EXPLORING THE INDUSTRIAL HYGIENE ACADEMIC CURRICULUM:

EXPECTATIONS AND PERCEPTIONS OF THE PROFESSION

A Dissertation

by

DAVID CLARENCE BREEDING

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

May 2008

Major Subject: Interdisciplinary Engineering

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ABSTRACT

Exploring the Industrial Hygiene Academic Curriculum: Expectations
and Perceptions of the Profession. (May 2008)
David Clarence Breeding, B.S., East Tennessee State University;
M.S., East Tennessee State University; M.B.A., Vanderbilt University
Chair of Advisory Committee: Dr. James C. Rock

Although the multi-disciplinary profession of industrial hygiene (IH) has been established for many years and IH practitioners have been prolific in developing the technical tools for recognition, evaluation and control of workplace hazards, few in the IH discipline have turned the tools and methods of academic research toward the academic curriculum itself. A review of the literature revealed that published research in IH curriculum has been minimal, and that none has considered comparing faculty and employer expectations. Evaluating the nature of the current IH curriculum, and the preferences and expectations of the IH profession for graduates' competencies, is true to the goal of IH practice, i.e., conducting research as a basis for on-going evaluation and review of existing programs, and using research findings to plan preventive interventions in order to ensure continued good health of both programs and impacted individuals.

This research was an initial, exploratory study to identify and assess the expectations and perceptions of the IH faculty and employers in the areas of IH curriculum content and structure. The expectations and perceptions of IH academic program faculty were compared with those of employers of graduates of IH programs. Characteristics of current IH academic programs were identified, as a baseline for future evaluation of the IH curriculum. Actual and expected undergraduate majors of those entering IH masters programs were identified to aid in targeting effective recruitment programs and efficient resource allocation. The study populations' skill and capacity with computers and the Internet were assessed as an indicator of readiness to incorporate distance learning methodology and electronic media delivery into traditional classroom delivery of industrial hygiene education. Recommendations were given for model IH curricula derived from the survey participants' responses, and for future work.

DEDICATION

To my Parents

Edith Sharp Breeding

1921 – 1981

Clarence Herbert Breeding

1921 – 2003

Educators and teachers, who sparked my insatiable curiosity,

and my love of reading and learning.

And, to my wife

Diane Matthews Breeding

The real true love of my life.

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I thank the members of my committee, Dr. James C. Rock, Chair, Dr. Roy W. Hann, Jr., Dr. Calvin E. Woods, and Dr. John W. Poston, Sr. I thank the dedicated staff at the Help Desk of the TAMU Department of Statistics for their review and counseling on the research methods and analysis. I thank Dr. Brian K. Williams of the SCS Dissertation Support Group for his patience and counseling during this process. I've had the privilege of taking classes from a number of excellent professors at TAMU, and I thank them all for the quality education I received. I would also thank Dr. James C. Rock for recruiting me to attend Texas A&M University.

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On a personal note, I also wish to thank my parents, life long educators and teachers, who sparked my insatiable curiosity and interest in scholarship and learning. Finally, I thank my wife, Diane, the real true love of my life, without whose unwavering support, enthusiastic encouragement and prodding I'd most likely be trying to race cars for a living.

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CHAPTER I

INTRODUCTION, PROBLEM STATEMENT, AND PURPOSE

Introduction

Industrial Hygiene (IH) is a uniquely interdisciplinary field, based in science, engineering, and preventive medicine. The goal of industrial hygiene practice is to plan and implement preventive intervention between the risk factor and the affected worker(s), and, thus, reduce unnecessary employee exposure to potentially harmful substances and processes in the occupational workplace and its adjacent communities (Breeding and Hagan, 1995). Evaluating the nature of the current IH curriculum, and the preferences and expectations of the IH profession for graduates' competencies, is true to the goal of IH practice, i.e., conducting research as a basis for on-going evaluation and review of existing programs, and using research findings to plan preventive interventions to ensure continued good health of both programs and impacted individuals.

This research was an initial, exploratory study to identify the expectations and perceptions of the industrial hygiene (IH) faculty and employers in the areas of IH curriculum content and structure. The expectations and perceptions of IH academic program faculty were compared with those of employers of graduates of IH programs.

The study populations' skill and capacity with computers and the Internet was assessed as an indicator of readiness to incorporate distance learning methodology and electronic media delivery into traditional classroom delivery of industrial hygiene education. The expectations and

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This dissertation follows the style of the *Journal of Engineering Education*.

perceptions of IH program faculty and of employers of graduates of IH degree programs were assessed. Comparing their responses identified commonalties and differences of the two surveyed populations. Characteristics of current IH academic programs were identified, as a baseline for on-going evaluation of the IH curriculum. The readiness of faculty and employers to accept distance education applications was assessed; and areas for future research in IH education were identified.

Problem Statement

Although the multi-disciplinary profession of industrial hygiene (IH) has been established for many years and IH practitioners have been prolific in developing the technical tools for recognition, evaluation and control of workplace hazards, few in the IH discipline have turned the tools and methods of academic research toward the academic curriculum itself. A review of the literature reveals that published research in IH curriculum has been minimal, and that none has considered comparing and contrasting faculty and employer expectations.

Traditionally each university and each academic program prides itself on individuality and uniqueness, and IH academic programs are no exception. Building on the strengths of the individual program is desirable and can be seen as adding value and distinctness, for the program as well as for the individual graduate. However, impacted groups, including potential and actual employers, also expect common core competencies from graduates of all IH academic programs. This is in accord with the expectations of many other academic and professional disciplines, i.e., that a graduate from an academic degree program should possess a set of core competencies common to all degree programs in the particular discipline, complimented by an emphasis in the unique strengths of the individual's particular institution of higher education.

Objectives of This Research

The objectives of this research were to review the literature of industrial hygiene education, and to conduct an initial, exploratory study to identify the expectations and perceptions of the industrial hygiene faculty and employers in the areas of IH curriculum content and structure. The expectations and perceptions of industrial hygiene academic program faculty were compared with those of employers of graduates of industrial hygiene degree programs. (Survey A of IH faculty and Survey B of IH employers are shown in Appendix A.) The study populations' skill and capacity with computers and the Internet was assessed as an indicator of readiness to incorporate distance learning methodology and electronic media delivery into traditional classroom delivery of Industrial Hygiene education.

The purposes of this research were to explore the expectations and perceptions of IH program faculty and of employers of graduates of IH degree programs, and by comparing the responses, to identify commonalties and differences; to review and report the literature of both safety and industrial hygiene education; to assess the readiness of faculty and employers to accept distance education applications; and to address areas for future research in IH education.

To achieve the objectives of this study, the research strived to address several critical questions:

1. Participant Demographics: Who is teaching industrial hygiene and who is hiring IH graduates?
2. What are the characteristics of current industrial hygiene academic programs and employers?
3. Is the profession ready for "high-tech" distance learning in IH education?
4. What inputs are used to develop the industrial hygiene academic curriculum?

5. What faculty/employer preferences for core competencies expected to be possessed by industrial hygienists entering professional practice?
6. What are the hot, emerging issues to which the IH curriculum must be responsive?

Terminology and Concepts

Much discussion exists in literature defining education and training – their commonalities and differences. In this study, discussion of survey results from faculty and employers may raise a plethora of questions this study was not designed to investigate surrounding the purposes and results of education and training, the hierarchical progression of learning, the inclusiveness of learning, the exclusivity of higher education, and proper matriculation between two-year programs of technical training and four-year courses of study in industrial hygiene and related fields. In its role of an exploratory study, this study cannot answer such questions or issues but does bring them to light for additional research.

For purposes of this study, the terms related to education and training are defined as follows:

- Adult Education: Adult Education refers to the practice of teaching and educating adults. Adult education or lifelong education takes on many forms, from formal class-based learning to self-directed learning; it has become widespread in many countries. (Field, 2006)
- Associate Degree: The Associate degree may be terminal at the technician level in applied science, or may transfer to a four-year program at a Senior College for matriculation toward a higher degree if the associate degree is in the arts, science, or fine arts. (North Carolina Community College System, 2008)

- Community College: A community college, or junior college, is a type of higher educational institution, offering lower division college-level courses in two-year, Associate degree programs. The Associate degree may be terminal at the technician level, or may transfer to a Senior College for matriculation toward a higher degree. (Baker, 1994)
- Curriculum: In formal education, a curriculum is the set of courses, and their content, offered at a school or university. (*American Heritage Dictionary of the English Language*, 4th ed., 2003)
- Distance Education: The organizational framework and process of providing instruction at a distance. Distance education takes place when teacher and student(s) are physically separated, and technology is used to bridge the instructional and physical gap. (Willis, 1994)
- Distance Learning: Distance Learning is the desired outcome of distance education, i.e., learning at a distance. (Willis, 1994)
- Education: The knowledge or skill obtained or developed by a learning process; a program of instruction; to provide schooling or training by formal instruction and supervised practice; the action or process of education and being educated; the process, structure and strategy for the formal transfer of knowledge and information from teacher to learner(s). (Simpson and Weiner, 1989)
- Educational Technology: Educational Technology, also called computer-assisted learning, involves the use of computers, the Internet, and information and communications technologies as a diverse set of tools and resources used to facilitate distance education and learning. (Willis, 1994)

- Faculty: Faculty are educators who teach at a college or university, a body of teachers. The term is also used to refer to all of the members of a learned profession. (*American Heritage Dictionary of the English Language*, 4th ed., 2003)
- Formal Education: Formal Education refers to the hierarchically structured, chronologically graded education system, running from primary school through university and including, in addition to general academic studies, a variety of specialized programs and institutions for full time technical and professional training. (*American Heritage Dictionary of the English Language*, 4th ed., 2003)
- Higher Education: Higher Education is formal education beyond the secondary level, especially education at the college and university level. Higher education, also called tertiary, third stage or post secondary education, often known as academia, is the non-compulsory educational level following the completion of a school providing a secondary education, such as a high school, or preparatory school. Tertiary education is normally understood to include undergraduate and postgraduate education, as well as vocational education and training. Colleges and universities are the main institutions that provide tertiary education. Collectively, these are sometimes known as tertiary institutions. Tertiary education generally results in the receipt of diplomas or academic degrees. Higher education includes teaching, research and social services activities of universities, and within the realm of teaching, includes both the undergraduate level (sometimes referred to as tertiary education) and the graduate (or postgraduate) level. (Baker, 1994)
- Instruction: Instruction is the act, practice, or profession of educating or instructing; an imparted or acquired item of knowledge; a lesson. (*American Heritage Dictionary of the English Language*, 4th ed., 2003)

- Pedagogy: Pedagogy is the strategy and structure of instruction. (*American Heritage Dictionary of the English Language*, 4th ed., 2003)
- Professional Development: Professional Development refers to skills required for maintaining a specific career path or to general skills offered through continuing education (Field, 2006). It can be seen as training to keep current with changing technology and practices in a profession or in the concept of lifelong learning. Developing and implementing a program of professional development is often a function of the human resources or organization development department of a large corporation or institution. Some professions are legislatively mandated to do professional development, and others do so voluntarily, to maintain and improve knowledge, skills, and competencies.
- Professor: A professor is a college or university teacher. The professorial ranks include full professor, associate professor, assistant professor, and, sometimes, instructor. (*American Heritage Dictionary of the English Language*, 4th ed., 2003)
- Senior College: A Senior College is a type of higher educational institution, which offers lower division and upper division college-level courses toward four-year, undergraduate, or Baccalaureate degree programs. Senior colleges and universities may also offer graduate degrees and conduct research. Some senior colleges also offer terminal Associate degrees in specialized areas. (Baker, 1994)
- Teacher: A teacher is one who teaches especially one whose occupation is to instruct or one who is hired to teach. A teacher is someone acknowledged as a guide or leader in the processes of learning. (*American Heritage Dictionary of the English Language*, 4th ed., 2003)

- Teaching: Teaching is the process of delivering instruction to learners. It is the process for formal delivery of knowledge and information from teacher to learner. (*American Heritage Dictionary of the English Language*, 4th ed., 2003)
- Trainer: A trainer is a teacher who trains. (*American Heritage Dictionary of the English Language*, 4th ed., 2003)
- Training: Training means to make one proficient with specialized instruction and practice (*American Heritage Dictionary of the English Language*, 4th ed., 2003), or to develop proficient behavior by specialized instruction and regular practice (Simpson and Weiner, 1989). It is a process for the transfer of specified proficiencies or competencies for short-term benefit and application, and is sometimes referred to as "Training and Development." Although training has a role in formal education, it is usually thought of as taking place in industry, business, and government. Training does not lead to a diploma and seldom qualifies for academic credit, but successful trainees may receive a certificate of completion.

CHAPTER II

BACKGROUND AND REVIEW OF THE LITERATURE

Although the multi-disciplinary profession of industrial hygiene (IH) has been established for many years and IH practitioners have been prolific in developing the technical tools for recognition, evaluation and control of workplace hazards, few in the IH discipline have turned the tools and methods of academic research toward the academic curriculum itself. A review of the literature reveals that published research in IH curriculum has been minimal, and that none has considered comparing and contrasting faculty and employer expectations.

The Industrial Hygiene discipline does not enjoy an exclusive degree title. While this research focused on the Master of Science (MS) degree as the primary professional academic degree in Industrial Hygiene, especially in regard to ABET accreditation, industrial hygienists were found to hold other masters-level degrees including, Master of Science (MS), Master of Public Health (MPH), Master of Arts (MA), Master of Engineering, Master of Nursing, and other masters-level professional discipline titles. Collectively, these are referred to herein as “masters-level degrees” or “Master’s degrees.” Information was also collected on associate-level degrees, baccalaureate-level degrees, and doctoral-level degrees, and such were referred to similarly throughout this dissertation. When a specific degree program was discussed, the specific title or acronym was used, for example, Master of Science (MS) degree, or Associate of Arts (AA) degree. This is consistent with the reporting format of the National Center for Education Statistics (NCES) of the U.S. Department of Education, which reports total associate degrees, bachelor degrees, master degrees, and doctoral degrees (NCES, 1998).

Documentation of Professional Competency

The term “professional competency” is defined by the Chartered Institute of Environmental Health (CIEH) as “the completion of tasks to the satisfaction of the employer, client and/or professional peers, within the recognized field of expertise of the profession, using all due care and without serious fault or error” (Barnett, 2000). Most professions strive to document the professional competency of practitioners through licensing, registration, or certification.

The diverse disciplines of environmental health and safety may indeed be one of the most documented of all professional arenas. A cartoon a few years ago in *The Synergist*, a monthly publication of the American Industrial Hygiene Association, illustrated the competency of an industrial hygienist being judged by physically measuring the height of his monumental pile of credentialing documents (*The Synergist*, 1997). The environmental health and safety (EH&S) disciplines, are diligently concerned with the legitimate documentation of the professional competency of practitioners.

Licensure

Derived from the English Common Law, a license is typically a special privilege, granted by the government, to do what otherwise would be unlawful, or prohibited (Breeding, 1999). For example, it is unlawful to drive an automobile without possession of a valid drivers’ license. For the reader who will require empirical evidence, a simple experiment may be in order: the next time you are pulled over by a police officer while driving an automobile on the public roads, try telling the officer that you have no drivers’ license. The rest of us will observe the experiment and objectively note your results. No amount of debate with a police officer at the side of a public roadway will replace the simple possession of a valid drivers’ license.

In practice, a license is an administrative lifting of a legislative prohibition (Breeding, 1999). A legislative body first prohibits the practice of a particular activity, unless a designated administrative agency has specifically lifted this prohibition by its approval, consent, or licensure. Government regulation of the activity is achieved by putting restrictions or conditions on the granting of the license. The imposed conditions may include specified education, training, insurance, facilities, equipment, experience, moral character, legal status, age, financial solvency, etc. Thus, a license serves to regulate an activity by placing conditions on the entering of the licensed activity; and, as a condition of accepting the license, the individual consents to the on-going control of his/her activities by the agency. Here again, consider our simple drivers license example — what conditions or limitations have been placed on your drivers' license?

Registration

Historically, prior to World War II, a registration was a mere device for record keeping and informational purposes (Breeding, 1999). Persons entering a particular field were required to register with a designated authority. Originally, anyone was free to engage in the particular activity, but having entered upon it was obligated to inform the authority of that fact — to tell the authority what he/she was doing, who he/she was, and where he/she was located — in order that representatives of the authority could inspect the activity. A registration was different from a license in that it imposed no prior conditions or restrictions on entering the activity.

The Blending of Licensure and Registration

The lay public tends to use the terms licensure, registration, and certification as interchangeable, but they are quite distinct and different. In recent years, governments have increasingly imposed conditions and restrictions upon registrations, thus obscuring the distinction between true registration and licensure in many arenas (Breeding, 1999). Licensure gives considerably more assurance to individuals entering a field or activity than registration. From the standpoint of public protection, licensure, by limiting entry into an activity to qualified practitioners, can be more effective than a simple, barrier-free registration (Breeding, 1999). In activities of little or no risk to the public, registration may serve a useful function if precautions are incorporated to prevent it becoming a program of quasi or de facto licensure (Breeding, 1999).

Credentialing to Document Professional Competency

Various state laws, to ensure practitioners possess professional competency in specific disciplines, mandate licensing, and registration of many professions. In general, to qualify for registration and licensing, the individual must satisfactorily complete a specified program of approved academic study, meet certain experience requirements, and pass a discipline-specific examination. From the Texas Engineering Practices Act of 1998, a general example here would be mechanical engineers, who must earn an undergraduate degree in mechanical engineering from an American Board of Engineering Technology (ABET) accredited university engineering program to qualify to take the professional engineering examination from their state board. Upon satisfactory completion of the examination process and meeting experience requirements, the new mechanical engineer is licensed by his/her state board to practice mechanical engineering within that state and to use the designation "Professional Engineer (PE)." Some Boards refer to the "PE" credential as a license and others as a registration; but, as can be seen from the original definitions of the terms, the "PE" credential is typically licensure due to the presence of legislatively imposed conditions and restrictions.

In Tennessee, those practicing in the area of environmental and occupational health may pursue licensing as a "Registered Professional Environmentalist (RPE)" from the Tennessee Board of Health-Related Professions. Also in Tennessee, a designated professional board oversees the specific practice of industrial hygiene; applicants successfully meeting state-prescribed criteria are authorized by the board to use the credentials "Registered Industrial Hygienist (RIH)" or "Registered Professional Industrial Hygienist (RPIH)" under the state-prescribed guidelines. This is an example of title protection legislation in the industrial hygiene profession.

State title protection laws affecting the practice of industrial hygiene have been adopted by thirteen states: Alaska, California, Colorado, Connecticut, Florida, Illinois, Indiana, Minnesota, Nebraska, Nevada, New Jersey, North Carolina, and Tennessee (Gibbs, 1999). Since publication of the Gibbs article, three other states — Ohio, Oregon, and Texas — have adopted such legislation. Other examples of state licensed or registered professionals include medical doctors (MD), nurses (RN), physical therapists (PT), sanitarians (RS), and lawyers. Many trades are similarly licensed by the states, including: contractors, plumbers, electricians, asbestos & lead abatement technicians, cosmetologists and others. More recently, several states are considering registration of mold investigators and remediators. State registration and licensing requirements vary somewhat from state to state, and several states maintain reciprocity agreements for some disciplines.

Voluntary Certification

Where practice in a discipline is not state-regulated, many professions have established mechanisms to document the professional competencies of their practitioners through the process of voluntary certification. Thus, in specialty professions where licensing and registration are not legislatively mandated, voluntary professional certification allows the practitioner to demonstrate and to document his/her professional competency. Examples here include the "Certified Public Accountant (CPA)" and the "Associate Risk Manager (ARM)," as well as many areas in the environmental health and safety-related disciplines. One study published in 1992, identified over 90 volunteer specialty credentials within the environmental health and safety-related disciplines (Meech, 1992). New EHS-related credentialing programs have been reported as "appearing at a rate of six to eight a year" (Meech, 1992; Johnson, 1989). Among the more widely-recognized of these EHS-related credentials are: "Certified Industrial Hygienist (CIH)," "Certified Safety Professional (CSP)," "Certified Safety Executive (CSE)," "Certified Safety Manager (CSM)," "Registered Environmental Manager (REM)," "Certified Environmental Health Scientist (CEHS)," "Registered Environmental Health Specialist (REHS)," "Certified Hazardous Materials Manager (CHMM)," "Certified Hazard Control Manager (CHCM)," "Certified Professional Ergonomist (CPE)," and "Certified Environmental Trainer (CET)."

In the professional practice of industrial hygiene, the most recognized credential is the "Certified Industrial Hygienist (CIH)," as administered by the American Board of Industrial Hygiene (ABIH). In March of 1996, Janette Hough reported on a disturbing trend in the CIH examination process. In 1979, the pass rate for the core examination was 76 percent; however, in 1995, the pass rate had declined to 43 percent (Hough, 1996). For the comprehensive examination, the pass rate declined from 63 percent in 1979 to 39 percent in 1995 (Hough, 1996). Lynn O'Donnell, Executive Director of the ABIH, has attributed the declining examination scores to "the IH profession's move toward specialization, examinees having more narrow field experiences, a growing emphasis on specific compliance issues, a larger pool of applicants, the growing popularity of the certification itself, poor study habits, a decline in mentoring, and poorly prepared applicants" (Hough, 1996). Although academic degree programs are not intended as certification examination preparation programs, the decline in CIH examination scores indicates additional justification for incorporation of critical core competencies into IH curricula.

Employing a method of formal or informal certification has been a common mechanism for many years for raising the standards of a discipline (Breeding, 1999). Certification has proven quite effective when based upon objective needs analysis and progressive standard setting. Certifying bodies must exercise great care not to set voluntary certification standards so high that there is little or no interest in pursuing the certified status. Conversely, certification standards must not be set so low that individuals can easily achieve certification, as this defeats the intent of raising a discipline's minimum standards to a higher level. Industrial hygiene academic programs have a vital role in ensuring that IH graduates entering professional practice possess the core competencies to achieve credentialing through discipline-related licensure, registration, and certification programs.

The Council of Engineering and Scientific Specialty Boards (CESB) was established in 1990 for the purpose of evaluating and accrediting certification programs. The CESB is an independent, voluntary membership body created for its member organizations that recognize, through specialty certification, the expertise of individuals practicing in engineering and related scientific and technical fields. Its creation was the culmination of work by volunteers representing 23 organizations who participated in the April 1988 National Conference on Engineering Specialty Certification (ECTF, 2006). In February 2006, the CESB Engineering Certification Task Force (ECTF) released its report, "Integrating Certification & Licensing for Engineers and Related Specialists," which provides a policy basis on how licensed professionals can appropriately use voluntary professional credentials to demonstrate competency in areas not addressed in traditional licensure examinations (ECTF, 2006). Licenses are required by statutory mandate, and credentials are voluntary. However, the CESB holds that licensure and certification are similar in several ways. Both objectively assess an individual's capabilities, protect the public from unprofessional practices, and enhance the stature of practicing professionals. Professional credentials have the ability to focus on narrow specialties that do not involve large segments of a profession as is commonly required of licensure, and the CESB policy is intended to help reduce the needless, redundant, and expensive competition between licensing and credentialing bodies (ECTF, 2006).

Accreditation Standards for Academic Programs

Industrial hygiene academic programs are accredited by the Related Accreditation Commission (RAC) of the American Board of Engineering and Technology (ABET, 1997a). ABET evaluates and accredits the traditional engineering disciplines, as well as several non-engineering "applied science" disciplines, including Industrial Hygiene.

The ABET-RAC guidelines for IH academic curricula are to a large extent non-exact, specifying, for the Master of Science (MS) degree, a minimum of 30 semester hours, including a minimum of 18 hours of "engineering-related science" (IH Science) and "engineering-related specialties" (IH Practice), and 12 hours of "unspecified" courses intended to allow freedom to meet stated objectives without constraint by the accreditation process (ABET, 1997b). The intent of the unspecified course block was to allow for unique secondary emphasis beyond the primary IH specialization. The ABET-RAC guidelines for accreditation of IH curricula were primarily based on a position paper entitled "Program Criteria for Industrial Hygiene and Similarly Named Engineering-Related Programs," prepared in 1985 by the Accreditation Committee of the American Academy of Industrial Hygiene (AAIH, 1985). ABET-RAC guidelines for IH baccalaureate degree programs specify a minimum of 120 semester hours; with a minimum of 15 hours of IH science, 15 hours of industrial hygiene practice, and 15 hours of technical subjects (ABET, 1997b).

In 2000, there were 26 ABET-accredited masters-level graduate programs in industrial hygiene, and 5 ABET-accredited baccalaureate-level undergraduate programs in industrial hygiene (ABET, 2000). A sixth undergraduate program initiated the ABET accreditation process in 2002, but withdrew before completing the evaluation process. As of October 2007, ABET listed 24 Masters-level programs and 5 Baccalaureate-level programs (ABET, 2007). ABET-RAC does not currently accredit either IH associate degree or doctoral degree programs.

What Is Industrial Hygiene?

Graduates of IH academic programs, their faculty, and their prospective employers, have difficulty identifying just what IH practice is and what common core competencies are expected from graduates of any IH academic program. To date, no discoverable research has been published on IH faculty expectations of graduates' core competencies. Only one study has been published on employer expectations of graduates' competencies. (Oestenstad et al, 1994). Oestenstad reported on the results of earlier demographic studies of AIHA members from 1967 and from 1987, and an American Conference of Governmental Industrial Hygienists (ACGIH) study from 1988, where organization members were surveyed regarding the minimum academic qualifications and course requirements for admission for the CIH examination. The results were not compared with then-current academic curricula.

Industrial hygiene (IH) is a multi-disciplinary profession, which encompasses both the art and science of anticipation, recognition, evaluation, and control of risk factors arising in and from the course of employment, that adversely affect physical, mental and social health and well-being (Plog et al, 1996; Brown and Gertz, 1975). The AIHA Membership Directory in the mid-1990's identified industrial hygiene as "… that science and art devoted to the anticipation, recognition, evaluation, and control of those environmental factors or stresses arising in or from the workplace that may cause sickness, impaired health and well-being, or significant discomfort among workers or among the citizens of the community" (Plog et al, 1996; Brown and Gertz, 1975). In November 2007, AIHA modified the definition and role of Industrial Hygiene on their membership web site:

> Industrial Hygiene is Science and art devoted to the anticipation, recognition, evaluation, prevention, and control of those environmental factors or stresses arising in or from the workplace which may cause sickness, impaired health and well being, or significant discomfort among workers or among citizens of the community.
>
> Industrial hygiene is the science of keeping people safe at work and in their communities. Industrial hygienists (IHs) are professionals dedicated to the health and well-being of workers. Originally, industrial hygienists worked primarily in factories and other industrial settings but as our society has changed, so has the definition of industrial hygiene. Today, IHs can be found in almost every type of work setting.
>
> Industrial hygienists are scientists and engineers committed to protecting the health and safety of people in the workplace and the community. Industrial hygiene is considered a "science," but it is also an art that involves judgment, creativity, and human interaction.
>
> The goal of the industrial hygienist is to keep workers, their families, and the community healthy and safe. They play a vital part in ensuring that federal, state, and local laws and regulations are followed in the work environment. (AIHA, 2007)

Thus, Industrial Hygiene (IH) is indeed a uniquely interdisciplinary field, based in science, engineering, and preventive medicine.

Industrial hygiene developed from the disciplines of public health and preventive medicine, and has been defined as man's first line of defense against work-related illness and injury (Brown and Gertz, 1975). The goal of industrial hygiene practice is to plan and implement preventive intervention(s) between the risk factor and the worker, and, thus, reduce unnecessary employee exposure to harmful substances in the occupational workplace and its adjacent communities (Brown and Gertz, 1975). Over the years, far too many IH graduates have entered the workplace with limited views of the scope of their responsibility and of the expectations of their employers. In practice, industrial hygiene draws upon the techniques, knowledge, and skills across all known professions and disciplines in its quest to abate work-related disease and injury, ideally via pre-exposure intervention (Brown and Gertz, 1975).

The American Industrial Hygiene Association (AIHA), founded in 1939 at a major peak of U.S. industrialization (AIHA, 1994), is the preeminent professional organization for the IH profession. AIHA founding member, W.A. Cook, estimated that in the late 1930's there were about 300 practitioners of IH in the nation, and no single professional organization at that time was devoted exclusively to IH concerns (AIHA, 1994). By 1938, many pressing needs to develop the discipline of IH motivated the Board of the American Association of Industrial Physicians and Surgeons (AAIPS) to organize a permanent "American Conference on Occupational Diseases" composed primarily of "non-medical industrial hygienists" with Dr. C.P. McCord as chair (AIHA, 1994). McCord subsequently proposed an autonomous, independent association of such non-medical industrial hygienists (AIHA, 1994), which has evolved into the current American Industrial Hygiene Association.

Why Study History?

In 1905, G. Santayana wrote, "Progress, far from consisting in change, depends on retentiveness ... Those who cannot remember the past are condemned to repeat it" (Lachs, 2000). In addition, when asked why he studied history, K. Macleod wrote:

> I study history because the truth is more interesting and ultimately more instructive than a farrago of fable. I have acquired the taste, not just for truth but also for detail, for the particular pleasure that comes from seeing the real relationship between events in terms of cause and effect rather than narrative convention. It's a satisfaction, which I'll defend as genuinely scientific.

> The argument that those who do not learn from history are doomed to repeat it fails to impress most people, convinced as they are that there is no risk whatsoever of history's more ruinous errors being repeated. So I have to reach for the argument that real history told a better story because it is a truer story; that reality has its own beauty, sterner and higher that that of myth (Macleod, 1999, p. 134-7).

Thus, a brief consideration of the history of Industrial Hygiene education is appropriate herein.

A Brief History on Industrial Hygiene Education

The literature is not replete with materials relative to the education of industrial hygienists. The literature from 1900 to 1970, in reference to education as preparation for careers in occupational safety and health, primarily refers to the disciplines of safety engineering and industrial safety; with IH as a one or two course component element, if IH was included at all (Heinrich, 1959; Rockwell, 1962; Harper, 1962; Tarrants, 1963; Mason, 1963; ASSE, 1966a; ASSE, 1966b; ASSE, 1968; Vernon and Mayyasi, 1970; Nietschmann, 1970). In this era, academic programs in safety were frequently sub-emphasis areas and/or course offerings in disciplines such as Industrial Engineering and Industrial Education. Health-related topics were most often addressed in medical school curricula.

Although adverse effects associated with occupations were recognized early in history, there was little concern for protecting the health of workers prior to about 1900. Hippocrates first recognized lead toxicity early in the fourth century, B.C. (Asimov, 1982). He recorded gastrointestinal and neurological disorders among miners exposed to lead dust. About 500 years later, a Roman scholar, Gaius Plinius Secundus, better known as Pliny the Elder, noted the dangers in working with zinc and sulfur, and described a protective mask that could be used by laborers exposed to large amounts of dust or lead fumes (Lendering, 1964). In the second century, Galen, a Greek physician serving in the imperial Roman court of Emperor Marcus Aurelius, recognized the dangers of acid mists to copper miners (Moore, 1997).

The next major historical achievement in the field of Industrial Hygiene was Ulrich Ellenbog's writing on occupational diseases and his notable hygiene instruction. O*n the Poisonous and Noxious Vapors and Mists of Metals*, written in 1437, but not published until 1524, was used extensively by metal workers to protect themselves against the effects of silver, mercury, and lead fumes (Gochfield, 2005). In *De Re Metallica* (*The Nature of Metals*) in 1556, Italian physician and mineralogist Georgius Agricola described occupationally acquired asthma and ulceration of the lungs attributed to toxic dusts, and suggested preventive ventilation and protective masks for miners (Agricola, 1556). Agricola's complete and systematic treatise on mining and metallurgy of the time, also described mining accidents and documented the earliest known account of silicosis, a disease of the lungs resulting from inhalation of silica or quartz dust (Agricola, 1556). After Agricola came Philippus Aureolus Theophrastus Bombastus von Hohenheim-Paracelsus, who is recognized as having laid the foundation for the study of modern toxicology. It was Paracelsus who established the dose-response relationship with respect to toxic substances; his famous comment on this relationship is that "It is the dose that makes the poison" (Casarett et al., 1986). Paracelsus contended that:

- "experimentation is essential in examination of responses to chemicals;
- one should make a distinction between therapeutic and toxic properties of materials;
- these are sometimes, but not always, indistinguishable except by dose; and
- one can ascertain a degree of specificity of chemicals and their therapeutic or toxic effects" (Casarett and Doull, 1986).

Further contributions were made in the mining and mining-related industries. One example is an excellent clinical description of respiratory diseases in smelter workers caused by excessive exposure to silica and lead. Describing “miner's phthisis,” or shortness of breath, physician Samuel Stockhausen in 1656 wrote, "Prophylaxis rather than remedies should be used so that fogs, vapors, and metal dust be avoided and the miners try to preserve their strength" (Brown and Gertz, 1975).

Great contributions were made during the 18th century by Bernadino Ramazzini, an Italian physician, considered by some as the father of modern occupational medicine (Franco, 1999). Ramazzini wrote a groundbreaking book, *Treatise on the Diseases of Artisans*, in which he related disease processes to hazardous exposures in numerous trades. Published in 1700, it contains such accurate descriptions of certain diseases that its contents are valid today. In addition to identifying and investigating occupationally acquired diseases, he recommended prophylactic measures such as bathing, changes of clothing, and covering the mouth with fabric to prevent inhalation of dusts (Franco, 1999). He suggested moderation in working as the best safeguard against occupational illness. Ramazzini anticipated the need to limit the exposure time to a hazard as a measure to prevent injuries. Periodic interruption of working activity and shorter duration was recommended to prevent eye injuries among artisans who made very small objects, and for a number of jobs requiring a standing position or severe muscular effort, including bricklayers, woodworkers, and printers (Franco, 1999).

The 18th century saw many notable physicians scratching the surface of the industrial hygiene problem. Sir George Baker correctly attributed a condition, known then as "Devonshire Colic," to lead in the cider industry and was instrumental in its removal (McConaghey, 1967). Sir Percival Pott, in recognizing soot as one of the causes of scrotal cancer, was a major force in the passage of the *Chimney-Sweep Act of 1788* (Legge, 1955). The observed relationship between scrotal cancer and exposure to coal tar products is significant as the first evidence of carcinogenicity resulting from occupational exposure. It is now well known that the carcinogenic substance responsible is 3,4-benzpyrene ($C_{20}H_{12}$), C.A.S. No. 50-32-8 (Casarett and Doull, 1986).

The next significant legislation, *The Health and Morals of Apprentices Act of 1802*, which protected workers in the textile industry, had four fundamental preventive provisions: it limited the workday to 12 hours, prohibited night work, required that ventilation be provided, and required that the walls be washed at least twice a year (Brown and Gertz, 1975).

Two Factory Acts succeeded the Health and Morals Act. *The Factory Act of 1833* limited the hours of work for children and provided for mandatory inspections in certain factories and industries (Brown and Gertz, 1975). It was one of the first demonstrations of government interest in the health of workers. It has been considered one of the first effective legislative acts that required some concern be given to the working population, as it provided compensation for accidents rather than controlling the causes of these accidents. *The Factory Act of 1867* broadened coverage to include industries and businesses employing more than 50 persons (Brown and Gertz, 1975). It also prohibited the eating of meals in noxious plant environments, provided for machine guarding, and required mechanical ventilation for control of injurious dusts.

The term "*industrial hygiene*" may have been first used as early as 1910, by the U. S. Public Health Service and the U. S. Bureau of Mines in reporting the first exploratory studies in the mining and steel industries (NIOSH, 1973). The New York Department of Labor and the Ohio Department of Health promulgated the first state-level IH programs in 1913 (NIOSH, 1973). "It is not certain who coined the phrase '*industrial hygiene'*; however, prior to 1900 it does not appear to have been used widely. Nevertheless, there were a number of individuals, particularly physicians and engineers, who practiced their profession in the context of occupational health during this time" (Perkins, 1997).

In 1918 Dr. Alice Hamilton, a physician with the U.S. Department of Labor, was appointed as the first female faculty member at Harvard University (Hamilton, 1943). In her autobiography, *Exploring the Dangerous Trades*, Dr. Hamilton described the difficulties she experienced incorporating occupational health, industrial medicine and preventive medicine into the curriculum of the Harvard Medical School (Hamilton, 1943). Today, Dr. Hamilton's legacy remains embodied in the Industrial Hygiene Graduate Program at the Harvard School of Public Health (Harvard, 2002). The Harvard Industrial Hygiene Program, established in 1921, and first offered in 1922, as a medical specialty in "*Industrial Health*," is recognized as one of the earliest Industrial Hygiene academic programs. Dr. Hamilton's autobiography stands as one of the earliest documents in the literature of Industrial Hygiene education. Dr. Hamilton first used the term "*industrial disease*" in 1910 (DiNardi, 1997). Vernon Rose has stated, "On an individual basis, Dr. Hamilton's work, which comprised not only the recognition of occupational disease, but the evaluation and control of causative agents, should be considered as the original practice of industrial hygiene..." (Rose, 1997).

France, Germany, and the United States began passing public health and safety-related laws during the 20th century. The first significant occupational disease legislation in the U.S. was the *Walsh-Healy Public Contracts Act of 1936* (Brown and Gertz, 1975). With wartime activities escalating, this act made it mandatory for any company supplying goods and services to the U.S. government to maintain a safe and healthful work environment. Portions of this act were ultimately included in the *Occupational Safety and Health Act of 1970*.

In the interim, significant legislation relative to the mining industry was enacted. The *Metal and Non-Metallic Mine Safety Act of 1966* required mandatory reporting of accidental injuries and occupational diseases and provided for education and coordination between state and federal inspections (Brown and Gertz, 1975). The *Coal Mine Health and Safety Act of 1969* attained the highest degree of protection for miners to that time. It contained mandatory health standards, provided for the creation of an advisory committee to study mining hazards, and protected miners from imminent danger (Brown and Gertz, 1975). A provision of this act gave the federal government the power to withdraw miners found to be in danger from any mine and to prohibit reentry until safety was established.

In late December 1970, President Richard Nixon signed *Public Law 91-596* into federal law as *The Williams-Steiger Occupational Safety and Health Act of 1970* (OSHA); it became effective on April 28, 1971. It was the most comprehensive and extensive law of its kind to be enacted in the U.S. Its basic philosophy was "...to provide for the general welfare to ensure so far as possible every working man and woman in the nation safe and healthful working conditions and to preserve our human resources." This is referred to as “the general duty clause” (§ 5(a)(1)), and it is used when specific reference to a hazard or situation is not included in OSHA.

The *Occupational Safety and Health Act* (OSHA) applied to all employers and employees associated with businesses "affecting interstate commerce." It required the employer to provide a place of employment free from recognized hazards that cause or are likely to cause death or serious physical harm to employees. It further required employers to comply with occupational health standards set forth by the U. S. Department of Labor under the provisions of OSHA. The employee is compelled under OSHA to comply with these regulations as they apply to his/her own actions and conduct. The act provided exemptions from certain reporting and record keeping requirements for employers with ten or fewer employees.

Following promulgation of the *Occupational Safety and Health Act* in December 1970, the literature began to indicate a trend toward emergence of the various safety-related course offerings into the newly coined disciplines of occupational safety and occupational health (Beyers, 1970; Magnuson, 1970; Berry, 1971; Corn, 1971; Seagle, 1971; Vernon, 1971; Key, 1971: Kusnetz, 1971; Vernon and Konzen, 1972; Vernon and Konzen, 1973). In the 1970's few published articles specifically addressed IH education.

In 1970, Texas A&M University faculty members Ralph Vernon and Adil Mayyasi, published an article entitled, "*Evaluation and Development of Education for Occupational Safety and Health Professionals*" in the Journal of the American Society of Safety Engineers (Vernon and Mayyasi, 1970). This article reported on the development of the ASSE position on safety engineering education from 1949 to 1970. The article was broad-based, reporting on a survey of the four ASSE-recommended functions of a Safety Professional, on the preferences of graduate engineers for 57 courses in occupational safety and health (OSH), on the preferences of ASSE members for 16 OSH courses, and on the preferences of 83 members of the American Industrial Hygiene Association (AIHA) for 15 courses in industrial hygiene (Vernon and Mayyasi, 1970). The article also identified curricula for BS and MS degrees in Industrial Safety, including graduate programs in systems safety engineering, human factors engineering and industrial hygiene. In evaluating preferences, the authors used the titles of 33 engineering courses then taught at 16 major U.S. engineering schools. The authors identified that the role of the safety professional was to "translate hypothesized optimal solutions into real solutions through implementing these into system designs" (Vernon and Mayyasi, 1970). The authors noted that at Texas A&M University, "consideration is being given to programs in industrial hygiene and industrial safety..." (Vernon and Mayyasi, 1970). (A Master of Science (MS) degree program in industrial hygiene was established in 1972 in the Department of Industrial Engineering at Texas A&M University.) It is interesting to note that, although their course preferences survey ranked courses in management, public speaking and writing as No. 1 and No. 2, respectively, the authors did not include courses in communications, management, or engineering economy in their recommended curriculum models.

In 1972, concerned that students were only able to get professional IH training in graduate school, J.F. Wieser published a curriculum for a Bachelor of Science degree in Occupational Hygiene and Safety, at Wiley College in Marshall, TX in the AIHA Journal (Wieser, 1972). The curriculum included three years of undergraduate college courses with laboratories and exercises with an emphasis on strong science, mathematics and public health, and a fourth year of internship and practical training. The internship called for six months in an occupational health or public safety agency and six months in an industrial or agricultural establishment. In August 1971 Wieser had predicted that, "the working profession and the country will profit by having qualified professionals at a young age, occupational health and safety standards will rise and there will be an increase in productivity and a reduction in cases of occupational disease and injury" (Wieser, 1972). The 2006 catalog for Wiley College did not list a degree program for Occupational Hygiene and Safety, but did identify a Bachelor of Science degree program in Environmental and Biomedical Sciences (Wiley College, 2006).

In 1972 Texas A&M University faculty members Ralph Vernon and Richard Konzen, published the results of a NIOSH-funded study, "*Development of Associate and Baccalaureate Degree Programs for Occupational Safety and Health Personnel*" (Vernon and Konzen, 1972). They reported the results of two focus groups: a safety professionals group and a safety educators group. They also presented model curricula for an Associate of Science (AS) degree and a Bachelor of Science (BS) degree in "*occupational safety & health*." Industrial hygiene education was not addressed as a curriculum component, or as a course/subject in either curriculum.

In 1975, Ralph Vernon published a NIOSH Final Technical Report summarizing research findings that had resulted in development of curricula for occupational safety and health professionals based on task-activity analysis and related performance objectives (Vernon, 1975).

Employment requirements were studied for two occupational safety and health occupations: industrial hygiene and safety. The publication described early curricula for non-credit certificate programs, associate degrees, baccalaureate degrees, and graduate-level education in Occupational Safety and Health, derived from analyses of the tasks and activities of industrial hygienists and safety professionals (Vernon, 1975).

By 1975, industrial hygiene education had emerged from the shadow of safety engineering and occupational safety & health (OSH) programs. Articles addressing aspects of industrial hygiene education began to appear in the literature (Berry, 1975; Hermann, 1975; Corn, 1977; Levine et al., 1977). In 1982, Saltzman addressed IH education in his study of industrial hygiene and occupational safety manpower (Saltzman, 1982). In 1988, Lee and Dunkle addressed the academic qualifications of practicing industrial hygienists in the U.S. (Lee and Dunkle, 1998).

In 1977, Ahmad and Garrett addressed the changing role of the industrial hygienist with increased emphasis on health standards and practices to protect employees in the workplace (Ahmad and Garrett, 1977). They analyzed the occupational health curricula, and recommended increased emphasis on engineering and the physical sciences in preparing industrial hygienists with new techniques and methodologies for better understanding of the origins and effects of pollutants, contaminants, and disease vectors on the human body (Ahmad and Garrett, 1977).

In the 1980's, Heath and Spetz published a series of curriculum resource guides for the Illinois State Office of Education, Division of Adult Vocational and Technical Education (Heath and Spetz, 1980). Their guide on Industrial Hygiene Technology was to be used as the basis for offering industrial hygiene technician curricula at the post high school vocational certificate level and the associate degree level. It identified industrial hygiene technology as an emerging curricula in the U.S. and presented 15 abstracts of curriculum and instructional materials

In the 1990's, only three articles addressing IH education appeared in the literature (Sherwood, 1992; Constantin et al., 1994; Oestenstad et al., 1994). The Oestenstad et al. article attempted to evaluate employers' expectations for competencies of industrial hygienists (Oestenstad et al., 1994). It did not relate IH competencies back to IH faculty expectations for curricula, or to the academic curricula generating the IH graduates. Further, the study's list of IH competencies was not directly related to course titles or subject areas in IH curricula. Sherwood presented a literature review of training and education in the IH profession from 1972 to 1988, and made predictions for future training and education needs that were dependent on the author's assumptions for changes in higher education, engineering education, employment, and industry. He stated:

> Industrial hygienists should provide the unique and special skills required to established economically optimum control systems … Preparation for professional work in industrial hygiene will call for the specialized education of engineers required to design and maintain processes that minimize the use, production, or generation of hazardous materials. The numbers of engineers required to remove such substances from working areas should become a lesser requirement. (Sherwood, 1992, pp. 398-403)

Sherwood's predictions for IH training and education were predicated on his theory that "engineering should provide a broader base for students entering professional education" (Sherwood, 1992). He predicted that by 2020, "engineering will have recovered some of its lost status and be divided into fewer specialized compartments than it is today" (Sherwood, 1992). Sherwood's industrial hygienist of 2020 would be a process design engineer developing control technology to meet prescribed exposure levels and standards. He did not speculate who would prescribe the exposure levels and standards. Further, Sherwood promoted a general engineering technology education supplemented with extensive non-credit training, and proposed a three-track training development program beyond the masters' degree level: a management track, a specialist track, and a research track (Sherwood, 1992).

In July 2001, Virginia Carlson and D. K. Olson reported on the preferences of Midwestern occupational safety and health (OHS) professionals for non-academic, professional development training delivered by "technology-enhanced learning/distance education" (Carlson and Olson, 2001). They concluded that responding Midwestern OHS professionals were highly likely (87.4%) to participate in distance education for continuing education and the pursuit of academic degrees (Carlson and Olson, 2001). Although several universities offer distance education courses in IH, as of this writing there is only one known university degree program in IH offered entirely through distance education. In 1996, the Tulane University School of Public Health implemented an early distance education masters-level degree program in "*Occupational Health and Safety Management*," which included course work in IH. Two years later, in response to market demand, Tulane added a distance learning masters-level degree program in Industrial Hygiene, with options for both Master of Science (MS) and Master of Public Health (MPH) degrees.

In 1999, Freeman and Field described an effort to incorporate the concepts of contextual learning and cognitive apprenticeships into a cross-functional safety curriculum with the Industrial Technology degree program at Iowa State University (ISU) (Freeman and Field, 1999). Cross-functional safety curriculum components, including hazard identification, injury prevention, safe work procedures, personal protective equipment and regulatory compliance, were proposed for inclusion into classes in Occupational Safety, Metallic Materials and Processes, and Manufacturing Processes, within the ISU Industrial Technology degree programs to produce graduates in the industrial technologies capable of practicing safety upon entering the job market (Freeman and Field, 1999). Industrial Hygiene was not addressed in the ISU safety curriculum.

In 2005, faculty at the Midwest Center for Occupational Health and Safety, a 27-year old National Occupational Safety and Health Institute (NIOSH) Educational and Research Center (ERC) at the University of Minnesota, identified 29 crosscutting competencies in four academic programs: Occupational Medicine, Occupational Health Nursing, Occupational Injury Epidemiology, and Occupational Health and Safety (Olson et al., 2005). Industrial Hygiene was a course of study within the Occupational Health and Safety program, but was not a separate curriculum. The authors proposed that the identified competencies be considered for adoption as a set of interdisciplinary core competencies for Occupational Health and Safety professionals (Olson et al., 2005).

In 1995, the World Health Organization (WHO) identified a global shortage of practicing occupational health professionals believed to mirror an unequal distribution of the availability of occupational health services between industrialized and developing nations, (Delclos et al., 2005). Researchers at the Southwest Center for Occupational and Environmental Health at the University of Texas School of Public Health explored three aspects of professional development of international occupational health professionals: 1) current levels of recognition of professional titles, 2) general practice competencies, and 3) availability and extent of academic preparation (Delclos et al., 2005). The authors included industrial hygienists in the survey population of occupational health professionals, but did not address specific IH competencies in the 118 identified competencies for occupational health professionals (Delclos et al., 2005).

IH curricula incorporating critical core competencies and offered via distance education modalities to employed professionals at their place of employment may be the future of industrial hygiene education.

Industrial Hygiene and EHS-Related Degree Programs

Industrial Hygiene and the related Environmental Health and Safety (EH&S) disciplines attract students at all academic levels, provide needed competencies for the workplace, and significantly impact the economy. In 1972, the 14th edition of Macmillan's *The College Blue Book*, listed 114 environmental health and safety (EHS) related named degree programs (CBB, 1972). No IH-named programs were identified in 1972; although two programs in "Industrial Health" were identified, including one at Harvard University and one at the University of Massachusetts (CBB, 1972). In 1997, the 26th edition listed 217 EHS-related named degrees; of these 18 degrees were named "Industrial Hygiene," and 24 were named "Safety" (CBB, 1997). In 2002 the 28th edition listed 681 EHS-related named degree programs, of these 24 were named "Industrial Hygiene" and 34 were named "Safety" (CBB, 2002). In 2007 the 34th edition listed 1,136 EHS-related named degree programs, of these 23 were named "Industrial Hygiene" and 7 were named "Safety" (CBB, 2007).

Constantin et al. surveyed 112 U. S. colleges and universities and identified 54 institutions then providing graduate programs in industrial hygiene (Constantin et al., 1994). For the 1990-91 academic year, the study reported that, of the colleges with IH graduate programs, 37% were located in Public Health, 13% in Medicine/Pharmacy, 11% in Health Sciences, 11% in Engineering, 9% in Health Services, and the remaining 20% in other locations (Constantin et al., 1994). They reported that, of the undergraduate majors of students entering IH graduate programs, 42% were in the Biological Sciences, 23% in Physical Sciences, 14% in Environmental Health Sciences, 11% in Engineering, 2% in Social Sciences, 3% in Pre-Medicine, 1% in Education, and 4% in other disciplines (Constantin et al., 1994). IH enrollment in 1991 was estimated at 1,585 masters-level students and 103 doctoral-level students

(Constantin et al., 1994). The authors reported that 438 masters-level degrees and 20 doctoral-level degrees were awarded for the 1990-91 academic year (Constantin et al., 1994).

In December of 1998, the National Center for Education Statistics (NCES) of the U.S. Department of Education reported that for CPI code 51.2206, Occupational Health and Industrial Hygiene, 194 degrees were awarded in the 1995-96 academic year, including: 55 associate degrees, 67 bachelors, 68 masters, and 4 doctoral degrees (NCES, 1998). For CPI Code 51.2201, Environmental Health, 754 degrees were awarded, including: 76 associate degrees, 426 baccalaureate degrees, 214 master's degrees, and 38 doctoral degrees (NCES, 1998).

Excellence in Higher Education

Strictly speaking, excellence is perfection. In 1996, Bill Reading of Harvard University wrote that, "*Excellence* serves as the unit of currency within a closed field" (Reading, 1996). In more general terms, we view excellence as the quality of excelling, or the striving for perfection. Excellence begins when we know that being good enough or even competent won't carry the day, when doing more or trying harder won't bridge the gap, when excellence is simply the only alternative. Excellence is a matter of the stand we are, and the stand we take — a stand that allows for performance that surpasses what was previously possible, performance that defies old limits and maps new territory. From the academic point of view, excellence is a grade of "A+," not a grade of "C."

An institution of higher education is a community dedicated to the pursuit and dissemination of knowledge, to the study and clarification of values, and to the advancement of the society (MSCHE, 2006). In the late 1970's and early 1980's, schools, colleges, and universities began to pursue the goal of integrating excellence across the curriculum in higher education. In the U.S., the Middle States Commission on Higher Education (MSCHE) first published *Characteristics of Excellence in Higher Education: Standards for Accreditation* in 1919; the current twelfth edition was published in 2006 (MSCHE, 2006).

In 1995, the European Union formed the Consortium for Excellence in Higher Education (CEHE) to apply the European Foundation for Quality Management (EFQM) Excellence Model to the Higher Education Sector as a strategic tool for performance management and governance, strategic planning, developing key performance indicators, benchmarking, identifying good management practice and for the achievement of sustainable improvement in all aspects of performance (CEHE, 2007).

A commonly held opinion within academia is that academic excellence cannot be achieved and at the same time meet marketplace expectations. However, B.D. Ruben, distinguished professor of communication and organizational psychology and executive director of the Center for Organizational Development and Leadership at Rutgers University, presents an inclusive view of excellence for higher education emphasizing the importance of higher standards in the service and operational dimensions as well as in academics. *Pursuing Excellence in Higher Education* (Ruben, 2003) offers an in-depth examination of the key challenges for the academia. High on his list is a better understanding and addressing the needs of the workplace by bridging the gap between the *World of the Academy* and the *World of Work* (Ruben, 2003).

Initiated in 1997, Texas A&M University's *Vision 2020* is a strategy for attaining the university's plan to become a "Top Ten Public University" by the year 2020 (Vision 2020, 2007). Rather than merely establishing a goal to be recognized for excellence, *Vision 2020* identifies twelve specific areas on which the university will focus, and supports them with imperatives that define clear objectives for achieving excellence across the university's curriculum and community. *Vision 2020* is intended to provide direction to university's actions for achieving *a culture of excellence*. The *Vision 2020* web site states:

> “Excellence in anything is a rare commodity, and unlike many commodities it can disappear if not continually cultivated. Our excellence has grown over our history through the determination of the people who live and work here. We must continue to aspire to be better than we are. One way to say this is that we must continually expect and create a culture of excellence. A culture of excellence will set the tone for our future, build on existing strengths, and recognize our commitment to quality” (Vision 2020, 2007).

Conclusions

Clearly Industrial Hygiene and the related Environmental Health and Safety (EH&S) disciplines attract students at all academic levels and across disciplines, provide needed competencies for the workplace, and significantly influence the economy. Only one published study has attempted to evaluate employers’ expectations for competencies of industrial hygienists (Oestenstad et al, 1994). It did not relate IH competencies back to IH faculty expectations of curricula, or to the academic curricula generating the IH graduates. Further, the study’s list of IH competencies was not related to specific course titles or subject areas in IH curricula. It is thus valid, at this time, to evaluate the expectations and perceptions of both IH faculty and employers, to compare and contrast these expectations, and report the findings and conclusions for use in planning IH curriculum, reviewing ABET-RAC accreditation criteria, providing employers with a basis for evaluating applicants’ core competencies, and providing a foundation for achieving excellence across the curriculum in Industrial Hygiene Education.

CHAPTER III

RESEARCH METHODS

Industrial Hygiene and the related EHS disciplines have been shown to attract students at all academic levels, provide needed competencies for the workplace, and significantly influence the economy. Only one published study has attempted to evaluate employers' expectations for competencies of industrial hygienists (Oestenstad et al, 1994). It did not relate IH competencies to IH faculty expectations of curricula, or to the academic curricula generating the IH graduates. Further, the study's list of IH competencies was not directly related to course titles in IH curricula. It is thus valid, at this time, to evaluate the expectations and perceptions of both IH faculty and employers; to compare these expectations; and, to report the findings and conclusions for use in planning IH curriculum, revising ABET-RAC accreditation criteria, and providing employers with a basis for evaluating applicants' core competencies.

Methodology of This Research

A research design refers to "the arrangements of conditions for collection and analysis of data in a manner that aims to combine relevance to the research purpose with economy in procedure" (Sellitz et al, 1976). The purpose of this research was to identify and assess the expectations and perceptions of IH faculty and employers in the areas of curriculum content and structure. To achieve this purpose, the expectations and perceptions of industrial hygiene faculty were compared with those of employers of graduates of IH degree programs. The findings of this research serve to identify a common core curriculum base and allow emphasis of the individual programs' unique strengths, while maintaining core competencies across the curriculum.

The Study Design

This research surveyed industrial hygiene faculty and employers, assessed responses, and reports on the research findings. It was a purposive study, and directly targeted the entire populations of two tightly defined groups: IH teaching faculty, and employers actively seeking to hire IH graduates. The use of survey questionnaires was determined the most feasible strategy for eliciting information regarding the expectations and perceptions of the identified study populations in the areas of IH curriculum.

Two survey instruments — Survey A of IH faculty and Survey B of IH employers — were developed and delivered to samples of the identified, affected IH populations. Survey A assessed faculty respondent demographics, assessed current IH degree programs and curriculum planning practices, assessed respondent readiness for distance learning, and assessed respondent expectations for the core technical content of IH curricula. Survey B assessed employer respondent demographics, assessed respondent readiness for distance learning, assessed respondent expectations for the core technical IH curriculum content, and assessed respondent expectations for non-technical competencies and attributes of graduates of IH degree programs. Additionally, Survey B requested respondents to identify the Standard Industrial Classification (SIC) for their industry.

The survey design was developed in accord with methods in *The Survey Systems Design Manual* (Creative Research Systems, 2006) and in *The Total Design Method: Mail and Telephone Surveys* (Dillman, 1978).

To achieve the research objectives, the survey instruments addressed the following areas:

1. Participant demographics (faculty & employer)
2. Academic program/employer characteristics

3. Readiness for “high-tech” distance learning in IH education
4. Curriculum: planning & development inputs
5. Curriculum: subject/competency preferences
6. Emerging issues impacting IH curriculum development

Nature of the Sample

The survey instruments were delivered to samples of the identified, affected IH populations. Survey A was delivered to participants in the Academic Special Interest Group (ASIG) of the American Industrial Hygiene Association. The ASIG was founded at the 1997 American Industrial Hygiene Conference and Exposition (AICH&E) in Dallas, TX. Its participants represented faculty at 79 college and university academic degree programs in IH and closely related EHS disciplines, in the United States and Canada. Survey A was distributed to 46 faculty attending the 2000 ASIG meeting; 37 faculty completed the survey, for an 80% response rate. At the time, total ASIG membership was 61, indicating the sample represented 61% of the population of interest.

Survey B was delivered to the prospective employers of graduates of industrial hygiene degree programs participating in the AIHA Employment Services Job Fair at the 2000 AIHC&E. The AIHA Employment Services Committee provided addresses for 135 employers who registered for the Job Fair; survey forms were mailed to 110 verified and valid addresses. Addresses were verified using the U.S. Postal Service on-line zip code database. Using standard techniques for a mailed survey (Dillman, 1978), three follow up postcards were sent as reminders at two-week intervals. Seventy-seven employers completed and returned the survey, for a 57% response rate from the original 135 names, or a 70% response rate from the 110 valid addresses used. Additionally, Survey B requested employer respondents to identify the Standard Industrial Classification (SIC) for their industry.

Research Subjects

A Human Subjects exempt application was submitted to the Texas A&M University Institutional Review Board (IRB) for Human Subjects in Research. Approval by exemption was received on December 20, 1999. Each participant was informed that no personal identifiers would be connected to their responses in the analysis of data. Such personal identifiers were not captured in the survey by design to ensure maximum confidentiality and minimum intrusion. Participants were notified of the purpose and intent of the research to ensure informed consent.

Data Collection Techniques

Survey A contained 31 items, consisting of a mixture of open-response questions, forced-response questions, and matrices of rating or scoring questions; open-ended comments were solicited optionally. Survey B contained 26 items, consisting of a mixture of open-response questions, forced-response questions, and matrices of rating or scoring questions; open-ended comments were solicited optionally.

For some questions, multiple responses were indicated, and, where appropriate, such is indicated in the report tables. With the exception of the academic program characteristics and curriculum inputs, the survey items were designed to correspond to allow for appropriate analysis of the responses.

Method of Analysis

Data from the surveys were assigned values and recorded in a standard coding format for appropriate descriptive statistical analysis and reporting. Values for open-response questions and for forced-response questions were reported and discussed. Values for the matrices of subject matter rating items were ranked using the Springer worker competencies and attributes characterization model, a technique for analyzing forced-response ranking values (Springer et al, 1996), to allow a relative ranking of respondent preferences. The Springer Ranking Value (SRV) is determined to allow the participants' reported preferences for the IH subject areas to be ranked from highest to lowest preference. The Springer Ranking Value calculation is illustrated in Appendix I. Corresponding items were evaluated and resulting values compared to portray agreements and differences.

Correlational analysis was used to measure the degree of association between two variables, i.e., to determine the degree to which the variables are linearly related. Thus, correlation (specifically, the CORR function in the Excel spreadsheet statistical package) was used in this study to evaluate the agreement between the faculty and the employer groups for their preferences and expectations for subject topic (core competencies) content in the Industrial Hygiene curriculum. Interpretation of correlation may vary depending on the type of study, its goals and objectives and its context and purposes.

CHAPTER IV

FINDINGS: EXPECTATIONS AND PERCEPTIONS OF INDUSTRIAL HYGIENE FACULTY

Purpose of Survey A of IH Faculty

The purpose of this research was to identify and assess the expectations and perceptions of IH faculty in the areas of curriculum content and structure. To achieve this purpose, the expectations and perceptions of industrial hygiene faculty are identified and described. The findings serve to describe the academic environment for industrial hygiene education, to identify a common core curriculum base, and allow emphasis of the individual programs' unique strengths, while maintaining core competencies across the curriculum.

In order to achieve the research objectives and respond to the questions posed in Chapter One, Survey A addressed the following areas:

1. Participant demographics: Who is teaching Industrial Hygiene?
2. Academic program characteristics
3. Readiness for "high-tech" distance learning in IH education
4. Curriculum: planning & development inputs
5. Curriculum: subject/competency preferences
6. Emerging issues impacting IH curriculum development

Findings

Participant Demographics: Who is teaching Industrial Hygiene?

Q-A1. What is your position in Industrial hygiene?

As expected, the vast majority of respondents to Survey A were IH faculty. Ninety-two percent indicated they held an academic position, 5% indicated they held a management position, and 3% indicated no response.

Q-A2. Please indicate your number of years practicing industrial hygiene.

IH faculty were quite experienced in the profession, with a total of 709 years reported experience, with a 28 year range from a minimum of 6 years to a maximum of 34 years. The mean was 19.2 years with a Standard Deviation (SD) of 4.43 years. These and other descriptors are shown in Table 1. Figure 1 illustrates the response distribution.

A-Q2 Tests	A-Q2 Stats
Mean	19.16
Standard Error	0.73
Median	19.00
Mode	19.00
Standard Deviation	4.43
Sample Variance	19.58
Kurtosis	5.20
Skewness	0.62
Range	28.00
Minimum	6.00
Maximum	34.00
Sum	709.00
Count	37.00
Confidence Level (95.0%)	1.48

Table 1. Faculty Years in IH Practice.

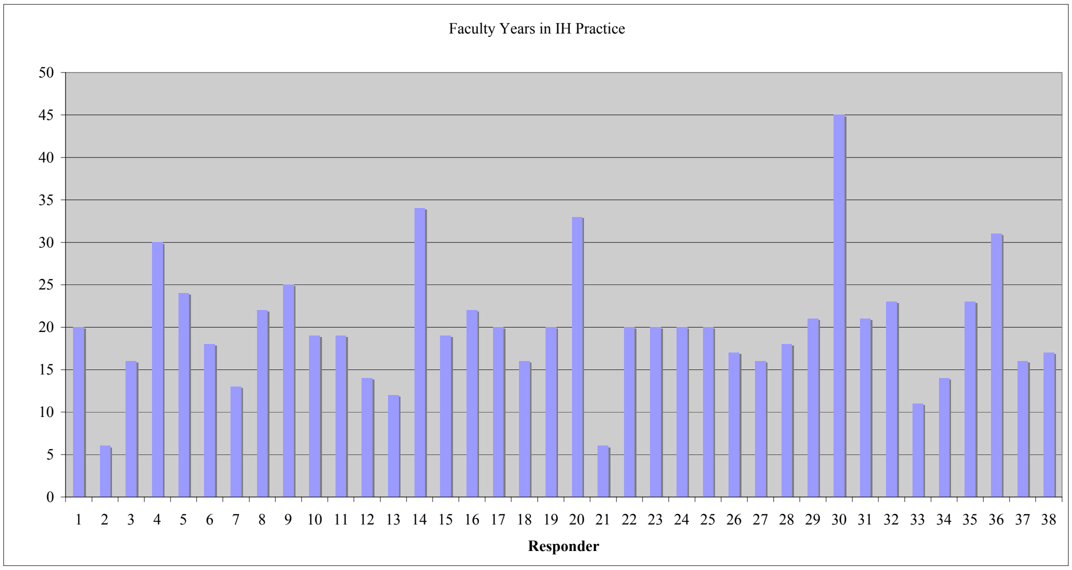

Figure 1. Faculty Reported Years in IH Practice.

Q-A3. What is your specialty area in Industrial Hygiene?

As reported in Table 2, the most frequently reported IH specialties were general/comprehensive practice (29%), environmental health science (11%), exposure assessment (9%), aerosols & bioaerosols (7%), and ventilation (7%). Some respondents indicated more than one specialty practice area.

Specialty	Frequency	Percent
General/Comprehensive Practice	13	29%
Environmental Health Science	5	11%
Aerosols & Bioaerosols	4	9%
Exposure Assessment	3	7%
Ventilation	3	7%
Toxicology	2	4%
Engineering	2	4%
Indoor Air Quality (IAQ)	2	4%
Chemistry	2	4%
Infectious Agents	1	2%
Laboratory Practice	1	2%
Lead	1	2%
Biohazards	1	2%
Modeling & Simulation	1	2%
IH Calculation	1	2%
Epidemiology	1	2%
IH Sampling	1	2%
Ergonomics	1	2%
Total Responses	45	100%

Table 2. Faculty Specialties in IH Practice.

Q-A4. What is the subject area of your academic degrees?

IH faculty is highly educated. Although respondents reported no Associate degrees, 37 reported holding Baccalaureate degrees (Table 3), 37 had master degrees (Table 4), and 37 held doctoral degrees (Table 5). Table 3 shows that baccalaureate degrees were held most frequently in the disciplines of Biology (19%), Environmental Health Science (19%), Chemistry (14%), and Engineering (14%). Table 4 shows that master degrees were held most frequently in the disciplines of Environmental Health Science (43%) and Industrial Hygiene (30%). Table 5 shows that doctoral degrees were held most frequently in the disciplines of Environmental Health Sciences (35%) and Industrial Hygiene (22%).

Baccalaureate Disciplines	Frequency	Percent
Biology	7	19%
Environmental Health Science	7	19%
Chemistry	5	14%
Engineering	5	14%
No Response	4	11%
Industrial Hygiene	3	8%
Occupational Health	1	3%
Physiology	1	3%
Kinesiology	1	3%
Psychology	1	3%
Architecture	1	3%
Microbiology	1	3%
Baccalaureate: Total Responses	37	100%

Table 3. Faculty Baccalaureate Subject Areas.

Master Disciplines	Frequency	Percent
Environmental Health Science	16	43%
Industrial Hygiene	11	30%
No Response	3	8%
Toxicology	2	5%
Occupational Health	1	3%
Safety	1	3%
Architecture	1	3%
Engineering	1	3%
Public Health	1	3%
Masters: Total Responses	37	100%

Table 4. Faculty Masters Subject Areas.

Doctoral Disciplines	Frequency	Percent
Environmental Health Sciences	13	35%
Industrial Hygiene	8	22%
No Response	5	14%
Epidemiology	2	5%
Public Health	2	5%
Engineering	2	5%
Toxicology	2	5%
Chemistry	2	5%
Biology	1	3%
Doctorates: Total Reponses	37	100%

Table 5. Faculty Doctoral Subject Areas.

Q-A5. What is your number of years in academia?

Faculty were quite experienced in academia, with a total of 451 years reported experience, with a 25 year range from a minimum of 1 year to a maximum of 26 years. The mean number of years of experience in academia was 12.19 years with SD of 7.28 years. These and other descriptors are shown in Table 6. Figure 2 shows the distribution of responses.

Academic Program Characteristics Section

Q-A6. What is the number of faculty in your IH program?

Respondents reported 115 IH faculty in the programs represented, from a minimum of 1 to a maximum of 10 faculty members per program. The mean was 3.9 faculty members per program with SD of 1.71. To be eligible for the ABET accreditation an IH academic program must have a minimum of 3 full-time faculty members. These and other descriptors are shown in Table 7. Figure 3 shows the distribution of responses.

A-Q5 Tests	A-Q5 Stats
Mean	12.19
Standard Error	1.20
Median	13.00
Mode	6.00
Standard Deviation	7.28
Sample Variance	52.99
Kurtosis	-1.11
Skewness	0.14
Range	25.00
Minimum	1.00
Maximum	26.00
Sum	451.00
Count	37.00
Confidence Level (95.0%)	2.43

Table 6. Faculty Years in Academia.

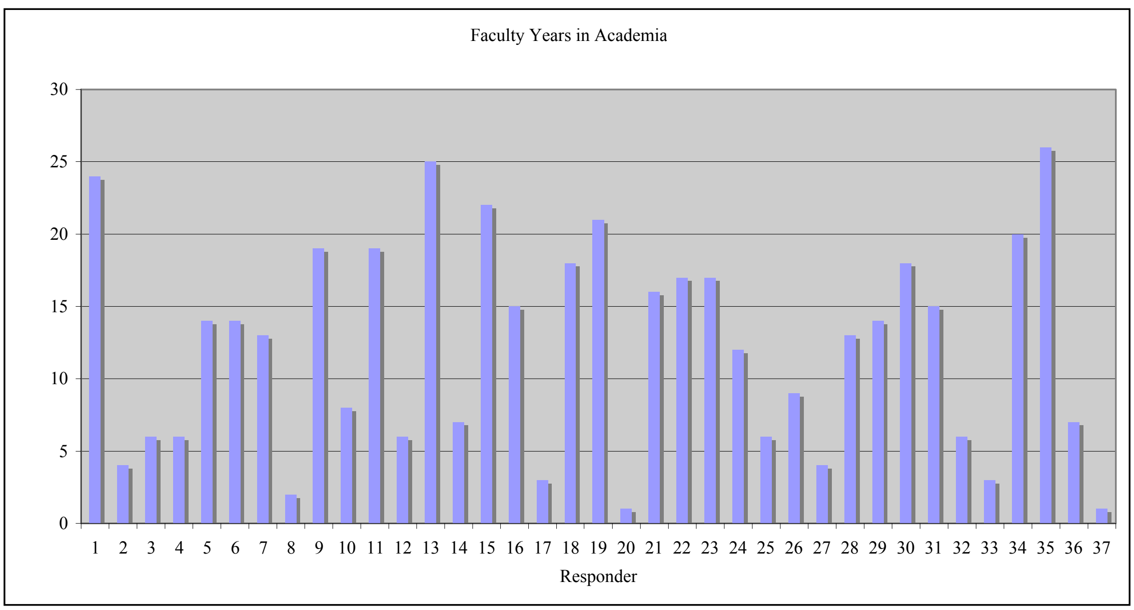

Figure 2. Faculty Reported Years in IH Academia.

A-Q6 Tests	A-Q6 Stats
Mean	3.49
Standard Error	0.30
Median	3.00
Mode	3.00
Standard Deviation	1.71
Sample Variance	2.92
Kurtosis	5.47
Skewness	1.81
Range	9.00
Minimum	1.00
Maximum	10.00
Sum	115.25
Count	33.00
Confidence Level 95.0%)	0.61

Table 7. IH Faculty per Program.

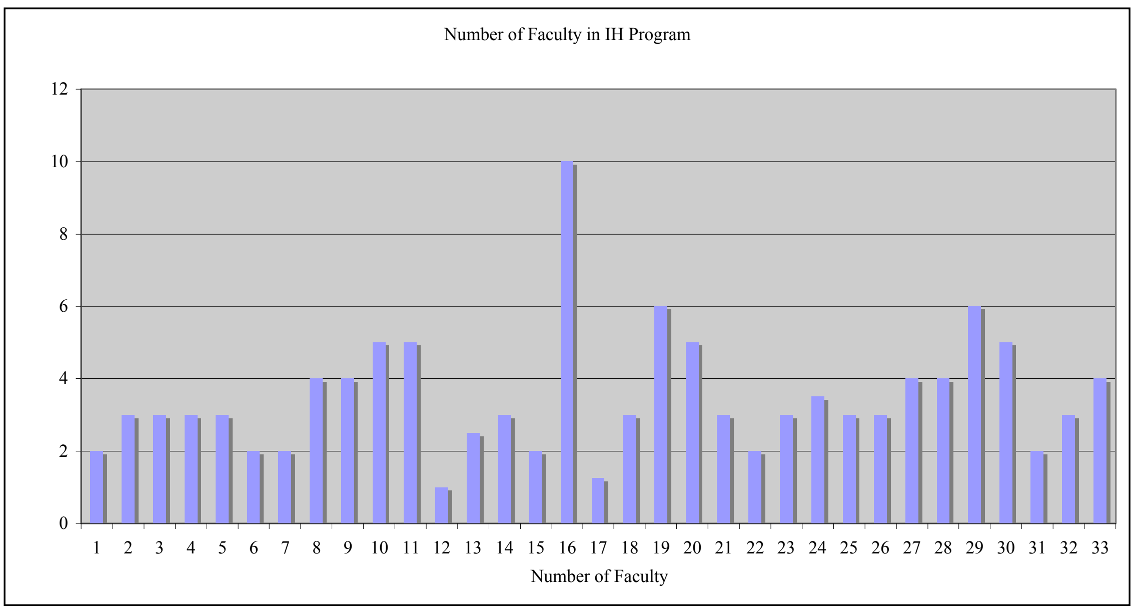

Figure 3. Reported Number of Faculty in IH Program.

Q-A7. What is the number of students in your IH program?

No enrollment was reported in IH Associate degree programs. Fourteen IH Baccalaureate degree programs were reported with 809 undergraduate students enrolled, from a minimum of 10 to a maximum of 180. The mean was 57.79 students per program with an SD of 48.08. These and other descriptors are shown in Table 8. ABET accredits only 5 Baccalaureate degrees in IH, at the time of this study. Figure 4 shows the distribution of responses.

A-Q7b-Bacc Tests	A-Q7b-Bacc Stats
Mean	57.79
Standard Error	12.84
Median	45.00
Mode	25.00
Standard Deviation	48.04
Sample Variance	2308.03
Kurtosis	2.13
Skewness	1.52
Range	170.00
Minimum	10.00
Maximum	180.00
Sum	809.00
Count	14.00
Confidence Level (95.0%)	27.74

Table 8. Baccalaureate Enrollment per Program.

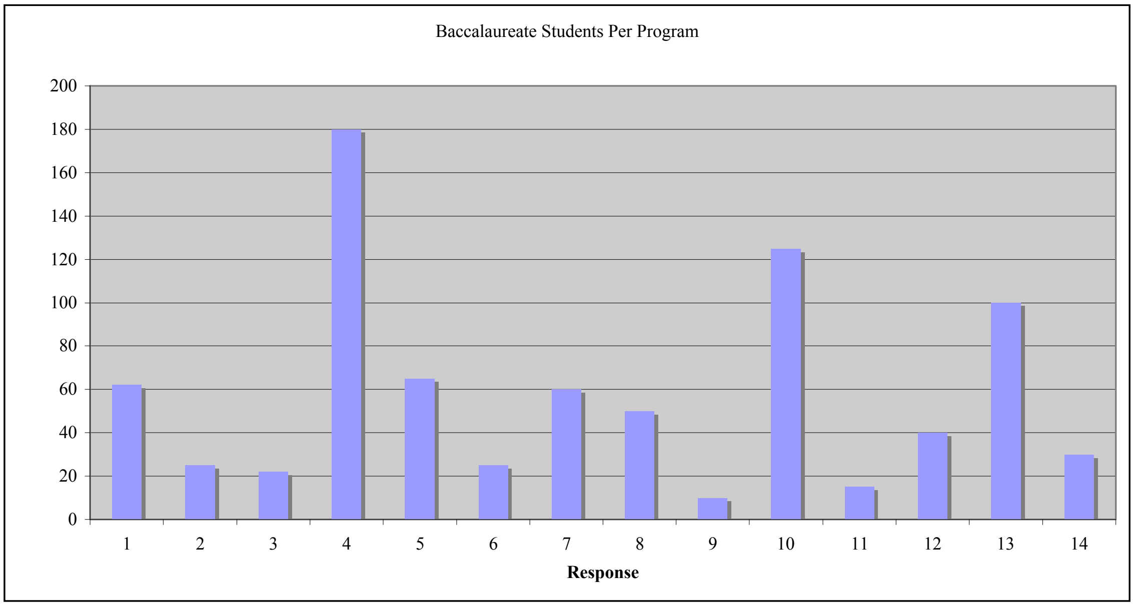

Figure 4. Reported Baccalaureate Students Enrolled per Program.

Twenty-six IH Masters degree programs were reported with 646 graduate students enrolled, from a minimum of 6 to a maximum of 65. The mean was 24.85 students per program with an SD of 16.38. These and other descriptors are shown in Table 9. ABET accredited 23 master's degree programs in IH, at the time of this study. Figure 5 shows the distribution of responses.

A-Q7c-Mstr Tests	A-Q7c-Mstr Stats
Mean	24.85
Standard Error	3.21
Median	22.00
Mode	30.00
Standard Deviation	16.38
Sample Variance	268.46
Kurtosis	1.02
Skewness	1.24
Range	59.00
Minimum	6.00
Maximum	65.00
Sum	646.00
Count	26.00
Confidence Level (95.0%)	6.62

Table 9. Masters Enrollment per Program.

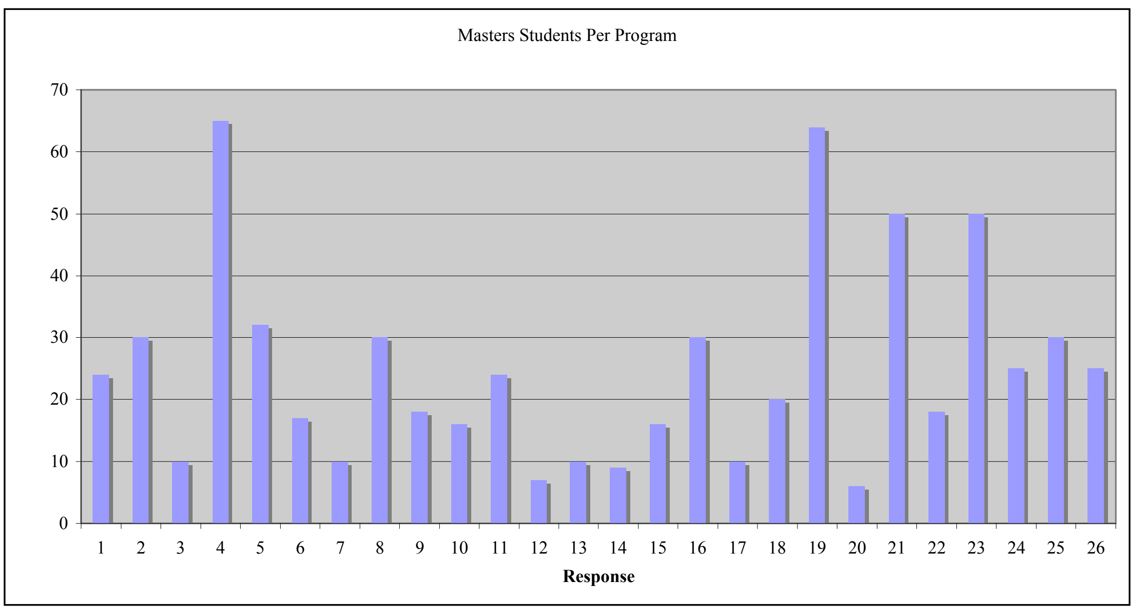

Figure 5. Reported Masters Students Enrolled per Program.

Eleven IH Doctoral degree programs were reported with 55 graduate students enrolled, from a minimum of 2 to a maximum of 10. The mean was 5 students per program with an SD of 2.45. These and other descriptors are shown in Table 10. ABET does not accredit doctoral programs in IH, at the time of this study. Figure 6 shows the distribution of responses.

A-Q7d-Doct Tests	A-Q7d-Doct Stats
Mean	5.00
Standard Error	0.74
Median	4.00
Mode	6.00
Standard Deviation	2.45
Sample Variance	6.00
Kurtosis	0.11
Skewness	0.85
Range	8.00
Minimum	2.00
Maximum	10.00
Sum	55.00
Count	11.00
Confidence Level (95.0%)	1.65

Table 10. Doctoral Enrollment per Program.

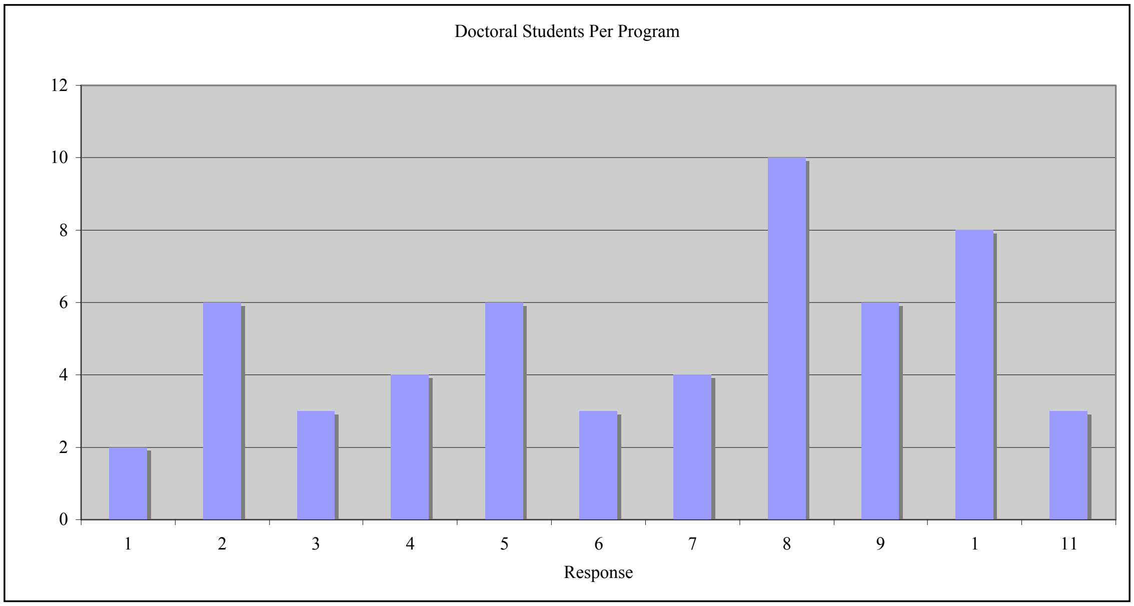

Figure 6. Reported Doctoral Students Enrolled per Program.

Q-A8. What are the common undergraduate majors of students in your graduate program?

The surveyed faculty reported the most frequent undergraduate majors of their graduate students were Biology (28%), Chemistry (19%), Environmental Health Science (18%), and Engineering (13%). Table 11 shows all the reported undergraduate majors and their rate of occurrence.

Undergraduate Discipline	Frequency	Percent
Biology	22	28%
Chemistry	15	19%
Environmental Health Science	14	18%
Engineering	10	13%
Safety	3	4%
Industrial Hygiene	3	4%
Agriculture	2	3%
Occupational Health	2	3%
Geology	2	3%
Liberal Arts	1	1%
Management	1	1%
Other Science	1	1%
Epidemiology	1	1%
Toxicology	1	1%
Total Responses	78	100%

Table 11. Common Undergraduate Majors of Graduate Students.

Q-A9. How is your IH degree program delivered?

Question 9 asked the surveyed faculty to identify the modes by which their IH programs were delivered to students. Table 12 shows that the most common delivery modes were "Traditional, on-campus, day" classes (55%) and "Traditional, on-campus, evening" classes (30%). "On-campus, weekend, or executive" classes and "Distance learning" classes were infrequent, at 8% and 6%, respectively. "Traditional, off-campus" classes in IH were reported as occurring least frequently (2%).

Delivery Mode	Frequency	Percent
Traditional, on-campus, day	29	55%
Traditional, On-campus, evening	16	30%
On-campus, weekend or executive	4	8%
Distance learning	3	6%
Traditional, off-campus	1	2%
Total Responses	53	100%

Table12. Degree Delivery Mode.

Q-A10. Please indicate the general age distribution of you IH students from the listed alternatives {in Q-A10}.

Question 10 asked the surveyed faculty to report on the general age distribution of their IH students. Table 13 shows that IH students were reported as "Well distributed, age-wise" (40%). Thirty-two percent were reported as "Younger, straight through from high school" and 28% were reported as "Older, with some professional experience."

General Age Distribution	Frequency	Percent
Well distributed, age-wise	19	40%
Younger, straight through from high school	15	32%
Older, with some professional experience	13	28%
Total Responses	47	100%

Table 13. General Student Age Distribution.

Distance Education Readiness Assessment Section: Do the employers possess the computer hardware, software, and Internet skills and capacity to be accepting of distance learning in IH education?

Q-A11a. Are you a computer user?

Question 11a asked the surveyed faculty if they were computer users. Table 14 shows that ninety-seven percent reported being computer users.

Computer User	Frequency	Percent
Yes	36	97%
No	1	3%
No Response	0	0%
Total Reponses	37	100%

Table 14. Faculty Computer Users.

Q-A11b. What is your experience (in years) as a computer user?

Table 15 shows that the surveyed faculty are experienced computer users with a total reported experience of 453 years, with a 34-year range from a minimum of 4 years to a maximum 38 years. The mean years of computer experience was 15.62 years, with an SD of 7.01 years. These and other descriptors are shown in Table 15. Figure 7 shows the distribution of faculty reported years of computer use.

A-Q11b-Doct Tests	A-Q11b-Doct Stats
Mean	15.62
Standard Error	1.30
Median	15.00
Mode	15.00
Standard Deviation	7.01
Sample Variance	49.17
Kurtosis	2.98
Skewness	1.24
Range	34.00
Minimum	4.00
Maximum	38.00
Sum	453.00
Count	29.00
Confidence Level (95.0%)	2.67

Table 15. Faculty Years of Computer Use.

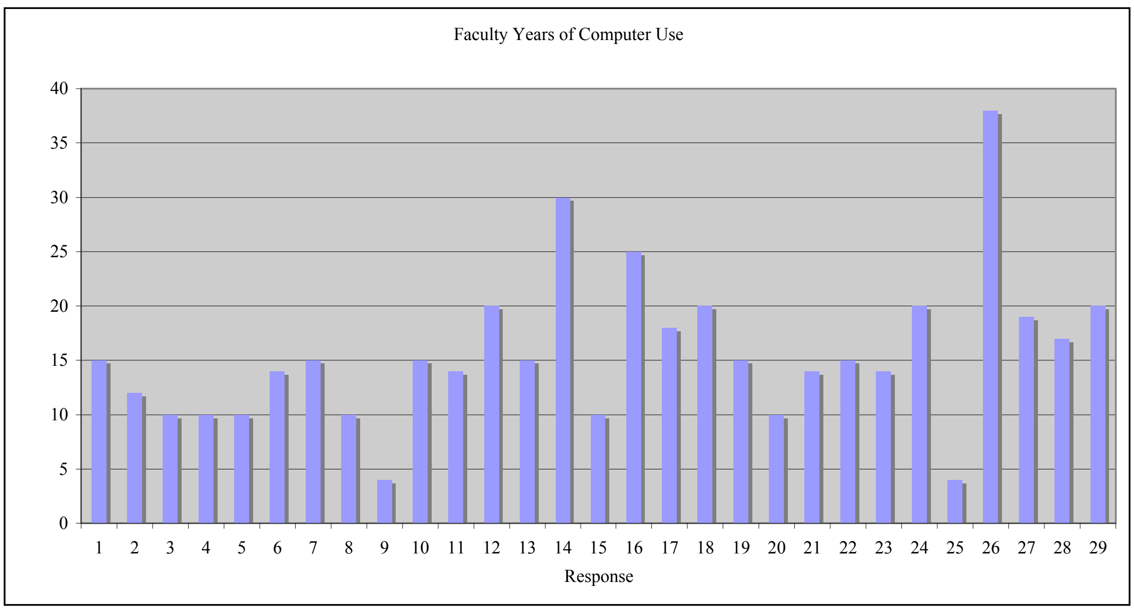

Figure 7. Reported Faculty Years of Computer Use.

Q-A12. What is your preferred computer platform?

Table 16 shows that 73% of the surveyed faculty preferred the “PC” and its clones, and 27% preferred Apple’s Macintosh computers. Seven respondents expressed a preference for both platforms. No respondent reported a preference for other computer platforms.

Response	Frequency	Percent
PC/clone	32	73%
Apple	12	27%
Other	0	0%
Total	44	100%

Table 16. Faculty Preferred Computer Platform.

Q-A13. What is your preferred operating system?

Table 17 shows that 62% of the surveyed faculty preferred the Microsoft Windows operating system, 16% preferred the Mac OS, 5% preferred UNIX/Linux operating systems, and 3% preferred DOS. Fourteen percent of respondents expressed no preference for any operating system.

Response	Frequency	Percent
Windows	23	62%
Macintosh (Mac OS)	6	16%
No Preference	5	14%
UNIX/Linux	2	5%
DOS	1	3%
Total	37	100%

Table 17. Faculty Preferred Operating System.

Q-A14. What is your level of computer skill?

Question 14 asked the surveyed faculty to rate their level of computer skill. As shown in Table 18, 51.35% rated themselves as "Intermediate" users, 43.24% considered themselves "Advanced" users, and 2.7% rated themselves as "Beginners."

Response	Frequency	Percent
Intermediate	19	51.35%
Advanced	16	43.24%
Beginner	1	2.70%
No Response	1	2.70%
Total	36	100%

Table 18. Faculty Computer Skill Level.

Q-A15a. Are you an Internet user?

Table 19 shows that 94.59% of the surveyed faculty rated themselves as experienced Internet users, and only 2.7% rated themselves (one respondent) as non-Internet users.

Response	Frequency	Percent
Yes	35	94.59%
No	1	2.70%
No Response	1	2.70%
Total	37	100%

Table 19. Are Faculty Internet Users?

Q-A15b. What is your experience (in years) as an Internet user?

Table 20 shows that the surveyed faculty are experienced Internet users with a total reported experience of 120 years, with a 7-year range from a minimum of 2 years to a maximum 9 years. The mean years of Internet experience was 4.14 years, with an SD of 1.6 years. These and other descriptors are shown in Table 20.

A-Q15b-Doct Tests	A-Q15b-Doct Stats
Mean	4.14
Standard Error	0.30
Median	4.00
Mode	5.00
Standard Deviation	1.60
Sample Variance	2.55
Kurtosis	1.79
Skewness	0.89
Range	7.00
Minimum	2.00
Maximum	9.00
Sum	120.00
Count	29.00
Confidence Level (95.0%)	0.61

Table 20. Faculty Years of Internet Usage.

Q-A16. What is your level of Internet skill?

As shown in Table 21, 70% rated themselves as "Intermediate" users, 19% considered themselves "Advanced" users, and 11% rated themselves as "Beginners."

Response	Frequency	Percent
Intermediate	26	70%
Advanced	7	19%
Beginner	4	11%
No Response	0	0%
Total	37	

Table 21. Faculty Level of Internet Skill.

Q-A17. Do you have a web site?

Table 22 shows that 76% reported having a web site, and 24% did not.

Response	Frequency	Percent
Yes	28	76%
No	9	24%
No Response	0	0%
Total	37	100%

Table 22. Faculty Web Site.

Q-A18. Is your web site personal, departmental, or university?

Table 23 shows that 11% reported having a personal web site, 47% reported that it was their program or departmental site, and 42% reported that it was their university's site.

Response	Frequency	Percent
Personal	6	11%
Program/Departmental	25	47%
University	22	42%
Total	53	100%

Table 23. Faculty Type of Web Site.

Q-A19. Do you use a web site in your teaching?

Table 24 shows that 57% reported using a web site in teaching, 30% did not use a web site in teaching, and 14% gave no response.

Response	Frequency	Percent
No	21	57%
Yes	11	30%
No Response	5	14%
Total	37	100%

Table 24. Faculty Using Web Site in Teaching.

Q-A20. If you do not use a web site, are you interested in using a web site in your teaching?

Table 25 shows that 51% of responding faculty was not interested in incorporating web-based teaching, 16% were interested, and 32% gave no response.

Response	Frequency	Percent
No	19	51%
Yes	6	16%
No Response	12	32%
Total	37	100%

Table 25. Faculty Interested in Web-Based Teaching.

Q-A21. Do you use distance-learning technology in your teaching?

Table 26 shows that 45% reported using distance-learning technology, and that 55% did not.

Response	Frequency	Percent
No	21	55%
Yes	17	45%
No Response	0	0%
Total	38	100%

Table 26. Faculty Interest in Distance Education.

Q-A22. What is your preferred method for distance education?

Question 22 asked the surveyed faculty to indicate their preferred method for distance learning. Table 27 shows that 50% preferred real-time "video conferencing" in a traditional classroom or conference room situation, 24% preferred "direct-to-desktop," 14% preferred "video taping" of class sessions for later viewing, and 12% preferred using "interactive optical media (CD or DVD). No preferences were reported for "written correspondence course" or for "other."

Response	Frequency	Percent
Video conferencing	21	50%
Direct to desktop	10	24%
Video taping	6	14%
Interactive CD or DVD	5	12%
Written correspondence course	0	0%
Other	0	0%
Total	42	100%

Table 27. Faculty Preferred Distance Learning Method.

Curriculum Development Section: What inputs are used to develop the IH curriculum?

Q-A23. What inputs are used to develop your Industrial Hygiene curriculum?

Question 23 asked the surveyed faculty to identify the sources of input into their curriculum development process. Table 28 shows that the major inputs were from faculty (22%), alumni (19%), the profession (17%), and other academic programs (14%). Only minor inputs were received from industry (11%), customer needs analysis (10%), market needs analysis (9%), and government (3%). No responses were given for other sources of curriculum input.

Response	Frequency	Percent
Faculty input	31	22%
Survey of your alumni	27	19%
Survey of the profession	25	17%
Student input	24	17%
Survey of other academic programs	20	14%
Survey of industry	16	11%
Customer needs analysis	15	10%
Market needs analysis	13	9%
Survey of government	4	3%
Other	0	0%
Total	144	122%

Table 28. Faculty Inputs for Curriculum Development.

Q-A24. Question 24 attempted to discern IH faculty preference for learning objectives. However, it proved difficult for respondents to answer, and only two participants elected to respond. After re-evaluation of the item, the author determined that there was not enough information to make a meaningful contribution and elected to delete it. Investigation into learning objectives in IH curricula may be a topic to be addressed in future research into the IH curriculum.

Q-A25. Within the university, the optimal location or "home" for the Industrial Hygiene program would be?

Question 25 asked the surveyed faculty to indicate their preference for the optimal location or "home" within the typical university organizational structure. Table 29 shows that a majority (63%) preferred that the Industrial Hygiene program be located within schools of "Public/Allied Health." Thirteen percent preferred "Life Sciences," 12% preferred "Engineering," 10% preferred "Physical Sciences," and 2% preferred "Other Collaborative or interdisciplinary structures. No responses were given for the alternatives of "Management," "Social Science," or "Agriculture."

Response	Frequency	Percent
Public/Allied Health	33	63%
Life Sciences	7	13%
Engineering	6	12%
Physical Sciences	5	10%
Other (collaborations)	1	2%
Management	0	0%
Social Science	0	0%
Agriculture	0	0%
Total	52	100%

Table 29. Faculty Preference for Optimal Placement of IH Program within University.

Q-A26. At your school, the location/home of the Industrial Hygiene program is?

Question 26 asked the surveyed faculty to identify where the IH program was located at their institution. Table 30 shows that, again, a majority of respondents (76%) reported that the IH program at their institution was located within "Public/Allied Health." Twelve percent reported "Engineering," 7% reported "Other" — specifically medical, veterinary, and technology — and

5% reported "Physical Sciences." No responses were given for the alternatives of "Management," "Social Science," or "Agriculture."

Response	Frequency	Percent
Public/Allied Health	32	76%
Engineering	5	12%
Other (Medicine, Veterinary, Technology)	3	7%
Life Sciences	2	5%
Physical Sciences	0	0%
Management	0	0%
Social Science	0	0%
Agriculture	0	0%
Total	42	100%

Table 30. Actual University Locations of IH Programs.

Q-A27. Is your Industrial Hygiene program ABET accredited?

Table 31 shows that the majority (76%) of the IH programs represented were not ABET accredited, and that 22% were ABET accredited. Three percent of respondents gave no response for Question 27.

Response	Frequency	Percent
No	28	76%
Yes	8	22%
No Response	1	3%
Total	37	100%

Table 31. Is Your IH Program ABET Accredited?

Q-A28. If you answered no in #Q27, is ABET accreditation planned for the future?

Table 32 shows that 35% planned to pursue ABET accreditation at a future date, 30% did not plan to pursue accreditation, and 35% gave no response.

Response	Frequency	Percent
Yes	13	35%
No	11	30%
No Response	13	35%
Total	37	100%

Table 32. For Non-Accredited Programs, Is ABET Accreditation Planned?

Curriculum Planning Section: What are faculty preferences for core competencies expected to be possessed by industrial hygienists entering professional practice?

Q-A29. Rate your preference for each of the following subject topics in the IH curriculum.

Question 29 asked the respondents to rate their preference for each of 42 subject areas typical of inclusion in the IH curriculum, selected from course titles and course syllabus topic areas from the 23 ABET-accredited IH Masters degree programs. Table 33 shows the ranked faculty preference for inclusion of subjects in the Industrial Hygiene curriculum. Additionally, it identifies IH faculty preference for an IH Masters' degree curriculum, assuming the typical 36-semester hour structure for master's degrees. Values for the matrices of subject matter rating items were ranked using the Springer worker competencies and attributes characterization model, a technique for analyzing forced-response ranking values (Springer et al, 1996), to allow a relative ranking of respondent preferences. . The Springer Ranking Value (SRV) is determined to allow the participants' reported preferences for the IH subject areas to be ranked from highest to lowest preference. The Springer Ranking Value calculation is illustrated in Appendix I.

Original Item No.	Subject	Springer Ranking Value	Semester Hours Credit
2	Industrial Hygiene Measurement	5.63	3
4	Industrial Hygiene Controls	5.31	6
3	Instrumentation & Calibration	5.2	9
1	Intro. Industrial Hygiene course	5.14	12
5	Toxicology	5.06	15
8	Internship	4.97	18
9	Industrial Ventilation	4.69	21
6	Epidemiology	4.66	24
14	Ergonomics & Human Factors	4.51	27
41	Quantitative Industrial Hygiene	4.49	30
19	Respiratory Protection	4.43	33
25	Industrial Safety	4.43	36
10	Noise Control	4.40	39
11	Hearing Conservation	4.37	42
15	Industrial Hygiene Problems	4.23	45
16	Environmental Health	4.20	48
7	Field Experience	4.09	51
20	Occupational Health	3.94	54
29	Hazardous Waste Management	3.89	57
30	Environmental Science	3.89	60
17	Environmental Management	3.83	63
26	OSHA Compliance	3.80	66
32	Labor Relations	3.80	69
31	Environmental Law & Policy	3.77	72
33	Industrial Hygiene Management	3.60	75
39	Public Health	3.60	78
12	Acoustical Physics	3.57	81
27	Laboratory Safety	3.49	84
22	Health Physics	3.46	87
23	Radiation Safety	3.43	90
28	Safety Engineering	3.43	93
18	HazMat & HAZWOPER	3.40	96
21	Occupational Medicine	3.34	99
13	Acoustical Engineering	3.06	102
40	Preventive Medicine	2.83	105
24	Fire Science	2.71	108
34	Environmental Engineering	2.69	111
38	Industrial Engineering	1.97	114
36	Chemical Engineering	1.83	117
37	Mechanical Engineering	1.71	120
35	Electrical Engineering	1.69	123
42	Finance & Budget Management	1.43	126

Table 33. Ranked Faculty Preference for Subjects in the IH Curriculum (With Preferred 36 Semester Hour MS Curriculum Identified).

Q-A30. Are the above listed IH curriculum components appropriate for Associate, Baccalaureate, Masters, or Doctoral degree programs?

Table 34 shows that only 6% of IH faculty respondents rated the overall subject areas as appropriate at the Associate level, while 40% ranked them appropriate at the Masters level, 33% ranked them appropriate at the Baccalaureate level, and 21% ranked them appropriate at the Doctoral level. These low overall approval responses indicate that respondents were not supportive of the entire list of subjects overall at any degree level. Question A30 did not discern the appropriateness of individual subjects at each degree level; such differentiation on the SRV ranking preference scale would be meaningful and should be considered an appropriate topic for future research.

Response	Frequency	Percent
Masters Degree	29	40%
Baccalaureate Degree	24	33%
Doctoral Degree	15	21%
Associate Degree	4	6%
Total	72	100%

Table 34. Subject Appropriateness for Degree Level.

Emerging Issues Section: What are faculty expectations for emerging issues to which the curriculum must be responsive?

Q-A31. What are the hot, upcoming topic areas in the Industrial Hygiene that will need to be considered in the future IH curriculum?

Question 31 asked the IH faculty respondents to list their expectations for emerging issues and topics of sufficient impact to be considered for inclusion in the future IH curriculum. Table 35 shows the ranked faculty expectations for the reported 22 upcoming IH topic areas.

Response	Frequency	Percent
Integration/Coordination of EH & IH	10	18%
Indoor Air Quality	9	16%
Management	8	14%
Bioaerosols	4	7%
Behavior-Based Safety & Health	3	5%
Risk Assessment/Risk Management	3	5%
Auditing	2	4%
Exposure Assessment	2	4%
Human Factors Engineering	2	4%
Noise/Hearing	2	4%
Aerosol Technology	1	2%
Aging Workforce	1	2%
Children's Health	1	2%
Complex Problem Solving	1	2%
Environmental Endocrine Agents	1	2%
Global Industrial Hygiene	1	2%
Learning Methods	1	2%
Modeling, Calculations	1	2%
Non-Occupational Environments	1	2%
Non-Traditional Work shifts	1	2%
Occupational Disease & Illness	1	2%
Recurrence of Old Problems	1	2%
Total	57	100%

Table 35. Faculty Preference for Emerging Areas Influencing IH Curricula.

Respondent Comments

The survey instrument designated space for surveyed IH faculty to write in unstructured comments. Following are the comments from the faculty survey respondents.

Item	Faculty Comments
1	The web can open up a whole new group of students.
2	Who is our customer?
3	Accreditation equivalent to ABET is not available in Canada.
4	Need to define “Quantitative Industrial Hygiene.”
5	What is “Occupational Health?”
6	Nice survey!
7	I would like to know more about distance learning.
8	This is a very timely issue. Results will be valuable.
9	My principle interest is in providing the best IH program that can be developed.
10	This is a valuable first effort, however the tool design may not get the information.
11	I would like to see more opportunity for cross-disciplinary collaboration.
12	Subject preference matrix is very confusing to me.

Table 36. Comments from Surveyed IH Faculty.

Summary of the Faculty Survey Results

To achieve the objectives of this study, the researcher strived to address seven critical questions:

1. Participant demographics: Who is teaching industrial hygiene?

Of the respondents to Survey A, 92% identified themselves as IH teaching faculty with a mean of 19.16 years of experience, and a mean of 12.19 years in academia. Faculty teaching specialties within IH were general/comprehensive practice (29%), environmental health science (11%), exposure assessment (9%), aerosols & bioaerosols (7%), and ventilation (7%). IH faculty were highly educated, with 37 reporting baccalaureate degrees, 37 reported master degrees, and 37 reported holding doctoral degrees. Baccalaureate degrees were held most frequently in the disciplines of Biology (19%), Environmental Health Science (19%), Chemistry (14%), and Engineering (14%). Master’s degrees were held most frequently in the disciplines of Environmental Health Science (43%) and Industrial Hygiene (30%). In addition, doctoral degrees were held most frequently in the disciplines of Environmental Health Sciences (35%) and Industrial Hygiene (22%).

Respondents reported 115 IH faculty in the programs represented, from a minimum of 1 to a maximum of 10 faculty members per program, with a mean of 3.9 faculty members per program. To be eligible for the ABET accreditation an IH academic program must have a minimum of 3 full-time faculty members.

2. Academic program characteristics: What are the characteristics of current industrial hygiene academic programs?

Fourteen IH Baccalaureate programs were reported with 809 undergraduate students enrolled, from a minimum of 10 to a maximum of 180, with a mean of 57.79 students per program and SD of 48.08. Fourteen IH Baccalaureate programs were reported with 809 undergraduate students enrolled, from a minimum of 10 to a maximum of 180, and a mean was 57.79 students per program. Twenty-six IH Masters programs were reported with 646 graduate students enrolled, from a minimum of 6 to a maximum of 65. The mean was 24.85 students per program with SD of 16.38. Eleven IH Doctoral programs were reported with 55 graduate students enrolled, from a minimum of 2 to a maximum of 10, with a mean was 5 students per program and an SD of 2.45. The most common delivery modes were reported as "Traditional, on-campus, day" classes (55%) and "Traditional, on-campus, evening" classes (30%).

A majority of the surveyed faculty (63%) preferred that the Industrial Hygiene program be located within schools of "Public/Allied Health." Thirteen percent preferred "Life Sciences," 12% preferred "Engineering," 10% preferred "Physical Sciences," and 2% preferred "Other Collaborative or interdisciplinary structures. When asked to identify where the IH program was located at their institution, a majority of respondents (76%) reported that their IH program was located within "Public/Allied Health." Twelve percent preferred "Engineering," 7% preferred

"Other" — specifically medical, veterinary, and technology — and 5% preferred "Physical Sciences."

Respondents reported that a majority (76%) of the IH programs represented were not ABET-accredited, and that 22% were ABET-accredited. The surveyed faculty who identified that their IH program was not ABET accredited, were asked if accreditation was planned for the future. Thirty-five percent reported that they planned to pursue ABET accreditation at a future date, 30% did not plan to pursue accreditation, and 35% gave no response.

3. What are the undergraduate majors of students entering your IH graduate program?

The surveyed faculty reported the most frequent undergraduate majors of their IH graduate students were Biology (28%), Chemistry (19%), Environmental Health Science (18%), and Engineering (13%). Only 4% of students entering IH graduate programs held Baccalaureate degrees in Industrial Hygiene. IH students were reported as "Well distributed, age-wise" (40%). Thirty-two percent were reported as "Younger, straight through from high school" and 28% were reported as "Older, with some professional experience."

4. Readiness for Distance Education: Is the profession ready for "high-tech" distance learning in IH education?

Industrial hygiene faculty had the hardware and software experience and capability to incorporate distance-learning strategies into IH education, but may have had limited interest and motivation, at this time. Ninety-seven percent of the surveyed faculty reported being computer users, with a mean of 34 years of computer experience. Seventy-three percent of the responding faculty preferred the PC and its clones, and 27% preferred Apple's Macintosh computers; seven respondents expressed a preference for both platforms. Sixty-two percent of the surveyed faculty preferred the Microsoft Windows operating system, 16% preferred the Mac OS, 5% preferred UNIX/Linux operating systems, and 3% preferred DOS. Fourteen percent of respondents expressed no preference for any operating system. More than fifty-one percent rated their level of computer skill as “Intermediate” users, 43.24% considered themselves “Advanced” users, and 2.7% rated themselves as “Beginners.” Fifty-seven percent reported using a web site in teaching, 30% did not use a web site in teaching, and 14% gave no response. However, 51% of responding faculty were not interested in incorporating web-based teaching, 16% were interested, and 32% gave no response. Forty-five percent of faculty reported using distance learning technology and 55% did not.

5. Curriculum planning & development inputs: What inputs are used to develop the industrial hygiene academic curriculum?

An internally focused curriculum development process appeared characteristic of academic IH programs. The surveyed faculty reported that the major sources of input into their curriculum development process were from faculty (22%), alumni (19%), the profession (17%), and other academic programs (14%). Only minor inputs were received from industry (11%), customer needs analysis (10%), market needs analysis (9%), and government (3%). No responses were given for other sources of curriculum input.

6. Curriculum: subject/competency preferences: What are faculty preferences for core competencies expected to be possessed by IH’s entering professional practice?

Question 29 asked the respondents to rate their preference for each of 42 subject areas typical of inclusion in the IH curriculum, selected from course titles and course syllabus topic areas from the 23 ABET accredited IH Masters degree programs, at the time of the survey. The previous Table 33 shows the ranked faculty preference for inclusion of subjects in the Industrial Hygiene curriculum. Additionally it identifies IH faculty preference for an IH Masters curriculum, assuming the traditional 36-semester hour structure for master degrees.

7. Emerging issues influencing IH curriculum development: What are the hot, emerging issues to which the IH curriculum must be responsive?

IH faculty respondents were asked to list their expectations for emerging issues and topics of sufficient impact to be considered for inclusion in the future IH curriculum. The previous Table 35 shows the ranked faculty expectations for the reported 22 upcoming IH topic areas. The most frequently reported emerging issues were the Integration and Coordination of Environmental Health Sciences and Industrial Hygiene (18%), Indoor Air Quality (16%), and Management (14%).

CHAPTER V

FINDINGS: EXPECTATIONS AND PERCEPTIONS OF EMPLOYERS OF INDUSTRIAL HYGIENISTS

Purpose of Survey B of IH Employers

The purpose of this survey was to identify and assess the expectations and perceptions of employers of industrial hygienists in the areas of curriculum content and structure. To achieve this purpose, the expectations and perceptions of those employers actively seeking to hire IH graduates were identified and described. Survey B of employers assessed employer respondent demographics, assessed respondent readiness for distance learning, assessed respondent expectations for the core technical IH curriculum content, and assessed respondent expectations for non-technical competencies and attributes of graduates of IH degree programs.

To achieve the research objectives and respond to the questions posed in Chapter One, Survey B addressed the following areas:

1. Participant demographics: Who is employing IH graduates?
2. Academic program/employer characteristics
3. Readiness for “high-tech” distance learning in IH education
4. Curriculum: planning & development inputs
5. Curriculum: subject/competency preferences
6. Hot, emerging issues impacting IH curriculum development

Findings

Participant Demographics Section: Who is hiring Industrial Hygiene graduates?

Q-B1. What is the nature of your position in Industrial Hygiene?

Sixty-two percent of prospective employers participating in the AIHA Employment Services Job Fair responding to Survey B described themselves as “Management: Make hiring decisions.” Sixteen percent indicated they were “Technical: Make hiring decisions;” 9% indicated that were “Technical: Make hiring recommendations;” 4% were “Management: Make hiring recommendations;” and 8% identified themselves as “Other.”

Q-B2. What is your number of years of experience?

The prospective employers were quite experienced, with a total of 1,465 years reported experience, with a 33-year range, from a minimum of 2 years to a maximum of 35 years. The mean was 19.53 years with SD of 7.13 years. These and other descriptors are shown in Table 37. Figure 8 shows the distribution of the employer response.

B-Q2 Tests	***B-Q2 Stats***
Mean	19.53
Standard Error	0.82
Median	19.00
Mode	15.00
Standard Deviation	7.13
Sample Variance	50.77
Kurtosis	-0.28
Skewness	0.05
Range	33.00
Minimum	2.00
Maximum	35.00
Sum	1465.00
Count	75.00
Confidence Level (95.0%)	1.64

Table 37. Employer Years in IH Practice.

Figure 8. Employer Reported Years of Experience.

Q-B3. What is the Standard Industry Classification of your business or profession?

The prospective employers were primarily from "Manufacturing" (39%), "Professional, Scientific, Technical, Consulting" (35%), and "Education Services" (10%). A complete reporting of the responses is shown in Table 38.

Standard Industry Classifications (SIC)	Frequency	Percent (Descending)
Manufacturing	30	39%
Professional, Scientific, Technical, Consulting	27	35%
Education Services	8	10%
Finance & Insurance	2	3%
Public Administration, Government	2	3%
Utilities	2	3%
Accommodation, Food Services	1	1%
Construction	1	1%
Health Care	1	1%
Information, Telecommunications	1	1%
No Response	1	1%
Transportation, Warehousing	1	1%
Administrative & Support	0	0%
Agriculture, Forestry	0	0%
Arts, Entertainment, Recreation	0	0%
Management of Companies, Enterprises	0	0%
Mining	0	0%
Other	0	0%
Real Estate	0	0%
Retail Trade	0	0%
Wholesale Trade	0	0%
Total Responses	77	100%

Table 38. Employer Responders by SIC Code.

Q-B4. What is the subject area of your academic degrees?

The prospective employers were well educated. While 19 respondents (25%) reported holding Associate degrees (Table 39), all 77 (100%) reported holding Baccalaureate degrees (Table 40) and seven reported having double majors in their Baccalaureate degrees, 66 (86%) reported holding Master degrees (Table 41), and 12 (16%) held Doctoral degrees (Table 42). As the responses were not mutually exclusive, these results indicate that all 19 Associate degree holders had also completed their Baccalaureate degree. Two respondents reported holding other professional degrees: one in medicine (MD) and one in law (JD). Table 39 shows the employers' reported associate degree topics. Of the 19 employers holding Associate degrees, the most frequently held were reported in General Science (36%), Chemistry (21%), and Engineering (21%). Table 40 shows that employers' baccalaureate degrees were held most frequently in the disciplines of Biology (21%), Environmental Health Science (17%), Chemistry (14%), and Engineering (8%). Table 41 shows that the employers' master's degrees were held most frequently in the disciplines of Industrial Hygiene (32%), Environmental Health Science (16%), Management (12%), and Safety (9%). Table 42 shows that employers' Doctoral degrees were held most frequently in the disciplines of Engineering (4%), Environmental Health Sciences (4%), and Industrial Hygiene (3%).

Associate Disciplines	Frequency	Percent
No Response	58	75%
Science, General	6	8%
Chemistry	4	5%
Engineering	4	5%
Agriculture	1	1%
Athletics, Physical Education (PE)	1	1%
Biology	1	1%
Environmental Health Science	1	1%
Music	1	1%
Associate: Total Responses	77	100%

Table 39. Employer Associate Subject Areas.

Baccalaureate Disciplines	Frequency	Percent
Biology	18	21%
Environmental Health Science	14	17%
Chemistry	12	14%
Engineering	7	8%
Physics	4	5%
Science, General	4	5%
Bio-Chemistry	3	4%
Safety	3	4%
Agriculture	2	2%
Industrial Hygiene	2	2%
Management, Administration	2	2%
Anthropology	1	1%
Athletics, PE	1	1%
Construction Management	1	1%
Geography	1	1%
Health	1	1%
Language	1	1%
Literature	1	1%
Mathematics	1	1%
Microbiology	1	1%
Music	1	1%
Occupational Health	1	1%
Pharmacy	1	1%
Zoology	1	1%
No Response	0	0%
Baccalaureate: Total Responses	84	100%

Table 40. Employer Baccalaureate Subject Areas.

Masters Disciplines	Frequency	Percent
Industrial Hygiene	25	32%
Environmental Health Science	12	16%
No Response	11	14%
Management, Administration	9	12%
Safety	7	9%
Engineering	2	3%
Occupational Health	2	3%
Public Health	2	3%
Biology	1	1%
Chemistry	1	1%
Education	1	1%
Emergency Management	1	1%
Geography	1	1%
Science, General	1	1%
Toxicology	1	1%
Masters: Total Responses	77	100%

Table 41. Employer Masters' Subject Areas.

Doctoral Disciplines	Frequency	Percent
No Response	65	84%
Engineering	3	4%
Environmental Health Sciences	3	4%
Industrial Hygiene	2	3%
Geography	1	1%
Occupational Health	1	1%
Risk Assessment	1	1%
Science, General	1	1%
Doctorates: Total Reponses	77	100%

Table 42. Employer Doctoral Subject Areas.

Distance Education Readiness Assessment Section: Do the employers possess the computer hardware, software, and Internet skills and capacity to be accepting of distance learning in IH education?

Q-B5a. Are you a computer user?

Table 43 shows ninety-five percent reported being computer users.

Computer User	Frequency	Percent
Yes	73	95%
No	2	3%
No Response	2	3%
Total Response	77	100%

Table 43. Employer Computer Users.

Q-B5b. What is your experience (in years) as a computer user?

Table 44 shows that the surveyed employers were experienced as computer users with a total reported experience of 774 years, with a 30-year range, from a minimum of zero years to a maximum of 30 years. The mean years of computer experience was 10.32 years, with an SD of 7.38 years. These and other descriptors are shown in Table 44. Figure 9 shows the distribution of the employer response for 58 respondents, excluding the 17 who reported zero years of experience.

B-Q5b Tests	B-Q5b Stats
Mean	10.32
Standard Error	0.85
Median	10.00
Mode	0.00
Standard Deviation	7.38
Sample Variance	54.49
Kurtosis	-0.02
Skewness	0.25
Range	30.00
Minimum	0.00
Maximum	30.00
Sum	774.00
Count	75.00
Confidence Level (95.0%)	1.70

Table 44. Employer Years of Computer Use.

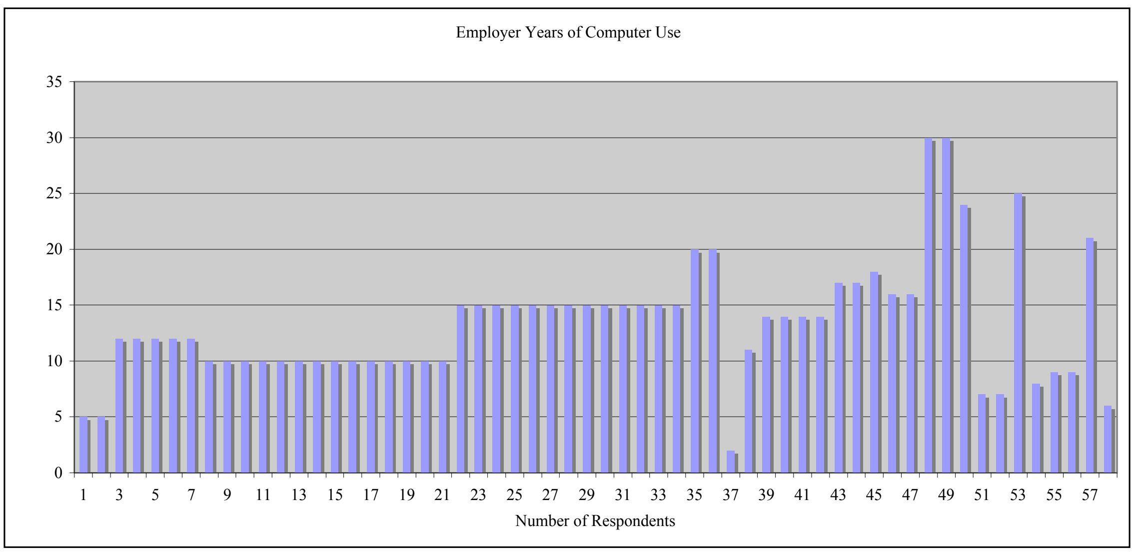

Figure 9. Employer Reported Years of Computer Experience.

Q-B6. What is your preferred computer platform?

Table 45 shows that 68% of the surveyed employers preferred the IBM PC and its clones, while 24% preferred Apple computers, and 8% reported a preference for other computer platforms.

Response	Frequency	Percent
PC/clone	62	68%
Apple	22	24%
Other	7	8%
Total	91	100%

Table 45. Employer Preferred Computer Platform.

Q-B7. What is your preferred operating system?

Table 46 shows that 70% of the surveyed employers preferred the Microsoft Windows operating system, 23% preferred the Mac OS, and 2% preferred UNIX/Linux operating systems. Four percent expressed no preference, and no preference was expressed for DOS.

Response	Frequency	Percent
Windows	57	70%
Macintosh	19	23%
No Preference	3	4%
UNIX/Linux	2	2%
DOS	0	0%
Total	81	100%

Table 46. Employer Preferred Operating System.

Q-B8. What is your level of computer skill?

Question 8 asked the surveyed employers to rate their level of computer skill. As shown in Table 47, 26% rated themselves as "Intermediate" users, 65% considered themselves "Advanced" users, and only 5% rated themselves as "Beginners."

Response	Frequency	Percent
Advanced	50	65%
Intermediate	20	26%
Beginner	4	5%
No Response	3	4%
Total	77	100%

Table 47. Employer Computer Skill Level.

Q-B9a. Are you an Internet user?

Table 48 shows that 94% of the surveyed employers rated themselves as experienced Internet users, and 4% rated themselves as non-Internet users. Three percent those surveyed gave no response.

Response	Frequency	Percent
Yes	72	94%
No	3	4%
No Response	2	3%
Total	77	100%

Table 48. Are Employers Internet Users?

Q-B9b. What is your experience (in years) as an Internet user?

Table 49 shows that the surveyed employers are experienced Internet users with a total reported experience of 184 years, with a 12-year range from a minimum of zero years to a maximum 12 years. The mean years of Internet experience was 2.52 years, with an SD of 2.85 years. These and other descriptors are shown in Table 49. Figure 8 shows the distribution of the employer response.

B-Q9b Tests	B-Q9b Stats
Mean	2.52
Standard Error	0.33
Median	2.00
Mode	0.00
Standard Deviation	2.85
Sample Variance	8.11
Kurtosis	1.95
Skewness	1.37
Range	12.00
Minimum	0.00
Maximum	12.00
Sum	184.00
Count	73.00
Confidence Level (95.0%)	0.66

Table 49. Employer Years of Internet Usage.

Q-B10. What is your level of Internet skill?

Question 10 asked the surveyed employers to rate their level of Internet skill. As shown in Table 50, 61% considered themselves "Advanced" users, 16% rated themselves as "Intermediate" users, and 18% rated themselves as "Beginners." Five percent gave no response.

Response	Frequency	Percent
Advanced	47	61%
Intermediate	12	16%
Beginner	14	18%
No Response	4	5%
Total	77	100%

Table 50. Employer Level of Internet Skill.

Q-B11. Do you have a web site?

Question 11 asked the surveyed employers if they had a web site. Table 51 shows that 65% reported having a web site, and 31% did not. Four percent gave no response.

Response	Frequency	Percent
Yes	50	65%
No	24	31%
No Response	3	4%
Total	77	100%

Table 51. Employer Web Site.

Q-B12. Is your web site personal or business?

Question 12 asked the employers reporting having a web site, if it was a personal site, or their company's web site? Table 52 shows that 12% reported having a personal web site, 75% reported that it was their program or departmental site, and 13% gave no response.

Response	Frequency	Percent
Personal?	9	12%
Business?	58	75%
No Response	10	13%
Total	77	100%

Table 52. Employer Type of Web Site.

Q-B13. Do you use a web site for employee education and training?

Table 53 shows that 45% of surveyed employers reported using a web site in employee teaching and training, 52% did not use a web site in teaching, and 3% gave no response.

Response	Frequency	Percent
No	40	52%
Yes	35	45%
No Response	2	3%
Total	77	

Table 53. Employers Using Web Site in Teaching.

Q-B14. If you do not use a web site, are you interested in using a web site for employee education and training?

Table 54 shows that 9% of responding faculty were not interested in incorporating web-based teaching, 40% were interested, and 51% gave no response.

Response	Frequency	Percent
No	7	9%
Yes	31	40%
No Response	39	51%
Total	77	100%

Table 54. Employers Interested in Web-Based Teaching.

Q-B15. Does your company use distance-learning technology?

Question 15 asked the surveyed employers if they used distance-learning technology in their employee teaching and training. Table 55 shows that 55% reported using distance-learning technology, and that 43% did not. Three percent gave no response.

Response	Frequency	Percent
No	33	43%
Yes	42	55%
No Response	2	3%
Total	77	100%

Table 55. Employer Interest in Distance Education.

Q-B16. What is your preferred method for distance education?

Question 16 asked the surveyed employers to indicate their preferred method for distance education. Table 56 shows that 30% preferred real-time “video conferencing” in a traditional classroom or conference room situation, 26% preferred “direct-to-desktop,” 24% preferred “interactive optical media (CD or DVD), 11% preferred “video taping” of class sessions for later viewing, and 7% preferred a “written correspondence course.” One respondent expressed a preference “Other,” but gave no specifications.

Response	Frequency	Percent
Video conferencing	41	30%
Direct to desktop	36	26%
Interactive CD or DVD	33	24%
Video-taping	15	11%
Written correspondence course	10	7%
Other	1	1%
Total	136	100%

Table 56. Employer Preferred Distance Learning Method.

Q-B17. Which of the listed delivery modes would you (your company) prefer that applicants for IH positions obtained their academic degrees?

Table 57 shows that 29% of responses to Question 17 expressed preference that applicant's degrees be obtained via "Traditional, on-campus, day program," 23% preferred "On-campus, evening program," 23% preferred an "On-campus, executive program," 14% preferred a "Non-traditional distance learning program," and 12% preferred a "Traditional, off-campus program." The 77 employers surveyed were allowed to express preference for multiple options, and gave 235 responses.

Response	Frequency	Percent
Traditional, on-campus, day program	68	29%
On-campus, evening program	54	23%
On -campus, executive program	53	23%
Non-traditional, distance learning program	32	14%
Traditional, off-campus program	28	12%
Total responses	235	100%

Table 57. Employer Acceptance of Degrees.

Q-B18. Would you (your company) support an IH employee in obtaining further education via distance-learning programs?

Table 58 shows that 87% of surveyed employers would support an IH employee in obtaining further education via distance learning programs; 8% would not; and 5% gave no response.

Response	Frequency	Percent
Yes	67	87%
No	6	8%
No response	4	5%
Total responses	77	100%

Table 58. Employer Support for Distance Education Degrees.

Curriculum: What inputs should be used to develop the IH curriculum?

Q-B19. What inputs are preferred to develop the academic curriculum?

Question 19 asked the surveyed employers to express preference for inputs into the academic curriculum development process. Table 59 shows that the 19% preferred “Customer needs analysis,” 18% preferred “Survey of industry needs,” 16% preferred “Market needs analysis,” 15% preferred “Survey of the profession,” 12% preferred “Survey of government,” 12% preferred “Survey of alumni,” 10% preferred Survey of other academic programs,” 10% preferred “Faculty input,” 7% preferred “Student input,” and 2% preferred “Other” (unspecified). The 77 employers surveyed were allowed to express preference for multiple options, and gave 472 responses.

Response	Frequency	Percent
Customer needs analysis	74	16%
Survey of industry needs	70	15%
Market needs analysis	63	13%
Survey of the profession	59	13%
Survey of government	49	10%
Survey of alumni	47	10%
Survey of other academic programs	39	8%
Faculty input	38	8%
Student Input	27	6%
Other	6	1%
Total	472	100%

Table 59. Employer Preferred Inputs for Curriculum Development.

Q-B20. Within the university, the optimal location or home for the IH program would be?

Question 20 asked the surveyed employers to indicate their preference for the optimal location or “Home” within the typical university organizational structure. Table 60 shows that a majority (62%) preferred that the Industrial Hygiene program location be within schools of “Public/Allied Health.” Fifteen percent preferred “Engineering,” 12% preferred “Life Sciences,” 6% preferred “Physical Sciences, 3% preferred “Other Collaborative or interdisciplinary structures, and 1% preferred “Social Science.” No responses were given for the alternatives of “Management” or “Agriculture.” The 77 employers surveyed were allowed to express preference for multiple options, and gave 94 responses.

Response	Frequency	Percent
Public/Allied Health	58	62%
Engineering	14	15%
Life Sciences	11	12%
Physical Sciences	6	6%
Other (collaborations)	3	3%
Management	1	1%
Social Science	1	1%
No Response	0	0%
Agriculture	0	0%
Total	94	100%

Table 60. Employer Preference for Optimal Placement of IH Program within the University.

Q-B21. What is the role of ABET accreditation of an applicant's IH degree program in your hiring decision?

Question 21 asked the surveyed employers to identify the role of ABET accreditation of an applicant's IH degree program in their hiring decision. Table 61 shows the employer preference for ABET accreditation of IH programs in hiring. Forty-four percent expressed that it would be "Nice to have, but not a requirement;" 21% reported that it would be "Preferable;" 17% indicated that it was "Not a factor;" 10% indicated that it would be a "Major factor in the hiring decision;" and 3% indicated that it would be "Absolutely essential for hire." Five percent gave no response.

Response	Frequency	Percent
Nice to have, but not a requirement	34	44%
Preferable	16	21%
Not a factor	13	17%
Major factor in the hiring decision	8	10%
No Response	4	5%
Absolutely essential for hire	2	3%
Total	77	100%

Table 61. Employer Preference for ABET Accreditation of IH Programs in Hiring.

Q-B22. When considering an applicant who holds a Master's degree in IH, what undergraduate degree is most preferable?

The surveyed employers reported the most preferred undergraduate majors of applicants with an IH Master's degree were "Chemistry" (19%), "Environmental Health Science" (15%), "Biology" (15%), and "Engineering" (13%). Table 62 shows the reported preferences for undergraduate majors. The 77 employers surveyed were allowed to express preference for multiple options, and gave 268 responses.

Response	Frequency	Percent
Chemistry	51	19%
Environmental Health Science	40	15%
Biology	39	15%
Engineering	35	13%
Physics	16	6%
Industrial Hygiene	14	5%
Safety	13	5%
Life Sciences	11	4%
Public Health	7	3%
Management	6	2%
Physical Science	6	2%
Agriculture	4	1.49%
Mathematics	4	1.49%
General Science	3	1.12%
Human Behavior/Social Science	3	0.75%
No Response	2	0.75%
Non-Science/Other	2	0.75%
Nursing	2	0.75%
Art	1	0.37%
Biochemistry	1	0.37%
Computer Science	1	0.37%
Exposure Assessment	1	0.37%
Health-Related	1	0.37%
History	1	0.37%
International	1	0.37%
Pre-Medicine	1	0.37%
Prevention	1	0.37%
Toxicology	1	0.37%
Total	268	100%

Table 62. Employer Preference for Undergraduate Major with IH Masters.

Curriculum Planning Section: What are employer preferences for core competencies expected to be possessed by an IH entering professional practice?

Q-B23. Rate your preference for each of the following subjects in the IH Curriculum.

Question 23 asked the respondents to rate their preference for each of 42 subject areas typical of inclusion in the IH curriculum, selected from course titles and course syllabus topic areas from the 23 ABET-accredited IH master's degree programs. Table 63 shows the ranked employer preference for inclusion of subjects in the Industrial Hygiene curriculum. Additionally, it identifies prospective employers' preference for an IH Masters degree curriculum, assuming the typical 36-semester hour structure for Master degrees. Values for the matrices of subject matter rating items were ranked using the Springer worker competencies and attributes characterization model, a technique for analyzing forced-response ranking values (Springer et al, 1996), to allow a relative ranking of respondent preferences. The Springer Ranking Value (SRV) is determined to allow the participants' reported preferences for the IH subject areas to be ranked from highest to lowest preference. The Springer Ranking Value calculation is illustrated in Appendix I.

Original Item No.	Subject	Springer Ranking Value	Semester Hours Credit
2	Industrial Hygiene Measurement	4.56	3
3	Instrumentation & Calibration	4.43	6
4	Industrial Hygiene Controls	4.35	9
1	Intro. Industrial Hygiene course	4.29	12
41	Quantitative Industrial Hygiene	4.16	15
19	Respiratory Protection	4.08	18
10	Noise Control	3.96	21
5	Toxicology	3.95	24
7	Field Experience	3.95	27
9	Industrial Ventilation	3.95	30
15	Industrial Hygiene Problems	3.94	33
11	Hearing Conservation	3.88	36
26	OSHA Compliance	3.81	39
31	Environmental Law & Policy	3.74	42
16	Environmental Health	3.66	45
33	Industrial Hygiene Management	3.65	48
20	Occupational Health	3.64	51
8	Internship	3.60	54
14	Ergonomics & Human Factors	3.51	57
18	HazMat & HAZWOPER	3.43	60
25	Industrial Safety	3.36	63
42	Finance & Budget Management	3.32	66
32	Labor Relations	3.31	69
6	Epidemiology	3.22	72
17	Environmental Management	3.19	75
27	Laboratory Safety	3.18	78
29	Hazardous Waste Management	2.94	81
28	Safety Engineering	2.86	84
23	Radiation Safety	2.84	87
21	Occupational Medicine	2.77	90
39	Public Health	2.75	93
40	Preventive Medicine	2.75	96
30	Environmental Science	2.66	99
22	Health Physics	2.65	102
34	Environmental Engineering	2.62	105
24	Fire Science	2.51	108
12	Acoustical Physics	2.39	111
36	Chemical Engineering	2.19	114
13	Acoustical Engineering	2.18	117
37	Mechanical Engineering	1.83	120
38	Industrial Engineering	1.65	123
35	Electrical Engineering	1.45	126

Table 63. Ranked Employer Preference for Subjects in the IH Curriculum (With Typical 36-Semester Hour Masters Degree Curriculum Identified).

Q-B24. Are the above listed IH curriculum components appropriate for Associate, Baccalaureate, Masters, or Doctoral degree programs?

Question 24 asked the employer respondents if the 42 IH subject areas in Question 23 were appropriate at the Associate, Baccalaureate, Masters, or Doctoral levels. Table 64 shows that only 11% of employer respondents rated the subject areas as appropriate at the Associate level, while 36% ranked them appropriate at the Master's level, 30% ranked them appropriate at the Baccalaureate level, and 23% ranked them appropriate at the Doctoral level. The 77 employers surveyed were allowed to express preference for multiple options, and gave 192 responses. Employer respondents reported that the subject topics (core competencies) listed were most appropriate for Masters and Baccalaureate education, but were not totally inappropriate for Doctoral programs or even some applications at the Associate level. However, these low overall approval responses indicate that respondents were not supportive of the entire list of subjects overall at any degree level. Question B24 did not discern the appropriateness of individual subjects at each degree level; such differentiation on the SRV ranking preference scale would be meaningful and should be considered an appropriate topic for future research.

Response	Frequency	Percent
Doctoral Degree	44	23%
Masters Degree	69	36%
Baccalaureate Degree	58	30%
Associate Degree	21	11%
Total Responses	192	100%

Table 64. Subject Appropriateness for Degree Level.

Emerging Issues Section: What are employer expectations for emerging issues the curriculum must be responsive to?

Q-B25. What are the hot, upcoming topic areas in Industrial Hygiene that will need to be considered in the future IH curriculum?

Question 25 asked the employer respondents to list their expectations for emerging issues and topics of sufficient impact to be considered for inclusion in the future IH curriculum. Table 65 shows the ranked employer expectations for the reported upcoming IH topic areas. The 77 responding employers were allowed to express preference for multiple options, and gave 228 responses.

Response	Frequency	Percent
Ergonomics & Human Factors	21	9.21%
Indoor Air Quality (IAQ)	19	8.33%
EHS Integration/Consolidation	17	7.46%
Management & Leadership	13	5.70%
No Response	11	4.82%
Behavior-Based Safety	10	4.39%
Global, International Practice	10	4.39%
Risk Assessment, Risk Management	9	3.95%
Bio-Hazards	7	3.07%
Environmental Law & Policy	7	3.07%
Exposure Assessment	7	3.07%
Multiple Chemical Sensitivity (MCS)	7	3.07%
Computer Skills	5	2.19%
Economics	5	2.19%
Non-Occupational Environments	5	2.19%
Bioaerosol Assessment	4	1.75%
Electromagnetic Frequencies (ELMF)	4	1.75%
Epidemiology	4	1.75%
Instrument Technology	4	1.75%
Audit/Evaluation	3	1.32%

Table 65. Employer Expectations for Emerging Issues Influencing Industrial Hygiene Curricula.

Response	Frequency	Percent
Communications Skills: Verbal, Written	3	1.32%
Hazard Analysis & Control	3	1.32%
Mold, Fungi	3	1.32%
Toxicology	3	1.32%
Ventilation, HVAC Systems	3	1.32%
Construction Safety & Health	2	0.88%
Endocrine Disrupters	2	0.88%
Environmental Compliance	2	0.88%
Industrial Engineering	2	0.88%
Life Cycle Analysis	2	0.88%
Planning	2	0.88%
Trace Chemical Exposure	2	0.88%
Training	2	0.88%
Air Pollution Engineering	1	0.44%
Analytical Methods	1	0.44%
Bio-Engineering	1	0.44%
Biostatistics	1	0.44%
Chemistry	1	0.44%
Emerging Diseases	1	0.44%
Environmental Allergens	1	0.44%
Ethics	1	0.44%
Family & Child Exposure	1	0.44%
Genetic Testing for Susceptibility to Occupational Illness	1	0.44%
High-Tech Applications	1	0.44%
ISO Management Systems	1	0.44%
Labor Relations	1	0.44%
Lead Paint	1	0.44%
Lowered Emphasis on Air Sampling	1	0.44%
Lowered Emphasis on Hazard Evaluation	1	0.44%
Man-Made Fibers	1	0.44%
Medical Monitoring & Surveillance	1	0.44%
Physiology	1	0.44%
Prevention	1	0.44%
Problem Solving	1	0.44%
Re-emergence of Old Diseases	1	0.44%
School Safety & Health	1	0.44%
Solvent Metabolism	1	0.44%
Survival of the IH Profession	1	0.44%
Total Responses	228	100.00%

Table 65, Continued

Question 26 asked employer respondents to rank their preferences for the several non-IH core competencies and attributes from the Springer worker competencies and attributes characterization model (Springer et al., 1996). Table 66 shows the ranked employer expectations for these non-IH worker competencies and attributes, and indicates their value in the workplace. The Springer Ranking Value (SRV) is determined to allow the participants' reported preferences for the IH subject areas to be ranked from highest to lowest preference. The Springer Ranking Value calculation is illustrated in Appendix I.

Original Item No.	Subject	Springer Ranking Value
12	Makes sound decisions; uses wise judgment	4.62
18	Speaks and writes effectively	4.57
24	Uses analytical and critical thinking skills	4.46
22	Can summarize information	4.42
11	Honest, dependable, polite	4.37
20	Good command of language; appropriate use of language	4.36
21	Competence in reading, writing, and computation	4.33
1	Maturity and experience in job responsibility	4.29
6	Contributes to group efforts; team player	4.24
13	Enhances job skills to meet new challenges	4.22
14	Sets goals; takes pride in work accomplished	4.18
28	Exercises safety precautions	4.17
17	Lifelong learning commitment; solid work ethics	4.16
4	Accepts challenges presented by new equipment, procedures, techniques	4.13
7	Works readily within a diverse workgroup	4.12
27	Understands concepts of job	4.12
2	Willingness to work under pressure	4.11
19	Follows oral and written instructions	4.09
3	Adapts to change; secure enough to take risks	4.07
9	Courteous, considerate, pleasant	4.07

Table 66. Ranked Employer Preferences for Non-Technical Competencies in Graduates of IH Programs.

Original Item No.	Subject	Springer Ranking Value
8	Accepts constructive criticism	4.01
29	Exhibits versatility and leadership	4.01
25	Works with a variety of technologies	4.00
16	Works without excessive guidance	3.97
33	Knows how social, organizational, and technological systems work; operates effectively within them	3.95
10	Good grooming; professional personal appearance	3.88
26	Selects the correct procedures, tools, or equipment to maximize output	3.88
23	Can monitor one's work	3.79
5	Teaches others new skills	3.71
30	Can motivate co-workers	3.70
31	Assesses forces affecting employer	3.64
32	Concerned with productivity	3.54
15	Willingness to relocate	3.20

Table 66 continued.

Respondent Comments

The survey instrument designated space for surveyed employers to write in unstructured comments. Following are the comments from the employer survey respondents.

No.	Prospective IH Employer Comments
1	"Can't afford to hire an IH masters degree. Too expensive. Management can't be taught. It's follow the leader.
	Organic chemistry is a must. IHs need to be taught how to write and execute a work plan, basic marketing skills, effective speaking, and communication skills."
2	"Don't water down your academic programs with courses and emphasis on non-traditional IH roles and responsibilities, e.g. safety management, environmental compliance, etc. You can't be a jack of all (these) trades and expect to be an IH too. It's just not possible."
3	"Different areas of practice mandate different skills.
4	"IH should be a discipline of Environmental Health Sciences."

Table 67. Comments from Prospective IH Employers.

No.	Prospective IH Employer Comments
5	"IH and Ergonomics are a driving force in instilling a positive safety culture."
6	"IH programs should have a stronger emphasis on oral and written communication skills, computers, and database management."
7	"It is important for curriculum to be based upon real world needs, with real world examples and projects. A good business background is important too. Day, evening, distance — depends on the university and the program."
8	"The graduate should be knowledgeable of profit potential, psychology, people skills, human behavior management, and selling of self and programs."
9	"The core curriculum should emphasize understanding of new instruments, air handling systems, and all aspects of sampling. IH graduates need ability to think outside the box. Students I have always want specific criteria for their assignment. It's not like that in industry. Someone says perform exposure monitoring and you do it. No body tells you to make a sampling plan or how many samples to take. Also, need skill in wireless computing and virtual reality."
10	"In addition to traditional competencies, candidates must be able to demonstrate oral and written communication skills, problem analysis skills (including scientific method and logic.) Knowledge of laws and regulations must extend to third party (common law) liabilities."
11	"Basic certifications are critical: Asbestos AHERA, Lead Inspector, and Risk Assessment certifications."
12	"Most young folks cannot accept constructive criticism. The writing of new graduates is TERRIBLE! New hires must understand the business aspects of productivity."
13	"I look for knowledge and understanding of engineering economics."
14	"I would prefer an IH trained in medical school."
15	"The ability to effectively communicate with management is crucial.
16	"IH is a multi-disciplinary and/or inter-disciplinary field. IH's should be able to contribute to safe design of buildings and facilities, tools, and equipment. IH's should be able to manage use of chemicals where toxicological data and analytical data are absent."
17	"IH programs should include increased emphasis on endocrine disrupters."
18	"Strong engineering emphasis needed to move IH from the physical sciences into the realm of applied sciences. IH concerns should be addressed during concept and feasibility of equipment design."
19	"IH programs should emphasize general IH, ventilation, human factors engineering, safety, infection control, and toxicology."
20	"The ideal IH curriculum should be: toxicology, epidemiology, ventilation, project administration, process engineering, radiological health, reactive chemicals, laboratory safety, problem solving, infection control, and safety."

Table 67 continued.

No.	Prospective IH Employer Comments
21	"A good IH needs to be able to think clearly in defining problems, forming hypotheses, and making decisions based on evidence. Need to be able to balance objective evidence with perceptions, and bring them together constructively.
	Needs a solid science foundation — sense of being a chemist, physicist, engineer — before starting in IH curriculum— balanced with enough humanities, arts, history, theology, philosophy to integrate objective (scientific) with subjective (human) factors — can't do that effectively with either one alone, but scientific basis is critical."
22	"Distance learning seems appropriate to use for adding knowledge and skills to existing base, not for basic education and training. Need sound technical IH courses, but application to actual workplace conditions. Need understanding of how a factory is organized — both mechanical and human. Clear thinking, clear analysis, clear argument, clear writing."
23	"Industrial Hygienists will not be competitive in business without knowledge of management and budgeting."
24	"People skills, management, business writing, technical report writing."
25	"Capable of high throughput pre-screening for industrial chemicals."
26	"Opportunities to earn masters while working will save $250K per employee."
27	"This is the first time anyone has ever sought my input on what I look for in new employee candidates."
28	"Survey is too long."
29	"Industry values distance learning for corporate travelers and other professionals who need to advance their careers."
30	"Schools should seek input from industry representatives in their service areas."
31	"IH classes over the Internet would save employers' money."
32	"I would like to be able to expect consistent performance between different IH programs' graduates."
33	"Distance learning is nice but very difficult for labs. IH's must have some lab experience — instrument calibration, maintenance, etc. In addition, classroom dynamics and interpersonal dynamics are very important."
34	"IHs should have a firm grounding in the basic disciplines — toxicology, epidemiology, ventilation — and emphasis in communications, project management, epidemiology, and ventilation.

Table 67 continued.

Summary of the Employer Survey Results

To achieve the objectives of this study, the researcher strived to answer six critical questions:

1. Participant demographics: Who is hiring industrial hygiene graduates?

Of the respondents to Survey B, 62% of prospective employers participating in the AIHA Employment Services Job Fair respondents to Survey B described themselves as "Management: Make hiring decisions," 16% percent indicated they were "Technical: Make hiring decisions;" 9% indicated that were "Technical: Make hiring recommendations;" 4% were "Management: Make hiring recommendations;" and 8% identified themselves as "Other." These prospective employers reported a mean work experience of 19.55 years, primarily from "Manufacturing" (39%), "Professional, Scientific, Technical, Consulting" (35%), and "Education Services" (10%), as show in the previous Table 38.

The prospective employers were highly educated. Twenty-five percent reported holding Associate degrees, 100% reported holding Baccalaureate degrees, and 7 individuals reported holding double majors in their Baccalaureate degrees. Eighty-six percent of surveyed employers held Master's degrees, and 16% held Doctoral degrees. As the responses were not mutually exclusive, these results indicate that all 19 Associate degree holders had also pursued and completed their Baccalaureate degree. Two respondents reported holding other professional degrees: one in medicine (MD) and one in law (JD).

The prospective employers most frequently held Associate degrees in "General Science" (8%), "Chemistry" (5%), and "Engineering" (5%). Baccalaureate degrees were held most frequently in the disciplines of "Biology" (21%), "Environmental Health Science" (17%), "Chemistry" (14%), and "Engineering" (8%). Master's degrees were held most frequently in the disciplines of "Industrial Hygiene" (32%), "Environmental Health Science" (16%), “Management” (12%), and “Safety” (9%). Doctoral degrees were held most frequently in the disciplines of “Engineering” (4%), “Environmental Health Sciences” (4%), and “Industrial Hygiene” (3%).

2. Academic program characteristics: What are the employers’ preferred characteristics of current industrial hygiene academic programs?

An overwhelming majority (62%) of the surveyed employers preferred that the Industrial Hygiene program location be within schools of “Public/Allied Health.” Fifteen percent preferred “Engineering,” 12% preferred “Life Sciences,” 6% preferred “Physical Sciences, 3% preferred “Other Collaborative or interdisciplinary structures, and 1% preferred “Social Science.”

The surveyed employers were asked to identify the role of ABET accreditation of an applicant’s IH degree program in their hiring decision. Forty-four percent expressed that it would be “Nice to have, but not a requirement;” 21% reported that it would be “Preferable;” 17% indicated that it was “Not a factor;” 10% indicated that it would be a “Major factor in the hiring decision;” and 3% indicated that it would be ”Absolutely essential for hire.” Five percent gave no response.

The surveyed employers reported the most preferred undergraduate majors of applicants with an IH Master’s degree were Chemistry (19%), Environmental Health Science (15%), Biology (15%), and Engineering (13%).

3. Readiness for “high-tech” distance learning in IH education: Is the profession ready for “high-tech” distance learning in IH education?

The prospective employers of industrial hygienists had the hardware and software experience and capability to incorporate distance-learning strategies into IH education, and may be more receptive and accepting of distance learning degree programs, at this time. Ninety-five percent of the surveyed employers reported being computer users, with a mean of 10.32 years of computer experience. Sixty-eight percent of the responding employers preferred the PC and it's clones, and 24% preferred Apple's Macintosh computers; seven respondents expressed a preference for both platforms. Seventy percent of the surveyed faculty preferred the Microsoft Windows operating system, 23% preferred the Mac OS, 2% preferred UNIX/Linux operating systems, and no respondent expressed a preference for DOS. Four percent of respondents expressed no preference for any operating system. Twenty-six percent rated their level of computer skill as "Intermediate," 65% considered themselves "Advanced," and 5% rated themselves as "Beginners." Forty-five percent reported using a web site in employee teaching and training, 52% did not use a web site in teaching, and 3% gave no response; however, 40% of responding employers were interested in incorporating web-based teaching, 9% were not interested, and 51% gave no response. Fifty-five percent of faculty reported using distance-learning technology, and 43% did not.

Twenty-nine percent of responding employers expressed preference that job applicant's degrees be obtained via "Traditional, on-campus, day program," 23% preferred "On-campus, evening program," 23% preferred an "On-campus, executive program," 14% preferred a "Non-traditional distance learning program," and 12% preferred a "Traditional, off-campus program." Eighty-seven percent of surveyed employers reported they would support an IH employee in obtaining further education via distance-learning programs; 8% would not; and 5% gave no response.

4. Curriculum planning & development inputs: What inputs should be used to develop the industrial hygiene academic curriculum?

The surveyed employers were asked to express preference for inputs into the academic curriculum development process. The prospective employers of industrial hygiene graduates reported preferring that faculty incorporate some external inputs into the curriculum development process. Nineteen percent of employer respondents preferred “Customer needs analysis,” 18% preferred “Survey of industry needs,” 16% preferred “Market needs analysis,” 15% preferred “Survey of the profession,” 12% preferred “Survey of government,” 12% preferred “Survey of alumni,” 10% preferred Survey of other academic programs,” 10% preferred “Faculty input,” 7% preferred “Student input,” and 2% preferred “Other” (unspecified). Considering such external inputs into the curriculum development process would help to keep the curriculum current, responsive, and relevant, while enhancing expected core competencies and employment potential for graduates of such programs.

5. Curriculum: subject/competency preferences: What are employer preferences for core competencies expected to be possessed by industrial hygienists entering professional practice?

Question 23 asked the respondents to rate their preference for each of 42 subject areas typical of inclusion in the IH curriculum, selected from course titles and course syllabus topic areas from the ABET-accredited IH Masters degree programs at the time of the survey. The previous Table 63 shows the ranked employer preference for inclusion of subjects in the Industrial Hygiene curriculum. Additionally, it identifies prospective employers’ preference for an IH Masters degree curriculum, assuming the typical 36- semester hour structure for Master’s degrees. Respondents were asked if the 42 IH subject areas in Question 23 were appropriate at the Associate, Baccalaureate, Masters, or Doctoral levels. Only 11% of employer respondents rated the subject areas as appropriate at the Associate level, while 36% ranked them appropriate at the Master’s level, 30% ranked them appropriate at the Baccalaureate level, and 23% ranked them appropriate at the Doctoral level.

6. Emerging issues influencing IH curriculum development: What are the hot, emerging issues to which the IH curriculum must be responsive?

The employer respondents were asked to list their expectations for emerging issues and topics of sufficient impact to be considered for inclusion in the future IH curriculum in an unstructured, open-ended question. The responses were not mutually exclusive, and were not defined by the respondents. Employers reported 228 total responses for this open-ended question. Table 65 shows the ranked employer expectations for their reported upcoming IH topic areas. The most frequently reported emerging issues were “Ergonomics & Human Factors” (9%), “Indoor Air Quality” (IAQ) (8%), “Environmental Health and Safety (EH&S) Integration and Consolidation” (8%), and “Management” (9%).

CHAPTER VI

CONCLUSION, DISCUSSION, AND RECOMMENDATIONS

Individuals from many disciplines and backgrounds have been contributing to the recognition, evaluation, and control of potentially hazardous workplace exposures since early-recorded history. Since the onset of the modern Environmental Health and Safety (EH&S) movement in the late 1960's, industry and governments have sought to better define hazards, assess risks and the impact of accidents and exposure incidents, and mitigate their consequences. The EH&S professions have long recognized a need for knowledgeable and qualified IH professionals to enter the EH&S workforce with universities offering IH-related classes and degree programs and with voluntary professional credentialing programs, beginning in the early twentieth century. Although the multi-disciplinary profession of Industrial Hygiene has been established for many years and IH practitioners have been prolific in developing the technical tools for recognition, evaluation and control of workplace hazards, few in the IH discipline have turned the tools and methods of scholarly research toward the academic curriculum itself. A review of the literature reveals that published research on IH curricula has been minimal, and that none has evaluated faculty and employer expectations.

This was an initial, exploratory study to identify and evaluate the expectations and perceptions of IH faculty and employers in the areas of IH curriculum content and structure. The objectives of the study were to survey an identified population of IH faculty, to survey an identified population of IH hiring employers, to report the responses, and to compare the responses in select areas. Survey instruments were administered to the Academic Special Interest Group (ASIG) of the American Industrial Hygiene Association, and to hiring employers participating in the AIHA Job Fair program. Expectations and perceptions of IH faculty were herein compared with those of hiring employers of graduates of IH programs. The study populations' skill and capacity with computers and the Internet were assessed as an indicator of readiness to accept and incorporate distance-learning methodology and electronic-media delivery alongside traditional classroom delivery of industrial hygiene education. Comparing responses has identified commonalties and differences of the two surveyed populations. Characteristics of current IH academic programs were identified as a baseline for future evaluation and development of the IH curriculum. The readiness of faculty and employers to accept distance education applications was assessed; and areas for future research in IH education were identified. Recommendations are given for model IH curricula derived from the survey participants' responses.

Professional Experience

Table 68 illustrates the critical characteristics of both IH faculty and employers surveyed. As expected, faculty reported that their emphasis was in the academic applications of IH, while employers reported that theirs was in management. Faculty reported a mean of 22.6 years of professional experience, with a mean of 12.2 years in academia, and employers reported a mean of 19.5 years of professional experience, clearly indicating that both groups were well experienced. The top five reported faculty IH specialties were "General/Comprehensive Practice," "Environmental Health Science," "Aerosols and Bioaerosols," "Exposure Assessment," and "Ventilation." The employer group was not anticipated to be primarily industrial hygienists, and was not asked to report their IH specialties. However, sixty-two percent of prospective employers participating in the AIHA Employment Services Job Fair responding to Survey B described themselves as "Management: Make hiring decisions;" sixteen percent indicated they were "Technical: Make hiring decisions;" 9% indicated they were

"Technical: Make hiring recommendations;" 4% were "Management: Make hiring recommendations;" and 8% identified themselves as "Other."

Academic Degrees Held by Respondents

No surveyed IH faculty reported holding an Associate degree, while 75% of surveyed employers reported holding Associate degrees. IH faculty reported their top five Baccalaureate degrees held were in "Biology," "Environmental Health Science," "Chemistry," "Engineering," and "Industrial Hygiene." Employers most frequently reported that their top Baccalaureate degrees held were similarly in "Biology," "Environmental Health Science," "Chemistry," "Engineering," and "Physics." IH faculty reported most frequently holding Master's degrees in "Environmental Health Science," "Industrial Hygiene," "Toxicology," "Occupational Health," and "Safety." Employers most frequently reported that their top Master's degrees similarly were in "Industrial Hygiene," "Environmental Health Science," "Management and Administration," "Safety" and "Engineering." IH faculty most frequently reported holding Doctoral degrees in "Environmental Health Sciences," "Industrial Hygiene," "Epidemiology," "Public Health," and "Engineering." Employers reported most frequently holding doctoral degrees in "Engineering," "Environmental Health Sciences," "Industrial Hygiene," "Geography" and "Occupational Health." These responses, shown in Table 68, indicate that both faculty and employers surveyed were well educated in IH and related disciplines.

Not only are IH faculty and employer groups quite similar in both educational background and in work experience, but in their areas of academic study. An interesting difference is that a portion of the employer group often began their higher education at the Associate degree level, likely at a local community college, and matriculated to their Baccalaureate or Masters terminal degree while working full-time or part-time; while those who became faculty matriculated directly from their secondary education to senior-level institutions of higher education and pursued graduate level degrees as their terminal. As noted previously, 100% of employer respondents, including the 19 individuals holding an Associate degree, reported holding a Baccalaureate degree; and 86% of the employer respondents reported holding Master's degrees as their terminal.

Reported Number of Students in IH Degree Programs

Table 68 illustrates that IH faculty reported no students enrolled in Associate Degree programs, a mean of 57.8 students enrolled in Baccalaureate degree programs, a mean of 24.8 students enrolled in Master's Degree programs, and a mean of five students enrolled in Doctoral degree programs. Faculty reported no Associate degrees offered in the academic programs represented.

Reported Undergraduate Majors of IH Graduate Students

IH faculty reported that the most frequent undergraduate majors of students in their IH graduate programs were in "Biology," "Chemistry," "Environmental Health Science," "Engineering," and "Safety." Surveyed employers were largely in agreement, and reported most frequently preferring that IH graduate degree holders have undergraduate majors in "Chemistry," "Environmental Health Science," "Biology," "Engineering," and "Physics."

Additionally, the IH faculty reported that their students were most frequently traditional, on-campus, day students, and that their students were well distributed by age. The surveyed employers reported preference for hiring students that had been enrolled in traditional, on-campus, day programs.

Item	Faculty Response	Employer Response
Area in IH	Academic	Management
Mean Years in IH	19.6 (SD 4.43)	19.5 (SD 7.13)
Mean Years in Academia	12.2 (SD 7.28)	
IH Specialty	General/Comprehensive Practice Environmental Health Science Aerosols & Bioaerosols Exposure Assessment Ventilation	
Academic Degrees Held by Respondents		
Associates	None Reported	75%
Baccalaureate	Biology Environmental Health Science Chemistry Engineering Industrial Hygiene	Biology Environmental Health Science Chemistry Engineering Physics
Masters	Environmental Health Science Industrial Hygiene Toxicology Occupational Health Safety	Industrial Hygiene Environmental Health Science Management, Administration Safety Engineering
Doctoral	Environmental Health Sciences Industrial Hygiene Epidemiology Public Health Engineering	Engineering Environmental Health Sciences Industrial Hygiene Geography Occupational Health
Mean Number of Students in IH Program		
Associates	0	
Baccalaureate	57.8 (SD 48.0)	
Masters	24.8 (SD 16.4)	
Doctoral	5 (SD 2.5)	
Student Age Distribution	Well distributed, age-wise	
Undergrad Majors in Graduate Program	Actual	Preferred
	Biology Chemistry Environmental Health Science Engineering Safety	Chemistry Environmental Health Science Biology Engineering Physics
IH Program Delivery	Traditional, on-campus, day	Traditional, on-campus, day

Table 68. Summary of Educational Preferences of IH Faculty vs. Employers.

Recommendation: Targeted Student Recruitment

Faculty are recommended to utilize these identified actual and expected undergraduate majors of those entering IH masters programs to aid in targeting effective recruitment programs and for efficient allocation of scarce recruitment resources. Such targeted recruitment for IH masters degree programs would also aid in reversing the identified trend of declining enrollment in IH and EH&S degree programs across the nation (Zimmerman, 2002; NIOSH, 2005).

Distance Learning Capacities

Table 69 illustrates the capacity for utilizing and accepting distance-learning delivery modes for IH education. Ninety-seven percent of surveyed IH faculty reported they were computer users, and 95% of employers reported being computer users. Both groups were well experienced in computer usage, with faculty reporting a mean of 15.6 years and employers reporting a mean of 10.3 years. Both groups reported preference for PC/clone computers running the Windows operating system. Faculty rated their computer skills at the intermediate level, while employers rated their skills at the advanced level.

Ninety-five percent of surveyed IH faculty reported they were Internet users, and 94% of employers reported being Internet users, with faculty reporting a mean of 4.1 years of Internet usage and employers reporting a mean of 2.5 years. Faculty rated their Internet skills at the intermediate level, while employers rated their skills at the advanced level.

Seventy-six percent of surveyed IH faculty reported having a web site, while 65% of employers reported having a web site; and 30% of faculty reported using a web site in teaching, while 45% of the employer group reported using a web site in training. Sixteen percent of IH faculty were interested in incorporating their web site in their university teaching, as opposed to the reported 40% of employers who were interested in incorporating their web site in their employee training. Forty-five percent of IH faculty reported using distance-learning methods in their teaching, while 55% of the employer group reported using distance-learning methods in their employee training. Real-time video-conferencing was the most frequently preferred distance-learning delivery method for both groups.

Table 69 illustrates that both IH faculty and employers were experienced computer and Internet users with interest in incorporating both the web and distance-learning methods into their education and training programs. Additionally, 87% of surveyed employers reported that they would be in favor of, and would likely support, employees pursuing an IH graduate degree via a distance-learning alternative from a legitimate accredited university, which could keep potential graduate students on the job during matriculation.

Item	Faculty Response	Employer Response
Computer User	97%	95%
Mean Years as Computer User	15.6 (SD 7.0)	10.3 (SD 7.4)
Preferred Platform	PC/Clone	PC/Clone
Preferred OS	Windows	Windows
Level of Computer Skill	Intermediate	Advanced
Internet User	95%	94%
Mean Years as Internet User	4.1 (SD 1.6)	2.5 (SD 2.9)
Level of Internet Skill	Intermediate	Advanced
Do You Have a Web Site	76%	65%
Use Web Site in Teaching/Training	30%	45%
Interested in Web Teaching/Training	16%	40%
Do You Use Distance Learning	45%	55%
Preferred Distance Learning Mode	Video Conferencing	Video Conferencing
Would Support Employee in DL Degree		87%

Table 69. Capacity for Utilizing Distance Learning.

Recommendation: Expanded Degree Delivery System

IH degree programs offered via distance-learning and targeted to working IH and safety professionals would both complement traditional campus degree offerings and add value by affording working professionals graduate-level education opportunities to develop their skill and ability in providing the requisite safe and healthful working environment. Since the mid-1970's, Schools of Business Management have been offering "Executive MBA" degree programs targeted to working professionals as complimentary assets to their traditional on-campus MBA degree programs. As reported in September 2007 by GradSchools.Com, sixteen accredited Texas universities currently offer such "Executive MBA" degrees. Such existing distance-learning Masters programs offer examples and models for a distance-learning IH curriculum. Tulane University offers credible online Master's Degree programs in the occupational safety and health disciplines; and, GradSchools.Com currently identifies twelve online graduate distance programs in IH.

Preferences for Academic and Curriculum Planning

Table 70 illustrates the reported preferences of both IH faculty and employers for expected inputs into curriculum development and planning. IH Faculty reported that their main source of input for curriculum development was "Faculty Input," while the surveyed employers expressed a definite preference for curriculum development input from "Customer Needs Analysis." Clearly, IH faculty preferred to obtain their curriculum development inputs from internal sources such as other faculty, while the employers expected that the IH curriculum development process would most benefit from consideration of external, market driven inputs sourced from customer needs analysis.

Both the surveyed IH faculty and the employer groups reported a strong preference for the IH academic degree program(s) to be located within the university in Schools of Public and Allied Health, which corresponds well with the most frequently reported actual location of IH degree programs within the surveyed faculty's universities in Schools of Public and Allied Health.

Only 22% of surveyed IH faculty reported their programs were accredited by the American Board of Engineering Technology (ABET); and 35% of faculty in non-ABET accredited IH programs reported that their institutions were planning to pursue ABET accreditation in the future. In comparison, 21% of surveyed employers reported a preference in hiring for applicants holding degrees from ABET-accredited IH academic programs.

Questions A30 and B24 asked respondents if the 42 IH subject areas in Question 23 were appropriate at the Associate, Baccalaureate, Masters, or Doctoral levels. The low overall approval responses reported indicate that respondents were not highly supportive of the entire list of subjects overall at any degree level. However, Questions A30 and B24 did not discern the appropriateness of individual subjects at each degree level. Such differentiation on the SRV ranking preference scale would be meaningful and should be considered an appropriate topic for future research.

Item	Faculty Response	Employer Response
Main Curriculum Inputs?	Faculty Input	Customer Needs Analysis
Preferred University Location for IH	Public/Allied Health	Public/Allied Health
Actual Reported University IH Location	Public/Allied Health	
ABET Accredited	22%	
ABET Accreditation Planned	35%	
Preferred Applicants of ABET Accreditation		21%

Table 70. Preferences for Academic and Curriculum Planning.

Preferences for IH Core Competencies: Models for IH Masters Degree Curricula

Table 71 illustrates faculty and employer preferences for IH core competencies as reflected in model curricula for a Masters degree in Industrial Hygiene (assuming a typical thirty-six semester hour requirement). The ranked preference responses for each of forty-two IH subject topic areas (core competencies) were compiled from the course offerings of selected existing IH curricula, and listed in ascending order from the most frequently reported subject topic preference in the Springer Ranking Value model as shown in Table 33 and Table 65.

Data from correlational research can only be "interpreted" in causal terms based on established statistical theory, but correlational data cannot conclusively prove causality. As discussed in Chapter 3, several authors offer guidelines for the interpretation of a correlation coefficient; however, such criteria are somewhat arbitrary and should not be observed too strictly as the interpretation of a correlation coefficient depends on the context and purposes. At the bottom line, the interpretation of the scale depends highly on the context and purpose of the research, and, in any context, the goal “excellence” should, by definition, closely approach a perfect positive correlation.

The reported faculty and employer expectations for the subject topic matrix showed a positive correlation of 0.85 ($r=0.85$; $r^2=0.72$). This is a moderately positive correlation and less than a perfect correlation of 1.0; it indicates that the faculty and employer groups have a good common basis for their expectations and preferences for IH graduates’ core competencies as reflected in the subject topic curriculum matrix developed from common course subject topic titles from the 23 ABET-accredited IH academic programs with the addition of the traditional engineering discipline areas, but have room for improvement.

Excellence in Education has been a resounding theme in higher education since the early 1980’s. Strictly speaking, excellence may be considered perfection. Excellence is viewed generally as the quality of excelling or striving for the long-term goal of perfection. Excellence begins when we know that being good enough or even competent won't carry the day, when doing more or trying harder won't bridge the gap, when striving for the best is simply the only alternative. Excellence is a matter of the stand we take — a stand that allows for performance that surpasses what was previously possible, performance that defies old limits, maps new territory, and motivates us to do better. From an academic point of view, excellence is a grade of "A," not a grade of "C." While perfection may never be fully attained, it is a qualitative goal worth striving to reach.

The moderately positive correlation of 0.85 indicates that the agreement between the surveyed populations is good, but it falls short of the agreement needed for excellence. While perhaps not statistically grounded, in allegorical comparison an exam score of "85" might range from a "B-minus" in a more liberal grading system to a "C-plus" in a more rigorous grading system — and falls short of the goal of excellence as represented in a grade of "A," indicating opportunity to strive for improvement.

The twelve most frequently preferred subject topic areas are shown in Table 71 for a typical 36-semester hour Masters-level curriculum model, with 8 of the 12 subject topics being preferred by both faculty and employers. If the "Internship" and the "Field Experience" subjects are considered similar topics, then 9 out of the 12 topics could be considered as preferred by both groups. Additionally, all of the twelve employer subject preferences are included in the top fifteen faculty preferences, indicating that either thirty-six-semester hour IH Masters curriculum incorporating six optimal electives could facilitate the IH graduate to meet the expectation of most employers by judicious use of elective options. Appendix D illustrates the available published IH Masters degree curriculum models in comparison with the faculty and employer preferred curricula illustrated here in Table 71. These models are offered for consideration in academic curriculum development for improvements and refinements toward the pursuit excellence in Industrial Hygiene higher education.

IH Masters Curriculum		**Semester Hours Credit**
Faculty Preference	**Employer Preference**	
Industrial Hygiene Measurement	Industrial Hygiene Measurement	3
Industrial Hygiene Controls	Instrumentation & Calibration	6
Instrumentation & Calibration	Industrial Hygiene Controls	9
Intro. Industrial Hygiene course	Intro. Industrial Hygiene course	12
Toxicology	Quantitative Industrial Hygiene	15
Internship	Respiratory Protection	18
Industrial Ventilation	Noise Control	21
Epidemiology	Toxicology	24
Ergonomics & Human Factors	Field Experience	27
Quantitative Industrial Hygiene	Industrial Ventilation	30
Respiratory Protection	Industrial Hygiene Problems	33
Industrial Safety	Hearing Conservation	36

Table 71. Faculty vs. Employer Preference for Masters Degree Curriculum.

Table 72 shows how the faculty and employer subject topic curriculum preferences from Table 71 can be combined in a typical degree plan format to illustrate a model Industrial Hygiene Masters degree curriculum with required core components, elective course components, and academic components that support either a research interest (thesis option) or an applied science interest (non-thesis option), incorporates faculty and employer preferences, meets ABET accreditation requirements, and facilitates the pursuit of excellence across the curriculum in Industrial Hygiene higher education.

Core Course Component (24 Semester Hr.)
Industrial Hygiene Measurement Industrial Hygiene Controls Instrumentation & Calibration Intro. Industrial Hygiene Toxicology Industrial Ventilation Epidemiology Quantitative Industrial Hygiene
Elective Course Component (9 Semester Hr.)
Respiratory Protection Noise Control & Hearing Conservation Ergonomics & Human Factors Industrial Safety Industrial Hygiene Problems
Academic Component (3 to 6 Semester Hr.)
Internship or Field Experience Thesis Research Methods

Table 72. Combined Preference for IH Masters Curriculum.

Models for Associate, Baccalaureate, and Masters Curricula

Although this research did not focus specifically on Associate and Baccalaureate degree curricula, the subject topic preference responses coupled with the author's over 25-years of experience in IH and EH&S, including 17-years of college and university teaching, provided adequate information for developing recommended model curricula and for establishing a model for undergraduate prerequisite coursework to facilitate an applicant's preparation for entry into an IH Masters degree program. Appendix E illustrates the recommended model for undergraduate prerequisite coursework. The author's recommended models for an Associate Degree IH curriculum, a Baccalaureate degree IH curriculum, and a Masters degree IH curriculum are shown in Appendices F, G and H, respectively.

Preferences for Non-Technical Core Competencies

The employer group was asked to rank their preferences for the several non-IH core competencies from the Springer Worker Competencies and Attributes Characterization Model (Springer et. al., 1996). The complete preference ranking for these non-IH competencies and attributes was reported in Table 67. Table 73 shows the top five preferred non-IH worker competencies and attributes, as reported by employers. The results of this survey question item have been provided to Dr. S.B. Springer for inclusion into the database of such attributes in Texas' working employees maintained by the Texas Occupational Education Center. These non-IH competencies are incorporated into the recommended model curricula and in the graduate program perquisites in the Management and Leadership course topics, shown in Appendices E and H.

Non-IH Competencies
Makes sound decisions; uses wise judgment
Speaks and writes effectively
Uses analytical and critical thinking skills
Can summarize information
Honest, dependable, polite

Table 73. Top Five Employer Preferred Non-IH Competencies.

Expectations for Emerging Issues

Both the faculty and employer respondents were asked to list their expectations for emerging issues and topics of sufficient impact to be considered for inclusion in future IH curricula. The complete ranked listing of faculty responses was provided in Table 35. Table 65 shows the ranked employer expectations for emerging IH topic areas. Table 74 shows the top six most frequently reported preferences for emerging topics for both faculty and employer respondents, which should be considered in future IH curriculum development.

Faculty Response	Employer Response
Integration/Coordination of EH & IH	Ergonomics & Human Factors
Indoor Air Quality	Indoor Air Quality
Management	EHS Integration/Consolidation
Bioaerosols	Management & Leadership
Behavior-Based Safety & Health	Behavior-Based Safety
Risk Assessment/Risk Management	Global, International Practice

Table 74. Top Six Reported Emerging Issues in IH.

Recommendation: Stakeholder Communication

While both groups have similar total years of experience, faculty experience outside academia is less than half that of employer experience. Faculty could add value and enhance quality to the IH curriculum by considering experienced employer input in the curriculum development planning process. The author recommends that faculty use the existing vehicle of the external advisory committee system to enhance effective communications and interaction in the curriculum development process and consider both market needs and customer needs analyses in curriculum evaluation, and, thus, help to facilitate progress toward the ideal of excellence in the curriculum component of industrial hygiene higher education. While faculty are not obligated to incorporate external inputs, faculty should consider such external inputs from government, business, industry and hiring employers in their curriculum development evaluation, while continuing to ensure academic quality and consistency with expected core competencies and individual program specializations.

The faculty and employer reported preferences for subject topic competencies in IH were used to construct model curricula for an IH Masters-level degree as illustrated in Tables 71 and 72. Faculty should consider these curriculum models to add value in their curriculum development process, as well as considering the recommended curriculum models shown in the Appendices.

Additional Recommendations

To add further value and enhance quality in the IH curriculum development process, similar studies to this one should be conducted periodically, perhaps every three to five years, by, or coordinated by, the American Industrial Hygiene Association and results made available to colleges and universities. Of particular interest for future research would be to differentiate the faculty and employer preferences for the forty-two individual IH subject topic areas by ranking their individual appropriateness at each degree level. The results of future such research would facilitate the identification of trends, allow projections of future impact, help to ensure that preferences and expectations for IH graduates' core competencies remain current and viable in a dynamic and rapidly changing environment, and help to further the ideal of pursuing excellence across the curriculum in Industrial Hygiene higher education. Future publications and articles addressing the IH curriculum and expected core competencies for industrial hygienists will facilitate increasing awareness and communication of this issue across the profession.

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APPENDIX A

American Industrial Hygiene Conference & Exposition
IH Academic Faculty Curriculum Survey
Expectations & Perceptions of the Profession

Please take the time to answer the following questions and leave your sheets with the moderators or at the exit door. A summary of the survey results will be distributed to the AIHA Faculty SIG. Thank you!

PARTICIPANT DEMOGRAPHICS

1. Your job/position in Industrial Hygiene:
_____ IH Academic
_____ IH Technical
_____ IH Management
_____ Other Technical ____________________________________

_____ Other Management ____________________________________

2. Number of years in Industrial Hygiene practice: ________

3. Your specialty area(s) In Industrial Hygiene practice:
____

4. Subject area of your academic degrees:
BS ____
MS ____
PhD ____
Other ____

5. Your number of years in academia? ______________________________

ACADEMIC SECTION

6. Number of faculty in your program: ____________________

7. Number of students in your program:
AS _____ MS _____ Other _____

BS _____ PhD _____ Name: __________

8. The most common undergraduate majors in your graduate program:
i. ____ ii. ____

ii. ____ iv. ____

9. Your IH degree program is delivered via:
Traditional, on-campus day program Yes _____ No _____
On-campus evening program Yes _____ No _____
On-campus evening or executive program Yes _____ No _____

Traditional, Off-campus program Yes _____ No _____
Nontraditional, distance learning program Yes _____ No _____

10. Your students are predominately:
Younger, straight through from high school Yes _____ No _____
Older, with some professional experience Yes _____ No _____
Well distributed, age-wise Yes _____ No _____

COMPUTER & INTERNET DEMOGRAPHICS

11. Are you a computer user? No _____ Yes _____ (Years _______)

12. Computer Platform? PC/Clone _____ Mac _____ UNIX _____ Other _____

13. Preferred Operating System? ____

14. Level of computer skill? Beginner _____ Intermediate _____ Advanced _____

15. Are you an Internet user? No _____ Yes _____ (Years _______)

16. Level of Internet skill? Beginner _____ Intermediate _____ Advanced _____

17. Do you have a web site Yes _____ No _____

18. If yes above, is your web site:
Personal Yes _____ No _____
Program/Department Yes _____ No _____
College/university Yes _____ No _____

19. Do you use a web site in your teaching? Yes _____ No _____

20. If no above, are you interested in using a web site in your teaching? Yes _____ No _____

21. Do you use distance learning technology in your teaching? Yes _____ No _____

22. Which method(s) of distance learning technology do you prefer?
_____ Real-time video-conferencing
_____ Direct-to-desktop via Internet
_____ Interactive CD-ROM
_____ Written correspondence course
_____ Video-taping for later viewing
_____ Other __________________________________

IH CURRICULUM PLANNING SECTION

23. What inputs were/are used in developing your school's IH curriculum?
Market Needs Analysis Yes _____ No _____
Customer Needs Analysis Yes _____ No _____
Survey of the profession Yes _____ No _____
Survey of your alumni Yes _____ No _____

Student input Yes _____ No _____
Faculty input Yes _____ No _____
Survey of other academic programs Yes _____ No _____
Survey of Industry Yes _____ No _____
Survey of government Yes _____ No _____
Other: ____
____
____

24. Learning objectives should :
Be course/subject specific Yes _____ No _____
Be across the curriculum Yes _____ No _____
Use subjective format(s) Yes _____ No _____
Use objective format(s) Yes _____ No _____
Be quantitative Yes _____ No _____
Be qualitative Yes _____ No _____
Be some optimal mix of the above Yes _____ No _____

25. Within the university, the optimal location/home for the IH program would be:
Physical sciences Yes _____ No _____; discipline: __________________________
Life Sciences Yes _____ No _____; discipline: __________________________
Public Health Yes _____ No _____; discipline: __________________________
Management Yes _____ No _____; discipline: __________________________
Engineering Yes _____ No _____; discipline: __________________________
Social sciences Yes _____ No _____; discipline: __________________________
Agriculture Yes _____ No _____; discipline: __________________________
Other Yes _____ No _____; discipline: __________________________

26. At your school, the location/home for the IH program is: ______________________________
____

27. Your IH program is ABET accredited? Yes _____ No _____

28. If no above, is accreditation in the plan? Yes _____ No _____

COMMENT SECTION:

IH CURRICULUM DEVELOPMENT SECTION

29. Following is a list of the IH core competency/skill areas, as derived from the professional literature. Please rate the priority for each of the following subjects in the IH curriculum (1=lowest to 5=highest;) as either a stand-alone course or as a topic in a course . NOTE: this item does not address non-IH curriculum components or prerequisite requirements.

Competency/Skill	Rating Lowest Highest
Intro. IH course	1 2 3 4 5
IH Measurement	1 2 3 4 5
Instrumentation & Calibration	1 2 3 4 5
IH Controls	1 2 3 4 5
Toxicology	1 2 3 4 5
Epidemiology	1 2 3 4 5
Field Experience	1 2 3 4 5
Internship	1 2 3 4 5
Industrial Ventilation	1 2 3 4 5
Noise Control	1 2 3 4 5
Hearing Conservation	1 2 3 4 5
Acoustical Physics	1 2 3 4 5
Acoustical Engineering	1 2 3 4 5
Ergonomics	1 2 3 4 5
IH Problems	1 2 3 4 5
Environmental Health	1 2 3 4 5
Env. Management	1 2 3 4 5
HazMat & HAZWOPER	1 2 3 4 5
Respiratory Protection	1 2 3 4 5
Occupational Health	1 2 3 4 5
Occupational Medicine	1 2 3 4 5
Health Physics	1 2 3 4 5
Radiation Safety	1 2 3 4 5
Fire Science	1 2 3 4 5
Industrial Safety	1 2 3 4 5
OSHA Compliance	1 2 3 4 5
Laboratory Safety	1 2 3 4 5
Safety Engineering	1 2 3 4 5
Hazardous Waste Mgt	1 2 3 4 5
Environmental Science	1 2 3 4 5
Environmental Law & Policy	1 2 3 4 5
Labor Relations	1 2 3 4 5
IH Management	1 2 3 4 5
Environmental Engineering	1 2 3 4 5
Electrical Engineering	1 2 3 4 5
Chemical Engineering	1 2 3 4 5
Mechanical Engineering	1 2 3 4 5
Industrial Engineering	1 2 3 4 5
Public Health	1 2 3 4 5
Preventative Medicine	1 2 3 4 5
Quantitative IH	1 2 3 4 5
Economics/Finance	1 2 3 4 5

30. Are the above listed IH curriculum components appropriate for a:

AS degree	Yes _____	No _____
BS degree	Yes _____	No _____
MS degree	Yes _____	No _____
PhD degree	Yes _____	No _____

31. What are the hot, up-coming topic/subject areas in Industrial Hygiene, which will need to be considered in the IH curriculum over the next 3 to 5 years?

i. ____
ii. ____
iii. ____
iv. ____
v. ____

APPENDIX B

Texas A&M University
Industrial Hygiene Employer Expectation Survey
Expectations & Perceptions of the Profession

This survey is intended to identify the core competencies that employers expect in Industrial Hygienists, especially when considering recent college graduates for employment. The results will be compared with the results of a similar survey of IH faculty, to identify differences in expectations and opportunities for improvement. Thank you for your time and contribution!

PARTICIPANT DEMOGRAPHICS

1. Your job/position:

_____ Management: Make hiring decisions
_____ Management: Make hiring recommendations
_____ Technical: Make hiring decisions
_____ Technical: Make hiring recommendations
_____ Other: Make hiring decisions
_____ Other: Make hiring recommendations

2. Number of years experience: ________

3. You/your company is in what business/profession:

_____ Agriculture, Forestry
_____ Mining
_____ Utilities
_____ Construction
_____ Manufacturing
_____ Wholesale Trade
_____ Retail Trade
_____ Transportation & Warehousing
_____ Information
_____ Finance & Insurance
_____ Real Estate, Rental & Leasing
_____ Professional, Scientific & Technical
_____ Management of Companies & Enterprises
_____ Administrative & Support
_____ Education Services
_____ Health Care, Social Assistance
_____ Arts, Entertainment, Recreation
_____ Accommodation & Food Services
_____ Public Administration
_____ Other ______________________________

4. Subject area of your academic degrees:

AS ____

BS ____
MS ____
PhD ____
Other ____

COMPUTER & INTERNET DEMOGRAPHICS

5. Are you a computer user? No _____ Yes _____ (Years _______)

6. Computer Platform?	PC/Clone _____	Mac _____	UNIX _____	Other _____
7. Preferred Operating System?	PC/Clone _____	Mac _____	UNIX _____	Other _____
8. Level of computer skill?	Beginner _____	Intermediate _____	Advanced _____	
9. Are you an Internet user?	No _____	Yes _____	(Years _______)	
10. Level of Internet skill?	Beginner _____	Intermediate _____	Advanced _____	
11. Do you have a web site	Yes _____	No _____		

12. If yes above, is your web site:
Personal Yes _____ No _____ Business Yes _____ No _____

13. Do you use a web site for education & training? Yes _____ No _____

14. If no above, would you use a web site for education & training? Yes _____ No _____

15. Does your company use distance learning technology? Yes _____ No _____

16. Which method(s) of distance learning technology do you (would you) prefer?
_____ Real-time video-conferencing
_____ Direct-to-desktop via Internet
_____ Interactive CD-ROM
_____ Written correspondence course
_____ Video-taping for later viewing
_____ Other ___________________________________

17. You/your company would prefer that applicants for IH positions hold academic degrees obtained via:

Traditional, on-campus day program	Yes _____	No _____
On-campus evening program	Yes _____	No _____
On-campus evening or executive program	Yes _____	No _____
Traditional, Off-campus program	Yes _____	No _____
Non-traditional, distance learning program	Yes _____	No _____

18. You/your company would support an IH employee in obtaining further education or training, via distance learning programs? Yes _____ No _____

IH CURRICULUM PLANNING SECTION

19. What inputs should be used in developing/reviewing a school's IH curriculum?

Market Needs Analysis	Yes _____	No _____
Customer (Employer) Needs Analysis	Yes _____	No _____
Survey of the profession	Yes _____	No _____
Survey of alumni	Yes _____	No _____
Student input	Yes _____	No _____
Faculty input	Yes _____	No _____
Survey of other academic programs	Yes _____	No _____
Survey of Industry	Yes _____	No _____
Survey of government	Yes _____	No _____

Other: ____

20. Within the university, the optimal location/home for the IH program would be (select only one):

Physical sciences	Yes _____	No _____;	discipline: ______________________
Life Sciences	Yes _____	No _____;	discipline: ______________________
Public Health	Yes _____	No _____;	discipline: ______________________
Management	Yes _____	No _____;	discipline: ______________________
Engineering	Yes _____	No _____;	discipline: ______________________
Social sciences	Yes _____	No _____;	discipline: ______________________
Agriculture	Yes _____	No _____;	discipline: ______________________
Other	Yes _____	No _____;	discipline: ______________________

21. What role does ABET accreditation of an applicant's IH academic program play in your hiring decision? (select only one)

1- Not a factor in the hiring decision
2- Nice to have, but not a requirement
3- Preferable
4- Major factor in the hiring decision
5- Absolutely essential for hire

22. When considering an applicant who holds a masters-level degree in IH, for an IH position, what undergraduate degree/major is most preferable to you? (List in ascending order of preference)

i. ____

ii. ____

iii. ____

iv. ____

v. ____

INDUSTRIAL HYGIENE: EXPECTED CORE COMPETENCY AREAS

23. Following is a list of the IH core competency/skill areas, as derived from the professional literature. Please rate each competency area on the basis of your expectancy of an IH job applicant possessing competency in the area. (1=lowest expectation to 5=highest expectation). NOTE: this item does not address non-IH components or prerequisite requirements.

Competency/Skill	Rating Lowest Highest
Intro. IH course	1 2 3 4 5
IH Measurement	1 2 3 4 5
Instrumentation & Calibration	1 2 3 4 5
IH Controls	1 2 3 4 5
Toxicology	1 2 3 4 5
Epidemiology	1 2 3 4 5
Field Experience	1 2 3 4 5
Internship	1 2 3 4 5
Industrial Ventilation	1 2 3 4 5
Noise Control	1 2 3 4 5
Hearing Conservation	1 2 3 4 5
Acoustical Physics	1 2 3 4 5
Acoustical Engineering	1 2 3 4 5
Ergonomics	1 2 3 4 5
IH Problems	1 2 3 4 5
Environmental Health	1 2 3 4 5
Env. Management	1 2 3 4 5
HazMat & HAZWOPER	1 2 3 4 5
Respiratory Protection	1 2 3 4 5
Occupational Health	1 2 3 4 5
Occupational Medicine	1 2 3 4 5
Health Physics	1 2 3 4 5
Radiation Safety	1 2 3 4 5
Fire Science	1 2 3 4 5
Industrial Safety	1 2 3 4 5
OSHA Compliance	1 2 3 4 5
Laboratory Safety	1 2 3 4 5
Safety Engineering	1 2 3 4 5
Hazardous Waste Mgt	1 2 3 4 5
Environmental Science	1 2 3 4 5
Environmental Law & Policy	1 2 3 4 5
Labor Relations	1 2 3 4 5
IH Management	1 2 3 4 5
Environmental Engineering	1 2 3 4 5
Electrical Engineering	1 2 3 4 5
Chemical Engineering	1 2 3 4 5
Mechanical Engineering	1 2 3 4 5
Industrial Engineering	1 2 3 4 5
Public Health	1 2 3 4 5
Preventative Medicine	1 2 3 4 5
Quantitative IH	1 2 3 4 5
Economics/Finance	1 2 3 4 5

24. Are the above listed IH competencies appropriate for:

AS degree	Yes _____	No _____
BS degree	Yes _____	No _____
MS degree	Yes _____	No _____
PhD degree	Yes _____	No _____

25. What are the hot, up-coming topic/subject areas in Industrial Hygiene, which will need to be considered as core competencies in the IH curriculum over the next 3 to 5 years?
    i. ____
    ii. ____
    iii. ____
    iv. ____
    v. ____

COMMENTS: EXPECTED CORE COMPETENCIES FOR INDUSTRIAL HYGIENISTS
(Please add your comments regarding expected core competencies for industrial hygienists, IH academic degree programs, and distance learning options for industrial hygiene education and training.)

NON-INDUSTRIAL HYGIENE: EXPECTED CORE COMPETENCY AREAS

26. As an employer, please rate a level of expectance/importance to you for each competency or attribute listed below. (1=lowest expectation to 5=highest expectation.)

Employee Competency/Attribute	**Rating** **Lowest**				**Highest**
Maturity and experience in job responsibility	1	2	3	4	5
Willingness to work under pressure	1	2	3	4	5
Adapts to change; secure enough to take risks	1	2	3	4	5
Accepts challenges presented by new equipment, procedures, techniques	1	2	3	4	5
Teaches others new skills	1	2	3	4	5
Contributes to group efforts; team-player	1	2	3	4	5
Works readily within a diverse workgroup	1	2	3	4	5
Accepts constructive criticism	1	2	3	4	5
Courteous, considerate, pleasant	1	2	3	4	5
Good grooming; professional personal appearance	1	2	3	4	5
Honest, dependable, polite	1	2	3	4	5
Makes sound decisions, uses wise judgment	1	2	3	4	5
Enhances job skills to meet new challenges	1	2	3	4	5
Sets goals; takes pride in work accomplished	1	2	3	4	5
Willingness to relocate	1	2	3	4	5
Works without excessive guidance	1	2	3	4	5
Lifelong learning commitment; solid work ethics	1	2	3	4	5
Speaks and writes effectively	1	2	3	4	5
Follows oral and written instructions	1	2	3	4	5
Good command of language; appropriate use of language	1	2	3	4	5
Competence in reading, writing and computation	1	2	3	4	5
Can summarize information	1	2	3	4	5
Can monitor one's work	1	2	3	4	5
Uses analytical and critical thinking skills	1	2	3	4	5
Works with a variety of technologies	1	2	3	4	5
Selects the correct procedures, tools or equipment to maximize output	1	2	3	4	5
Understands concepts of job	1	2	3	4	5
Exercises safety precautions	1	2	3	4	5
Exhibits versatility and leadership	1	2	3	4	5
Can motivate co-workers	1	2	3	4	5
Assesses forces affecting employer	1	2	3	4	5
Concerned with productivity	1	2	3	4	5
Knows how social, organizational, and technological systems works; operates effectively within them	1	2	3	4	5

Thank you for your participation in this project to identify employer expectations of industrial hygiene core competencies for graduates of IH academic programs. Please list any additional comments on bottom of previous pages of this document.

Please mail survey to:

David C. Breeding
3126 TAMU
Texas A&M University
College Station, TX 77843-3126
or fax to: **979-458-3946**

APPENDIX C

ABET Accredited Industrial Hygiene Degree Programs		
Baccalaureate Degree Programs		
1	California State University, Northridge	
		Environmental and Occupational Health Science (BS) [1998]
2	North Alabama, University of	
		Industrial Hygiene (BA) [2003]
		Industrial Hygiene (BS) [2003]
3	Ohio University	
		Industrial Hygiene (BS) [1998]
4	Purdue University at West Lafayette	
		Occupational Health Sciences (BS) [1997]
5	Utah State University	
		Public Health, Emphasis: Industrial Hygiene (BS) [1998]
Masters Degree Programs		
1	University of California, Los Angeles	
		Industrial Hygiene (MSEHS) [1993]
		Industrial Hygiene (MSPH) [1993]
2	University of Central Missouri	
		Industrial Hygiene (MS) [1998]
3	University of Cincinnati	
		Environmental and Industrial Hygiene (MS) [1989]
4	Colorado State University	
		Environmental Health (Occupational Health and Industrial Hygiene specialization) (MS) [1996]
5	Harvard School of Public Health	
		Industrial Hygiene (MS) [1992]
6	Hunter College of the City University of New York	
		Environmental and Occupational Health Science (MS) [2002]

ABET Accredited Industrial Hygiene Degree Programms		
Masters Degree Programs		
7	University of Illinois at Chicago	
		Industrial Hygiene (MPH) [1993]
		Industrial Hygiene (MS) [1993]
8	University of Iowa	
		Industrial Hygiene (MS) [1995]
9	The Johns Hopkins University	
		Industrial Hygiene (MS) [1990]
10	University of Massachusetts Lowell	
		Industrial Hygiene (MS) [1994]
11	University of Michigan	
		Environmental Health Sciences-Industrial Hygiene (MPH) [2007]
12	Montana Tech of the University of Montana	
		Industrial Hygiene (MS) [1999]
13	The University of Oklahoma Health Sciences Center	
		Environmental Management and Industrial Hygiene (MPH) [2000]
		Environmental Management and Industrial Hygiene (MS) [2000]
		Industrial Hygiene (MPH) [1994]
		Industrial Hygiene (MS) [1994]
14	Purdue University at West Lafayette	
		Industrial Hygiene (MS) [1997]
15	San Diego State University	
		Industrial Hygiene (MS) [1997]
16	University of South Carolina	
		Industrial Hygiene (MPH) [1993]
		Industrial Hygiene (MSPH) [1993]
17	University of South Florida	
		Industrial Hygiene (MS) [1996]

ABET Accredited Industrial Hygiene Degree Programs		
Masters Degree Programs		
18	University of Texas at Houston	
		Industrial Hygiene (MPH) [1996]
		Industrial Hygiene (MS) [1996]
19	Toledo, University of	
		Occupational Health (Industrial Hygiene) (MS) [1996]
20	Tulane University	
		Industrial Hygiene (MS) [1998]
21	Uniformed Services University for the Health Sciences	
		Environmental and Occupational Health (MS) [2004]
22	University of Utah	
		Public Health w/emphasis in Industrial Hygiene (MPH) [2005]
		Public Health w/emphasis in Industrial Hygiene (MS) [1989]
23	Wayne State University	
		Occupational and Environmental Health Sciences (Specialty in Industrial Hygiene) (MS) [1996]
24	West Virginia University	
		Industrial Hygiene (MS) [1995]
TOTALS		
	5 Baccalaureate Degree Programs	
	24 Masters Degree Programs	

APPENDIX D

Comparison of Model Curricula for Industrial Hygiene Masters Programs			
Faculty Preference	**Employer Preference**	**AIHA, 1971**	**Cumulative Semester Hr's**
Industrial Hygiene Measurement	Industrial Hygiene Measurement	Air Pollution	3
Industrial Hygiene Controls	Instrumentation & Calibration	Air Sampling & Analysis	6
Instrumentation & Calibration	Industrial Hygiene Controls	Biostatistics	9
Intro. to Industrial Hygiene	Intro. to Industrial Hygiene	Non-Engineering Controls	12
Toxicology	Quantitative Industrial Hygiene	Industrial Ventilation	15
Internship	Respiratory Protection	Intro. Industrial Hygiene	18
Industrial Ventilation	Noise Control	Seminar	21
Epidemiology	Toxicology	Health Physics	24
Ergonomics & Human Factors	Field Experience	Noise & vibration	27
Quantitative Industrial Hygiene	Industrial Ventilation	Toxicology	30
Respiratory Protection	Industrial Hygiene Problems	Thesis	33
Industrial Safety	Hearing Conservation	Project	36
Perkins Model, 1997	**NIOSH Model, 1975; 1976**	**ABET, 1997; 2007**	**Cumulative Semester Hr's**
Intro. Industrial Hygiene	Intro. to Hazard Evaluation	Engineering-Related Sciences	3
Health Physics	Intro. to OSHA	IH-Related Sciences	6
Air Sampling & Analysis	Gas & Vapor Sampling	IH-Related Sciences	9
Fundamentals of Occupational Safety	Air Flow Measurements	Engineering-Related Specialties	12
Biostatistics	Particulate Sampling	Engineering-Related Specialties	15
Epidemiology	Industrial Ventilation	Engineering-Related Specialties	18
Noise Effects & Control	Heat Stress	Unspecified Courses	21
Temperature & Pressure	Radiation Safety	Unspecified Courses	24
Toxicology	Sound & Noise	Unspecified Courses	27
Occupational Diseases	Job Design	Unspecified Courses	30
Control of Occupational Hazards	Ergonomics	Other	33
IH Case Studies	Industrial Illumination	Other	36

APPENDIX E

Recommended Model for Undergraduate Prerequisite Coursework For Entry Into an Industrial Hygiene Masters Degree Program	
Required Prerequisite Courses:	
	General Chemistry I & II
	Organic Chemistry I & II
	Calculus I & II
	Physics I & II
	Biology I & II
	Human Anatomy & Physiology I & II
	Statistics or Biostatistics
Optional Prerequisite Courses:	
	Inorganic Chemistry I & II
	Physical Chemistry I & II
	Technical Writing
	Finance or Engineering Economy
	Management (Business or Engineering) & Leadership

APPENDIX F

Recommended Model for an Industrial Hygiene Associate Degree Two-Year Undergraduate Curriculum — Lower Division & Technical Courses With Appropriate Prerequisites for Entering an IH Baccalaureate Degree Program	
Freshman Year	
First Semester	**Second Semester**
General Chemistry I	General Chemistry II
Biology I	Biology II
English Composition I	English Composition II
Algebra I or Calculus I	Algebra II or Calculus II
Humanities or Social Sciences Elective	Humanities or Social Sciences Elective
Sophomore Year	
Third Semester	**Fourth Semester**
Hazardous Materials Management	Hazardous Waste Management
Organic Chemistry I	Organic Chemistry II
Physics I	Physics II
Industrial Hygiene	Environmental & Occupational Health
Industrial Safety	IH Instrumentation

APPENDIX G

Recommended Model for an Industrial Hygiene Baccalaureate Degree Four-Year Undergraduate Program Compliant with ABET Accreditation Standards Showing Recommended Lower Division & Upper Division Courses With Appropriate Prerequisites for Entering an IH Masters Degree Program	
Freshman Year	
First Semester	**Second Semester**
General Chemistry I	General Chemistry II
Biology I	Biology II
English Composition I	English Composition II
Algebra I or Calculus I	Algebra II or Calculus II
Human Relations	Public Health
Sophomore Year	
Third Semester	**Fourth Semester**
Human Anatomy & Physiology I	Human Anatomy & Physiology II
Organic Chemistry I	Organic Chemistry II
Physics I	Physics II
Environmental Health Science	Ergonomics & Human Factors
Leadership	Industrial Safety
Junior Year	
Fifth Semester	**Sixth Semester**
Radiation Safety or Radiological Health	Industrial Hygiene Engineering
Industrial Hygiene	Industrial Hygiene Instrumentation
Environmental Law & Policy	Environmental Engineering
Quantitative Analysis	Statistics or Biostatistics
Epidemiology	Exposure Assessment & Disease Control
Senior Year	
Seventh Semester	**Eighth Semester**
Quantitative Industrial Hygiene	Hazardous Materials Management
Management (Business or Engineering)	Hazardous Waste Management
Finance or Engineering Economy	Environmental Management
Toxicology	Occupational Health
IH Internship or Field Experience	Air and Water Quality Management

APPENDIX H

Recommended Model for an Industrial Hygiene Masters Degree		
Core Course Component		**(24 Semester Hr.)**
	Industrial Hygiene Measurement	
	Industrial Hygiene Controls	
	Instrumentation & Calibration	
	Intro. Industrial Hygiene	
	Toxicology	
	Industrial Ventilation	
	Epidemiology	
	Quantitative Industrial Hygiene	
Elective Course Component		**(Min. 9 Semester Hr.)**
	Respiratory Protection	
	Noise Control & Hearing Conservation	
	Ergonomics & Human Factors	
	Industrial Safety	
	Industrial Hygiene Problems	
	Management (Business or Engineering)	
	Leadership	
	Labor Relations	
Academic Component		**(3 to 6 Semester Hr.)**
	Internship or Field Experience	
	Thesis	
	Research Methods	

APPENDIX I

The Springer Worker Competencies and Attributes Characterization Model

Values for the matrices of subject matter rating items were ranked using the Springer worker competencies and attributes characterization model, a technique for analyzing forced-response ranking values to allow a relative ranking of respondent preferences (Springer et al., 1996).

Springer Ranking Value (SRV)

SRV = [(Rank 1 * Value) + (Rank 2 * Value) + (Rank 3 * Value) +(Rank 4 * Value)+ (Rank 5 * Value)]/N
SRV = [(1 * Value) + (2 * Value) + (3 * Value) +(4 * Value)+ (5 * Value)]/N
SRV = [(1 * 0) + (2 * 3) + (3 * 0) +(4 * 1)+ (5 * 34)]/35
SRV = 180/35
SRV = 180/35
SRV = 5.14

Value = Total of responses for the Ranking
N = Population responding

VITA

David Clarence Breeding holds both the BS (1974) and the MS (1979) in Environmental & Occupational Health from East Tennessee State University, the MBA (1988) in Organizational Analysis & Strategic Management Planning from Vanderbilt University, and is a graduate of the Environmental Controls Institute (1975) at Reynolds College. He has completed post-graduate studies in environmental management at George Washington University, in industrial hygiene at the Harvard School of Public Health, in industrial toxicology at Wayne State University, in hazardous materials emergency management at the Georgia Institute of Technology, in security vulnerability risk assessment at the Texas Engineering Extension Service, and in labor relations at the University of Tennessee.

Breeding has over 25 years of professional experience including, Director of the Office of Engineering Safety at Texas A&M University & TEES: Director of the OSHA Training Institute-Southwest Education Center; Head of Environmental & Occupational Safety Training with TEEX; Corporate Industrial Hygiene Manager for Champion International Corporation; Director of Education, Training & Technical Assistance with OSHA in North Carolina; Assistant Professor of Environmental & Occupational Health Sciences at Western Carolina University, and Assistant Professor of EH&S Technology at Walters State College. He began his career as a Health Compliance Officer for the State of Virginia, working with business, industry, and public institutions.

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