needs of the varied MI industries. I myself went through a learning curve upon graduation for areas that were not stressed in school and upon speaking to colleague-friends from different programs, the same was true. Since our professional field is

always changing, this information will better provide professors the information that will keep their programs "in line" with current/important developments as well as stressing the importance of the basics.

The populations for this study are medical illustrators and the pool was derived from the AMI member list. Approximately 700 surveys were mailed out and about 110 are needed back to be statistically sound. I have not yet reached that magic number! I hope this information/plea helps! Feel free to email me with any additional questions/concerns but I would prefer that the survey questions, strengths or weaknesses NOT be openly discussed on Listserv for fear that opinions, question interpretation, or peer pressure will sway the forthcoming responses/results. We certainly can discuss it all after I get all the responses back. Thank you again for your time and interest- and a special heartfelt "thank you" to all of you who have seen the importance of this undertaking and have already responded.

Andy Pecoraro, MS

APPENDIX M: AVERAGE RESPONSE FOR EACH COMPETENCY

The graphic below provides a summary of all eighty-nine competency items used in this study. It provides the average Likert score by each respondent and the standard deviation for each competency.

Response averages of 117 individual surveys

Survey Number	Survey Statement	Average response (n=117)	Standard deviation
1	Able to note necessary production information to production staff for a final preproduction mock-up.	4.50	1.63
2	Acquires information from client regarding knowledge base of audience.	5.91	1.17
3	Acquires new technical skills.	5.93	1.06
4	Acquires the appropriate textual content references to research the topic at hand.	6.05	1.07
5	Alters the final representation of the illustrated solution based on communications with the client.	6.21	1.09
6	Alters the rough representation of the illustrated solution based on communications with the client via thumbnail sketch.	6.04	1.28
7	Archives completed work for retrieval.	5.44	1.43
8	Arranges work area to be efficient.	4.81	1.38
9	Articulates verbal understanding of the problem/solution based on additional communications with the client.	6.15	.94
10	Assigns resources/personnel for desired outcome.	4.74	1.54
11	Assigns individuals to a production timeline.	4.43	1.67
12	Attends workshops, seminars, and meetings.	4.57	1.40
13	Budgets the cost effectiveness of production process via written assessments.	4.44	1.67
14	Catalogues morgue file for reuse in later projects.	4.26	1.78
15	Chooses medium type that is appropriate for message.	5.71	1.47
16	Collaborates with other professionals.	5.16	1.37
17	Communicates using appropriate terminology to effectively communicate with members of work-related disciplines.	5.94	.97
18	Composes sketch layouts for the project.	6.01	1.16
19	Consults expert personnel in the specialty related to the anatomy/procedure at hand.	5.56	1.40

20	Coordinates changing schedules among product participants, including outside vendors.	4.51	1.64
21	Creates a detailed (finished) representation of the final product.	5.84	1.46
22	Delegates workload to others to optimize efficiency.	4.46	1.63
23	Demonstrates understanding of concept by executing a finished, completed product.	6.19	1.39
24	Demonstrates understanding of concept by producing a final drawing.	6.07	1.29
25	Demonstrates understanding of concept by producing a rough thumbnail sketch.	5.68	1.43
26	Demonstrates understanding of concept by verbally explaining the problem and solution to others.	5.40	1.36
27	Describes verbally a desired outcome (proofs/proposals).	5.50	1.24
28	Designs with type (e.g. lettering/labeling/copy fitting) for readability and layout.	5.04	1.47
29	Determines the cost based on the amount of time, materials/supplies, and outsourced expenses needed to execute a project.	5.73	1.37
30	Distills the essence of client's message by creating a final, fully-realized representation of the client's message.	6.04	1.30
31	Distills the essence of client's message by creating a finished representational drawing of the client's message.	5.96	1.23
32	Distills the essence of clients message by creating a rough representational thumbnail sketch of the clients message.	5.54	1.39
33	Distills the essence of client's message, verbally, by explaining the problem and solution to others.	5.02	1.60
34	Drafts storyboards/flowcharts/navigation maps (e.g. shows sequences between relationships among elements).	4.83	1.60
35	Estimates cost based on materials needed.	4.83	1.76
36	Estimates cost based on medium application.	5.07	1.67
37	Estimates cost based on turnaround time.	5.55	1.41
38	Estimates cost of service bureau/out-service vendors.	5.09	1.63
39	Evaluates the project verbally for quality of information, use of aesthetics, and the degree to which product fulfills objective.	5.26	1.46
40	Examines medium type based on cost, time, and output format via a written recommendation or proposal.	4.57	1.96
41	Explains verbally the strength and weaknesses of the piece in terms of conveying the message (information).	5.09	1.53
42	Explains verbally the strength and weaknesses of the piece in terms of medium application (how medium was handled).	4.57	1.61
43	Generates multiple sketches/thumbnails to communicate	5.51	1.40

	a solution to a given problem.		
44	Has exposure to basic principles of teaching.	4.68	1.69
45	Has exposure to budget concerns/philosophies related to service bureaus or running a small business.	5.24	1.54
46	Has exposure to communication techniques through role-playing.	3.76	1.84
47	Has exposure to considerations necessary for beginning a new business or furthering an existing one.	5.08	1.66
48	Has exposure to interviewing techniques and skills.	4.55	1.68
49	Has exposure to management principles pertaining to conflict resolution.	4.31	1.83
50	Has exposure to management principles pertaining to employment and interview considerations.	3.91	1.77
51	Has exposure to management principles pertaining to employment termination.	3.62	1.86
52	Has exposure to management principles pertaining to record keeping.	4.56	1.64
53	Has exposure to management principles pertaining to supervising and evaluating personnel.	3.84	1.90
54	Has exposure to management principles related to organizational structure and behavior.	3.85	1.79
55	Has exposure to marketing/promotion philosophies/strategies for business.	5.22	1.57
56	Has exposure to negotiation techniques pertaining to cost, time frames, and ownership/usage.	5.70	1.50
57	Has exposure to practical approaches (case studies) for attaining resources/funds.	4.54	1.74
58	Has exposure to presentation techniques and formats.	5.42	1.52
59	Has exposure to pricing rates for freelance and service environments.	5.91	1.37
60	Has exposure to professional development skills.	5.49	1.48
61	Has exposure to purchasing considerations including needs analyses.	4.17	1.74
62	Has exposure to techniques comparing a goal to an outcome.	4.09	1.75
63	Has exposure to the considerations with which art directors face.	4.82	1.52
64	Has exposure to the principles of billing and cash flow.	5.01	1.59
65	Has exposure to various examples of work-related systems (management of assets, supplies, and information).	4.20	1.73
66	Has exposure to writing formats necessary for preparing professional articles.	3.85	1.59
67	Has exposure to writing formats necessary for preparing professional documents.	4.44	1.68
68	Has exposure to writing techniques, proper grammar, and scholarly formats.	5.26	1.57
69	Has membership in professional organizations.	5.18	1.54

70	Identifies ideas the viewer is intended to gain.	5.84	1.25
71	Maintains accurate time log for time spent on projects.	5.32	1.46
72	Meets deadlines.	6.79	.68
73	Negotiates/ Mutually agrees upon work related factors such as cost, turnaround time, etc	6.20	1.03
74	Networks with colleagues.	5.15	1.50
75	Obtains textual references that pertain to the problem at hand.	5.78	1.29
76	Obtains visual references that pertain to the problem at hand.	6.12	1.04
77	Orchestrates production schedules for concurrent projects.	5.73	1.25
78	Prepares product assets for conversion to presentation media.	4.79	1.57
79	Prepares written information relevant to reproduction of product.	4.35	1.69
80	Produces a pictorial solution to a visual problem.	6.26	1.02
81	Produces a storyboard to indicate sequence between or relationships among elements.	4.91	1.72
82	Produces final art according to contracts or agreements (renders, sculpts, computer generates).	6.50	.98
83	Reviews the visual reference material to expedite the initial creation phase.	5.98	1.05
84	Schedules production timeline in terms of objectives.	5.41	1.33
85	Schedules work according to deadlines.	6.32	1.03
86	Seeks client input (feedback) for ultimate approval of product.	6.41	.90
87	Subscribes to technical/professional publications.	4.62	1.50
88	Uses storyboarding/flowcharting/navigation mapping for visual representation of sequences and/or relationships among elements.	4.83	1.62
89	Writes text to correspond with imagery.	4.53	1.76

APPENDIX N: FACTOR ANALYSIS

The Factor Analysis used in this research was completely objective and based only upon the data included in the analyses. The SAS output was represented by a two-way table of raw data; competencies were listed in the columns, and replications, or responders, were presented in rows. In this research, "competencies" referred to the 89 competencies/tasks listed in the survey and scored from 1 to 7 by the respondents. The rows of the SAS output referred to the 117 responders who provided answers to each of the 89 items.

From this table, a correlation matrix (89x89) was developed which organized the correlation coefficients for all pairs of competencies. When a competency was paired with itself, the correlation coefficient was 1.00. Correlation coefficients can be positive or negative. All must be less than ± 1.00.

The first phase of Factor Analysis is known as Principle Components. The objective is data reduction. The analysis determines the number of dimensions (d) included in the data set. The number of dimensions is always smaller than the number of variables- in this case, the competencies. Each dimension was associated with an eigenvalue ≥ 1.00. An eigenvalue, also known as a characteristic or latent root, "is a mathematical property of a matrix; used in relation to the decomposition of a covariance matrix, both as a criterion of determining the number of factors to extract and a measure of variance accounted for by a given dimension" (Kim, p. 83). Each eigenvalue and associated vector accounted for a percent of the total variance in the data set. The eigenvalues were arranged in rank order beginning with the largest. In that way, individual percents could be accumulated. In the data set for this project, there were 21 eigenvalues ≥ 1.00. The first four factors, the major factors, accounted for 43.3% of the total variation in the data set and included 39 of the 89 competencies. There were a total of twenty-

one independent variables, composed of the 89 original competencies that accounted for 78.1% of the total variation in the data set. The complete solution provided 89 eigenvalues presented in rank order. However, only 21 eigenvalues $\geq$ 1.00 identified the real dimensions in the data reduction process.

The number of dimensions is much smaller than the number of competencies because the competencies are correlated and the dimensions are not. The Principle Components analysis reduced the original data set from 89 competencies to 21 variables. Each variable is a dimension in 21 dimensional spaces. Sometimes, these dimensions are mistakenly called factors. However, each dimension was composed of the sum of 89 products (solution derived weight times the average for each item). These calculations are only carried out when there is a need to plot the dimensions. This project did not require plotting any of the dimensions.

The second phase of Factor Analysis is known as Varimax Rotation. This step maximized the weights for each competency in such a way as to develop only one large weight per competency. This weight is assigned within just one dimension. For some competencies, no large weights were developed by the solution. To repeat, for this research project, there were 21 dimensions, organized in rank order by the magnitude of their eigenvalues. Associated with each dimension were 89 weights, one for each competency.

The third step in the analysis was the identification of the important competencies that belonged to each dimension. From the varimax rotation, all the weights were < 1.00 and for most competencies, one large weight stood out. Thus, it was possible to place almost every competency within one of the dimensions. However, Factor Analysis is a data reduction process. The weights were used to include only *important* competencies and to eliminate other competencies. Competencies with a weight $\geq$ 0.48 were identified as important enough to be included in the solution. All competencies with no weight $\geq$ 0.48 were eliminated. Thirteen (13) competencies were eliminated.

The fourth step organized the factors. Following the rules for eigenvalues $\geq$ 1.00 and competency weights $\geq$ 0.48 provided the completely objective Factor Analysis process.

Beginning with the dimension with the largest eigenvalue, all competencies with weights $\geq$ 0.48 were listed by description under a column for that dimension. This much shorter list of competencies in one column made up Factor 1. The competencies in that column could not be included in any other factor. Next, the dimension with the second largest eigenvalue listed all competencies with weights $\geq$ 0.48, and this became Factor 2. The process proceeded until there was one or more competencies listed under each of the 21 dimensions. Some competencies were not included in any of the factors because their associated low weights excluded them from being included in any of the dimensions.

At this stage in the process, most dimensions were finally called Factors. The factors associated with the largest eigenvalues and the larger numbers of competencies were called Major Factors. The dimensions associated with intermediate sized eigenvalues and with more than one competency were called Minor Factors. The dimensions with the smallest eigenvalues $\geq$ 1.00 and possessing a single competency were described as "potentially useful competencies." The concept was that Factors were made up of more than one competency. And a few individual competencies were recognized as potentially providing additional information because each of those competencies was first identified as a dimension, meaning that they were scored similarly by respondents.

The analyst's intervention began with the short list of competencies associated with each factor. The selected competencies within each factor were all competencies that were highly correlated. There was a "common thread" among the highly correlated competencies that suggested a title for each factor. In this way each factor was named.

Here is a summary of the "numbers" associated with the Factor Analysis for this research project. The survey included 89 competencies. Complete responses were provided by

117 respondents. The Principle Components analysis found 21 real dimensions among the 89 competencies. This indicates that several competencies were all part of one dimension because they were highly correlated. Varimax rotation assigned weights to each competency in each dimension. Assigning the competencies with the largest weights to only one dimension and then listing those competencies within each dimension created 14 multi-competency dimensions that included 69 competencies and 7 potentially useful single competencies. The process eliminated 13 competencies.

Here is a brief summary of the factor analyses that is presented under "Findings" in the text of this study.

Organized Structure	Number of Structures	Number of Total Items
Major Factors	4	39
Minor Factors	10	30
Single Competencies	7	7
Competencies eliminated		13

Only the final steps in the Factor Analysis are included in the text. Each factor is identified by the general subject(s) best described by the competencies included in that specific factor. Factor 3 is presented here as an example to help the reader relate to the above discussion.

From the Principle Components analysis:

		Variance accounted for:	
Dimension	Eigenvalue	Percent	Cumulative
First	22.59	25.4%	25.4 %
Second	7.13	8.0%	33.4%
Third	4.61	5.2%	38.6%

In the text, factors are presented in the order in which the identifying dimension appeared in the Principle Components phase of the solution. In this way, the sequence follows the variance accumulation. This is a ranking of mathematical importance based upon variance accounted for. However, this is not necessarily the exact ranked importance for the subject matter.

Factor 3 – Product Creation

Survey number	Survey statement	Weight	Mean	Standard deviation
25	Demonstrates understanding of concept by producing a rough thumbnail sketch.	0.838	5.68	1.43
32	Has exposure to negotiation techniques pertaining to cost, timeframes, and ownership/usage.	0.755	5.54	1.39
43	Generates multiple sketches/thumbnails to communicate a solution to a given problem.	0.652	5.51	1.40
18	Composes sketch layouts for the project.	0.625	6.01	1.16
6	Alters the rough representation of the illustrated solution based on communications with the client via thumbnail sketch.	0.590	6.04	1.28
26	Demonstrates understanding of concept by verbally explaining the problem and solution to others.	0.556	5.40	1.36
33	Distills the essence of client's message, verbally, by explaining the problem and solution to others.	0.537	5.02	1.60
24	Demonstrates understanding of concept by producing a final drawing.	0.519	6.07	1.24

Correlation Matrix

Comp	25	32	43	18	6	26	33	24
25	1.000	0.799	0.607	0.523	0.565	0.503	0.551	0.586
32		1.000	0.567	0.443	0.661	0.337	0.616	0.538
43			1.000	0.472	0.519	0.406	0.446	0.314
18				1.000	0.351	0.380	0.265	0.490
6					1.000	0.351	0.396	0.380
26						1.000	0.576	0.268
33							1.000	0.312
24								1.000

All correlations are statistically significant $p<0.01$.

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