PROGRAM ASSESSMENT:

INDUSTRIAL HYGIENE AND SAFETY SCIENCES

A Dissertation Presented to

The Faculty of the Graduate School

University of Missouri-Columbia

In Partial Fulfillment

Of the Requirements for the Degree

Doctor of Education

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by

JOHN NICHOLAS ZEY

Dr. Sandy Hutchinson, Dissertation Supervisor

DECEMBER 2010

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The undersigned, appointed by the Dean of the Graduate School, have e
dissertation entitled

PROGRAM ASSESSMENT: INDUSTRIAL HYGIENE

AND SAFETY SCIENCES

Presented by John Nicholas Zey

A candidate for the degree of doctor of education

And hereby certify that in their opinion it is worthy of acceptance.

Dr. Sandy Hutchinson, Dissertation Supervisor

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DEDICATION

I dedicate this dissertation, a product of seven years of labor, love, sweat and anxiety to the following individuals. First my beloved mother, Dorothy May (Fisher) Zey. She was and is my first hero. Her love of life and for her family has rubbed off on little Johnnie. She worked more than any other person I have ever known. I can never repay her contributions to me. Second, I dedicate this endeavor to my father, Eugene H. Zey. One sibling described him as tall, skinny and mean. Regardless, with his wife, Dorothy May Fisher, he raised 14 children who have all found their way in the world. After raising two kids of my own, I understand him a little better than I did. I was 14 when he died. Not a happy time in my life.

Next, I dedicate this dissertation to my 13 siblings. Yes, I know all their names; all are special to me in one way or another. They are from the oldest, Dorothy, Marceline, Kenny, Hubert, Janice, Claude, Richard, Mike, Ruth, Carol Beth, Bob, Steve and Michelle. Some say growing up poor in a large family is tough. I say it builds character. Besides, being child number 11, helped as my dad was worn out from disciplining the older kids! My number of spankings was relatively few.

Next I dedicate this dissertation to my high school class mates from good old Prairie Home High School. We were small in number, but big in ideas. They are a second family whom I will never forget. I formed my first friendships, outside of my family, among this group.

I also dedicate this dissertation to the dozens of individuals I worked closely with at NIOSH. I learned from all of them, both good and, occasionally, things that were not so good. Most especially, to those individuals who worked in Morgantown, WV from 1976-1980. We were young and inexperienced, but willing to ask for help. Fortunately we always found someone with the answers.

I dedicate this dissertation to my colleagues in the Department of Safety Sciences at UCM in Warrensburg, MO. It has been my pleasure to watch this Department evolve into what is, in my opinion, the best OSH department in the US. The Chairs I have served: Dr. Prince, Dr. Greife, Mr. Womble, Dr. Laster, and Dr. Blunt, have collectively guided this band of merry warriors through turbulent waters. Especially to Dr. Leigh Ann Blunt, who stood up to the bullies and has proven her colleagues in the Department of Safety Sciences, who selected her as Chair, were very astute in their selection, more so than some administrators.

To the students I have taught in the Department of Safety Sciences. They have endured my attempts at humor, my singing, my dancing, the voices I do (those I hear in my head) and my stress relievers (toys, jokes, etc).

Last, and certainly most importantly, I dedicate this tome to my immediate family. To my beautiful wife Alice, I was sure she would not go out with me, but she did. I am not sure how I found the courage to ask her out as we were standing on the 3rd floor of the WCM Science building in the Fall of 1974. But I did. Our first date was to play cards at my sister's house. Yes, even that did not deter her from becoming my wife. My children for whom I would surely give up my life to save are special to me beyond belief. Sarah, my first born, was the prettiest baby I have ever seen. Kat, my second born, was also the prettiest baby I have ever seen. Watching them grow and develop into adults has been neat. I can now let them leave the nest knowing they have what it takes to survive in the big world.

ACKNOWLEDGEMENTS

To the reviewers of my dissertation, and they were many in number, I offer my thanks. You helped make the final product much better for your efforts. The three external reviewers were Dr. George Agoki, with Andrews University in Berrien Springs, Michigan, Dr. Phil Smith, with the Uniformed Services University, Bethesda, Maryland, and Dr. Georgi Popov, with the Department of Safety Sciences, UCM, Warrensburg, Missouri. I also acknowledge my family members who reviewed this document, and faculty and administrators from UCM, who also took the time to review one or more drafts of the dissertation. A special note of thanks to Dr. Brenda Moeder, who twice reviewed my dissertation and helped me reduce the number of errors it contains.

My undying thanks to my dissertation committee: Dr. Hutchinson, Dr. Laster, Dr. Kreiner, Dr. Martin and Dr. Castro. I owe lots to my committee chair, Dr. Sandy Hutchinson. Dr. Sandy guided me through some rough spots and has the neatest – frog filled – office I have ever seen. My thanks will have to do until you five are better paid (don't hold your breath).

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PROGRAM ASSESSMENT:
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ABSTRACT

Program assessment has long been a critical element for academic programs to ensure continuous quality improvement of their programs. More recently, occupational safety, health and environmental programs have embraced assessment by external groups as well. The University of Central Missouri, a mid-sized school in Western Missouri has produced 400 alumni with master's degrees in industrial hygiene. The program, housed in the Department of Safety Sciences, is accredited by ABET. To assess what alumni of the program think of their preparation by the Department, as well as their views on what courses and topics and skills and knowledge entry level industrial hygienists should have, a comprehensive assessment of the program was conducted. Assessment instruments used in this research study included an on-line survey and a review of historical documents.

The results revealed that alumni overwhelmingly believe their preparation by the Department for their careers in industrial hygiene was above average. The skills and knowledge and courses and topics selected by alumni as essential for industrial hygiene graduate students included those in the practitioner category.

The majority if alumni believed their preparation by the Department for their career in industrial hygiene was above average or excellent. Very few believed their preparation was poor. The methodologies used in this research are applicable for use by faculty from other academic departments.

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CHAPTER ONE

INTRODUCTION

Each week in the United States millions of people go to and from their jobs without serious thought to the history of working conditions in the United States. Such jobs have often been presented in a light-hearted fashion in literature and movies. Examples of these portrayals include the Mad Hatter from *Alice in Wonderland* and chimney sweeps, as presented in *Mary Poppins.* The Mad Hatter from *Alice in Wonderland* is a harmless appearing, wild haired character who is a bit scatter-brained, but who manages to help Alice to reach her quest in the end. Chimney sweeps were presented as adult males who liked to sing and dance while cleaning chimneys. In reality these literary characters are loosely based on occupations that involved toxic exposures to chemical and physical agents. Chimney sweeps were actually young boys between five and ten years of age whose job required them to climb inside chimneys to clean the soot that had built up from burning coal (Brown & Thronton, 1957). The exposure of these young boys to soot often resulted in scrotal cancer (Rose, 2003). Exposes of the true nature of such jobs can be found in books including *The Jungle* and *The Grapes of Wrath* and in documentaries including *Song of the Canary* and *Can't Take It No More* (Hamilton, 1943; Sinclair, 1906; Steinbeck, 1939).

Society has long benefited from workers' labor. In the late 19th century, society had a much different view of work and workplace hazards (Grimaldi & Simonds, 1984). Unfortunately, workers were often viewed as expendable by their employer (Films for the Humanities & Sciences, 1992; Hamilton, 1943; National Institute for Occupational Safety and Health, 1988). Some companies placed workers' lives below the value of repairing faulty equipment If one worker was killed another could easily be found to take his place (Hammer, 1989). A statement in Hammer's book, Occupational Safety Management and Engineering describes the situation vividly:

> When the Railway Safety Act was being considered in 1893, a railroad executive said it would cost less to bury a man killed in an accident than to put air brakes on a car. The railroad executive probably was not an evil or malicious man. In all probability he believed in God, was a good husband and loving father, and probably patted his dog when he came home. He would have done anything to avoid injury to his family or dog, but the safety of other people was considered only in monetary terms. (p. 1)

In the 20th century, the public perception of the plight of workers began to change. Prior to that time, workplace fatalities were often attributed to "Acts of God" (Bever, 1996). In 1907 a fire at the Triangle Shirtwaist Company in New York City killed 147 immigrant women, in part because exit doors had been locked to prevent employee theft. Of this disaster, Rabbi Stephen Wise said, "It is not the Act of God but the inaction of man that is responsible…This was no inevitable disaster which could not be foreseen" (Bever, p. 20). Today, many companies consider their workers to be their most valuable asset. A key component to this shift in public opinion was the development of academic programs in occupational safety and health (Rose, 1988a). These programs produced individuals trained to anticipate, recognize, evaluate, and control workplace hazards (Plog, 2002). Among the programs that developed were industrial hygiene programs such as the one at the University of Central Missouri, in the Department of Safety Sciences.

Conceptual Underpinnings for this Research

The conceptual underpinnings for this study are based in the concepts of program assessment and specifically academic program assessment (Patton, 1997). As discussed by various authors, program assessments have been used extensively in academia and as such fit nicely into the research described herein. Certainly the researcher's decision to pursue program improvement through program assessment is also impacted by his experience growing up on a small farm with thirteen siblings. Most of the working people the researcher interacted with during his formative years were farmers, truck drivers and small business owners. The first two represent some of the most hazardous occupations in the United States, according to the National institute for Occupational Safety and Health (2010a). A 20 year career with NIOSH also influenced this researcher as he visited several hundred plants and also worked with academic programs in industrial hygiene (IH). Information gained during curricular work at the University of Missouri helped formulate and coalesce these various experiences into the current research project.

Statement of the Problem

Since 1974, the University of Central Missouri's (UCM) industrial hygiene program has produced over 400 alumni. During this 35 year time period, no comprehensive assessment of the program has been conducted by the department. Faculty and administrators are not certain how well the program has prepared entry level industrial hygienists for employment. The industrial hygiene program is accredited by ABET (2009a). ABET, previously known as the Accreditation Board for Engineering and Technology, is the accrediting body for industrial hygiene academic programs. UCM's IH program was awarded accreditation in 1998, with a subsequent renewal in 2004. The next accreditation visit is scheduled for Fall 2010 (ABETb, 2009). ABET requires programs to evaluate themselves on a continuing basis. If programs do not do this, they are in danger of losing their accreditation.

Academic departments are under pressure to demonstrate that they offer a quality product. The cost of attending college continues to rise (Archibald & Feldman, 2008). With the rising cost of college tuition, universities are focusing increased efforts on student recruiting. Parents, guardians, and students are more knowledgeable and more demanding in their selection of which college to attend. Additionally, credit hours generated by a department and per each faculty member are closely watched by university administrators. In 2004-2005, the Department of Safety Sciences produced only 2,463 credit hours (University of Central Missouri, 2009). This represented one of the lowest total of credit hours generated in over 30 years. By 2008-2009, the number of credit hours generated had grown to 5,257 (University of Central Missouri, 2009). This turnaround in credit hours generated is encouraging but could be temporary. The Department of Safety Sciences must provide evidence that it produces graduates who are adequately trained to be successful in their first job and have the knowledge of how to continue improving their skills to be successful long-term. The information collected from this research will meld into other assessment activities ongoing within the Department of Safety Sciences as part of a comprehensive assessment program (Greife, Zey, & Womble, 2006). These activities include exit exams, discussions with advisory boards and department retreats during which each course is evaluated for content. The information collected in this research study will help the Department of Safety Sciences make informed decisions for program planning and program improvement. Continual improvement of the department's academic programs is critical if the Department of Safety Sciences wishes to remain viable in this rapidly changing field (Thomas, 2001).

Purpose of the Study

This research will provide valuable information concerning the quality of the UCM Masters program in industrial hygiene since 1974, the first year alumni graduated from the program. The research will also indicate current strengths and weaknesses of the industrial hygiene program. The information collected can be utilized by the Department of Safety Sciences, the Dean of the College of Health and Human Services, other administrators of UCM, and constituents of the department in deciding what changes are needed to sustain and improve the quality of the industrial hygiene academic program. This information will also help meet assessment requirements of external review groups such as ABET (2009a), the National Institute for Occupational Safety and Health (2010b), and assist the department with internal reviews that occur approximately every five years. The research methodologies described in the following chapters can also serve as a model for other academic departments to use in their program assessment activities. The methodologies used in this research are not specific for OSHE program assessments. Faculty for any academic program could use these techniques, modifying where necessary to better fit their own needs.

Development of academic programs in industrial safety and industrial hygiene were foundational underpinnings to the evolving improvements in workplace conditions. A regional university in West Central Missouri, UCM developed both safety and industrial hygiene programs starting in the late 1960s through the early 1970s (Patterson, 1974). The focus of this research study is a comprehensive assessment of the industrial hygiene program at the University of Central Missouri.

Faculty from the Department of Safety Sciences established an assessment committee in 2004 that is providing guidance to the overarching assessment program for the department. An initial assessment plan was developed with the understanding that the plan would be updated on a regular basis (Greife, Zey, & Womble, 2006). Assessment of Safety Sciences academic programs is being strongly encouraged from both internal and external review organizations such as ABET (2009a), and the National Institute for Occupational Safety and Health (2008).

Information gleaned from the proposed research will be shared with all constituents of the industrial hygiene program at UCM including faculty, advisory board members, students, alumni, and other interested parties. It will also be used for external review organizations, including ABET. This information will also be available in publications and on the UCM website, thus assuring that all constituents have access to it.

Specific issues investigated in this research include alumni satisfaction with the preparation for their career in industrial hygiene. It will also assess the quality of the training by the department in sixteen topic areas. This will enable the researcher to assess if a trend exists in alumni opinions about the quality of the industrial hygiene program from the early 1970s to the current time. Other questions will assess alumni opinions of what knowledge and skills are needed by industrial hygienist graduates entering the current job market. This will help the faculty determine if the most important knowledge and skills are currently included in the program. Finally, information was collected on the career paths of graduates including whether they obtained certification, how many other OSHE professionals they work with and what percentage of time they spend in the primary areas of the profession.

Patton (1997) suggested that many assessments are conducted but most of them are never used to improve the program being evaluated. It is the belief of the researcher that the information gathered will be used to enhance the existing industrial hygiene masters program by using the information collected to make necessary and desirable changes. This assessment will help guide the faculty, college administration, and the IH program advisory board in making informed changes.

The research study described here is a program assessment of an industrial hygiene academic program. Program assessment has been around for decades but, according to Patton (1997), matured in the 1960s due to the growth of large government programs. Patton also noted that starting in the late 1890s, education has been a subject for assessment. “Education has long been a primary target for evaluation. Beginning with Joseph Rue’s comparative study of spelling performance by 33,000 students in 1897, the field of educational evaluation has been dominated by achievement testing” (p. 10). Patton also noted that the demand for assessment has been growing in non-government entities. The increasing importance of program assessment is not only evident in the United States but has grown worldwide. “Global interest in evaluation culminated in the first-ever International Evaluation Conference in Vancouver, Canada, in November 1995.” (Patton, p. 15). Madaus, Stufflebeam and Scriven speak of program evaluation having begun in the 19th Century but then exploding in the 1960s with President Johnson’s Great Society (1994). They divide up the history of evaluation into six time periods: the Age of Reform, the Age of Efficiency and Testing, the Tylerian Age, the Age of Innocence, the Age of Expansion and most recently, the Age of Professionalism.

Compared to education, occupational safety and health is a newer academic discipline, having come into existence in the first half of the 20th century (Rose, 1988a). Academic industrial hygiene programs are generally considered to have started around 1920 at Harvard University (Rose). Rose noted, however, that prior to Harvard’s program the first documented course in industrial hygiene was developed at the Massachusetts Institute of Technology (Rose). Other academic programs followed at Johns Hopkins, the University of Pittsburg and the University of North Carolina (Rose). Other universities that were among the first to develop industrial hygiene programs are the University of Cincinnati and the University of Iowa (University of Cincinnati, 2008; Yaffe, 1984).

After passage of the Occupational Safety and Health (OSH) Act in 1970 the number of industrial hygiene programs increased rapidly (Baetjer, 1980). The OSH Act established an enforcement agency, the Occupational Safety and Health Administration, and a research agency, the National Institute for Occupational Safety and Health (United States Department of Labor, 2004). The Act also provided the impetus to develop a workforce of trained OSH professionals and funds to support academic programs in occupational safety and health (Rentos & Purcell, 1988; Rose, 1988a).

According to Palomba and Banta (2001), higher education has often seemed immune from the scrutiny placed on elementary and secondary education. Ferguson (2006) found from a survey of assessment activities among industrial hygiene programs that were accredited by ABET (2009b) that individual assessment activities were often not combined into a systematic assessment program. Individual programs used one or more of several standard assessment techniques including exit exams, needs-assessment surveys, input from advisory boards, and periodic surveys of alumni (Ferguson).

Constantin, Pennington, Williamson, Finn, and Weitzman (1994) were among the first to acknowledge the importance of program accreditation for industrial hygiene programs. They surveyed 112 U.S. colleges and universities to assess graduate education programs in the field of industrial hygiene. The respondents mentioned the importance of IH academic programs achieving accreditation. Societal concerns of accountability and waste in government programs enhanced the need for all programs to be evaluated. More recent publications by Guillemin (2006) and Vincent (2005) discussed graduate education in industrial hygiene academic programs and the need for program accreditation.

Brauer (2002) stated that one reason for credentials such as accreditation is to reassure the public of the quality of a program. Program assessment is also encouraged by both state and regional oversight bodies including UCM's regional accrediting body, the Higher Learning Commission (2003).

Research Questions

To address the purpose of this study the following research questions will guide this study:

1. What topics/courses do alumni view as most important for IH graduate students to take as part of their curricular studies?
2. What skills and knowledge do alumni view as critical for entry level industrial hygienists?
3. How has the satisfaction of alumni with their preparation by the Department of Safety Sciences for their career in industrial hygiene changed since the program began?

Definitions of Terms

For the purpose of this study the following terms will be defined.

ABET: This organization was previously known as the Accreditation Board for Engineering and Technology. The organization has since changed its name to ABET. ABET is the organization that has been selected by the American Academy of Industrial Hygiene to provide an assessment program for industrial hygiene academic programs (Whitehead, 2007). Industrial hygiene and occupational safety are two of the academic disciplines for which ABET offers third party accreditation. ABET accredits over 550 colleges and universities, including almost 3,000 academic programs (ABET, 2010).

American Board of Industrial Hygiene (ABIH): ABIH is an organization that manages the certification program for individuals seeking to become certified in the practice of industrial hygiene. Once certified, these individuals can use the term Certified Industrial Hygienist and the acronym CIH (American Board of Industrial Hygiene, 2006).

American Conference of Governmental Industrial Hygienists (ACGIH): ACGIH is a professional organization of industrial hygienists organized in 1939. ACGIH has approximately 3,000 members located in numerous countries. They are best known for developing one type of occupational exposure criteria, Threshold Limit Values (*American Conference of Governmental Industrial Hygienists*, 2010).

American Industrial Hygiene Association (AIHA): AIHA is a professional association that started in 1939. It has a little over 10,000 members and has expanded to become an international association with members in over 40 countries. They publish one of the leading professional journals for industrial hygienists, *The Journal of Occupational and Environmental Hygiene* (American Industrial Hygiene Association, 2010).

Centers for Disease Control and Prevention (CDC): CDC is part of the US Public Health Service. There are nine centers in the CDC. The National Institute for Occupational Safety and Health is one of the CDC centers (Centers for Disease Control and Protection, 2010).

Certified Industrial Hygienist (CIH): A Certified Industrial Hygienist is a person who has passed a certification examination offered by the American Board of Industrial Hygiene. Over 10,000 individuals have obtained the CIH designation. Currently, there are approximately 7,000 practicing CIHs worldwide (American Board of Industrial Hygiene, 2006).

Colorimetric Indicator Tubes: Developed in the early 1920s in a collaborative effort between the U.S. military and Harvard University, these devices replaced canaries and mice that had previously been used to warn miners of hazardous air in mines. Colorimetric tubes are also referred to as gas detector tubes or indicator tubes.

Constituent Groups: Individuals who have a vested interest in the success of an organization are referred to as constituent groups. For the industrial hygiene program at UCM, they include alumni, students, potential students, potential employers, the advisory board, department faculty, and the UCM administration.

Higher Learning Commission: This group is responsible for assessment within the North Central Association of Schools and Universities. North Central is the accreditation body charged with conducting the assessments of colleges and universities in their region that apply for academic accreditation (Higher Learning Commission, 2003).

Industrial Hygiene: This is a field of applied science the involves the anticipation, recognition, evaluation, and control of potential occupational hazards, be they chemical, physical, biological, or ergonomic in nature. (Institute of Medicine, 2000). For the purpose of this study, industrial hygiene and occupational health will be used interchangeably.

Industrial hygiene code of ethics: These ethical guidelines were developed by the American Board of Industrial Hygiene with input from interested constituents (American Board of Industrial Hygiene, 2006).

National Institute for Occupational Safety and Health (NIOSH): The lead government body assigned the responsibility for conducting research into occupational safety and health hazards. NIOSH was established under the OSH Act of 1970. NIOSH develops recommended exposure limits (REL) that are used by occupational safety and health professionals to safeguard the health of workers (National Institute for Occupational Safety and Health, 2010b).

Occupational Exposure Limits (OEL): Criteria that have been developed by the federal government (e.g., permissible exposure limit, and permissible exposure limit) and professional societies (e.g., TLV), OELs are designed to protect the majority of workers whose exposures do not exceed the airborne concentration or energy level specified by the OEL.

Occupational Safety: A discipline in the health field whose mission is to prevent injuries and deaths on the job. Experts estimate that there are over 50,000 safety jobs in the United States. Reportedly, many of the people in current safety positions do not have academic degrees in OSH but learned the safety craft through experience, short courses and mentors.

Occupational Safety and Health Act: The federal legislation that established both the NIOSH and OSHA. The Act was signed into law by President Richard Nixon on December 29, 1970. It established OSHA and NIOSH as the lead organizations assigned the responsibility of protecting the American worker and also helped promote the discipline of occupational safety and health (Occupational Safety and Health Administration, 2010).

Occupational Safety and Health Administration (OSHA): The Federal agencies established under the OSH Act of 1970 (United States Department of Labor, 2009) to protect the health and safety of the American worker, OSHA promulgates permissible exposure limits that are legally enforceable standards.

OSHA is in the Department of Labor (Occupational Safety and Health Administration, 2010).

Program Evaluation: Program evaluation means to assess or ascertain the worth or value of some program (Rossi, Lipsey, & Freeman, 2004).

Recommended Exposure Limits (REL): Occupational exposure criteria developed by the National Institute for Occupational Safety and Health. RELs are designed to protect most workers if the occupational exposure amount is maintained below the level specified (National Institute for Occupational Safety and Health, 2005).

Threshold Limit Values (TLV): Occupational exposure criteria developed by the American Conference of Governmental Industrial Hygienists designed to protect most workers if workplace exposure concentrations are maintained below the TLV level (*American Conference of Governmental Industrial Hygienists*, 2009).

Limitations of the Study

This research contains various limitations. The researcher was unable to locate some of the alumni due to their passing, ill health or the unavailability of current contact information. This creates the possibility of obtaining biased data if a majority of the missing individuals hold common beliefs different from those obtained in the survey. These individuals may have never entered the field of industrial hygiene or they may have worked in the discipline for only a few years before leaving to raise children or to enter into another profession. They also may have entered into the profession, but not remained in contact with the University. This makes tracking these individuals more difficult.

The researcher’s familiarity with the Department of Safety Sciences is another limitation in this research. The researcher has taught in the department for 14 years and was a student in the department for approximately two years in the 1970s. This familiarity might influence the tone of questions asked of alumni and how the information is summarized. This specific limitation was addressed by establishing a small group of reviewers, external to the thesis committee, to review the draft dissertation and provide feedback to the committee chair and this researcher on the interpretation of the subjective data obtained via this research project. This group of three OSHE professionals included individuals who had knowledge of the OSHE discipline.

Other techniques that can be used to reduce the bias brought into the research study by the author include triangulation of certain data. The presence of historical minutes of department meetings, internal review reports, news articles, and other miscellaneous documents will help enhance the quality of the information collected. This triangulation of key dates and events will reduce the impact of the researcher’s biases.

Summary

Industrial hygiene academic programs have played a key role in improving workplace conditions for workers in the United States by producing graduates trained in reducing workplace injuries and illnesses. The industrial hygiene program at the UCM Department of Safety Sciences has experienced ebbs and flows in student numbers, credit hours generated and the annual number of students graduating since 1974. Future funding levels for UCM are uncertain. Unless the Department of Safety Sciences can demonstrate value to constituents inside and outside of UCM, the future existence of the IH program within the Department could be in question. In order to keep the program at the University of Central Missouri viable, the quality of the program must be maintained and, if possible, improved. This was accomplished by surveying alumni and reviewing historical documents. The information collected will be made available to constituents of the industrial hygiene program.

In the following chapter the background of industrial hygiene and the development of academic programs in industrial hygiene will be reviewed. The development of the Missouri Safety Center and the School of Public Services at the University of Central Missouri will be discussed. Both of these entities were instrumental in the development of the initial industrial hygiene academic program. Additionally, the personnel who established and directed the early years of the IH program at UCM and played a key role in the foundational underpinnings that formed the basic structure of the current program will be discussed.

An overview of the methods used in this assessment and why specific assessment techniques were selected will be provided in Chapter Three. In Chapter Four the author will summarize the results of the survey of alumni. In addition, an overview will be provided of the review of archival records and interviews of selected individuals. In Chapter Five the author will include an interpretation of the results of this assessment of the IH program. In addition the author will include suggestions for how the department might use the information obtained during this assessment to improve its responsiveness to students, alumni and other constituents. Suggestions for future research will also be included.

CHAPTER TWO

LITERATURE REVIEW

Chapter Two contains a summary of the literature reviewed for this research study. This summary will include a definition of the discipline of industrial hygiene, a discussion of the history of the discipline including important historical events, people, publications and advancements in sampling and analytical methods, as well as an explanation of how the discipline of industrial hygiene developed. Also included will be a discussion of which colleges and universities were first to develop industrial hygiene academic programs and a summary of how the program at the University of Central Missouri (UCM) developed. Brief overviews of some of the leading professional and governmental organizations in industrial hygiene will also be included.

A discussion of academic program assessment will be provided as assessment of the industrial hygiene program at the Department of Safety Sciences is the foundational underpinning for this research. Program assessment is needed not only for the faculty and administration of the Department of Safety Sciences, but also to meet requirements of external review organizations including ABET and the National Institute for Occupational Safety and Health (NIOSH). Finally, a discussion will be provided of how program assessment by external constituents has become more important for academic programs in industrial hygiene

Background of Industrial Hygiene

Industrial hygiene has been defined as the art and science devoted to the anticipation, recognition, evaluation, and control of occupational hazards that arise or may arise in the work environment (Luxon, 1984; Plog, 2002). It is a discipline that has roots in the educated classes of society. According to Goetsch (1998), the Code of Hammurabi (circa 2000 BC) includes phrases that can be interpreted as attempts at compensating workers and there is evidence of concern for occupational safety and health during Roman Times. Historically, physicians, scholars and at least one toxicologist/alchemist produced noteworthy publications on the health effects of occupational exposures (Clayton, 2000; Rose, 2003). Noted publications include *De Re Metalica,* written by Agricola in 1556, *De Morbis Artificum,* written by Bernardo Ramazzini in 1713, and *The Dangerous Trades,* written by Alice Hamilton in 1943 and then reissued in 1995 by the American Industrial Hygiene Association (Rose, 2003). These texts provide exposés on the working conditions in industry.

Industrial hygiene consists of several disciplines but it evolved primarily from medicine (Perkins, 2008). Most of the historical individuals investigating the causes of workplace disease were physicians. The names of the pioneering individuals whose efforts advanced the discipline of industrial hygiene include Percival Pott, Pliny the Elder, Agricola, Bernardo Ramazzini, and Alice Hamilton

(National Institute for Occupational Safety and Health, 1988; Plog, 2002; Rose, 2003).

Occupational hazards include chemical agents (e.g., asbestos, silica, coal dust, cotton dust), physical agents (e.g., heat, radiation, noise), biological agents (e.g., ebola, aids, hantavirus), ergonomic risk factors (e.g., force, awkward posture, repetition without rest), and psychosocial risks including stress (Clayton, 2000; Plog, 2002; Schaper & Bisesi, 2003). These hazards have the ability to overwhelm the human body's defense mechanisms (Eaton & Klaassen, 2001). Speaking about the magnitude of the body's response (e.g., adverse health effects) increasing as the dose increases, Eaton and Klaassen stated, "The magnitude of the response is in fact related to the dose" (p. 22). One key in assessing the toxicity of a specific chemical is how quickly the chemical is removed from the body, "…the more rapidly a chemical is eliminated from an organism, the lower will be its concentration and hence its toxicity in a target tissue or tissues" (Rozman & Klassen, 2001, p. 107). In other words, the human body has the ability to withstand the toxic effects of many chemicals if the rate of uptake into the body is slower than the rate of detoxification by the body (Amdur, 1974). If recovery times (time away from the hazardous exposure) are insufficient, adverse health effects develop that may cause temporary health effects. Amdur (1974) used hydrogen sulfide to explain this same concept. According to Amdur, "It has an acute action on the nervous system with rapid production of respiratory paralysis unless the victim is promptly removed to fresh air and revived with appropriate artificial respiration." Most chemicals are more toxic if a specific amount is given in larger doses than if the same amount of material is administered in several smaller doses (Amdur, 1974; Cohen, 2002).

Industrial hygienists need training in a number of different areas including biology, chemistry, math, engineering, psychology, toxicology, and environmental science (Plog, 2002). Academic programs in industrial hygiene typically require that an entering student possess certain background courses. Science-based programs usually require biology, chemistry and math courses such as required by the Department of Safety Sciences' Industrial Hygiene program (University of Central Missouri, 2010). Beginning with Fall Semester of 2009, the Department of Safety Sciences requirements for industrial hygiene graduate students include at least one year of chemistry (including organic), one year of biology (including physiology), one year of math (including statistics), and one semester of physics that includes a lab (University of Central Missouri).

Several authors have written about what skills and knowledge employers consider important for entry level industrial hygienists (Brosseau, Raynor, & Lungu 2005; Brosseau & Frederickson, 2009; Lee & Dunkle, 1988; Oestenstad, Boggs, & Perkins, 1994; Olson, Lohman, Brosseau, Fredickson, McGovern, Gerberich, et al., 2005; Rodgers, 2007). In all of these publications, basic skills of recognition, evaluation and control were considered critical. Other authors have summarized the status of industrial hygiene academic programs and/or have offered suggestions for what changes are needed for the future of industrial hygiene education (Constantin, Pennington, Williamson, Finn, & Weitzman, 1994; Guillemin, 2006; Vincent, 2005). Constatin et. al, were among the first authors to mention that many faculty at industrial hygiene programs believed accreditation was important. Guillemin and Vincent suggested that industrial hygiene academic programs should include other topics such as management. They also stressed the importance of modifying the delivery of programs by offering nontraditional formats including part-time and distance education programs.

Since 1970, at least seven authors have written or edited publications about the history of industrial hygiene and some authors have multiple publications on the subject (Baetjer, 1980; Clayton, 1973; Clayton, 2000; Corn, 1978; Harris, 2000; Henshaw, 2007; Luxon, 1984; Rose, 2003; Rose, 1988a; Yaffe, 1984). Rose (1988a) and Clayton (2000) presented general overviews of the history of occupational health and highlighted several historical individuals. Baetjer and Henshaw spoke of the impact of government bodies and legislation that were critical to eventually improving workplace conditions. Luxon compared industrial hygiene development in both the UK and the US, and focused on some of the important industrial technological advancements (e.g., flying shuttle for textile looms) and legislation. Yaffe edited a book containing interviews of over 20 “pioneers” of industrial hygiene from the first 60 years of the 20th Century.

Occupational Disasters

Occupational disasters often serve as sentinel events and the impetus for improvements in occupational working conditions (Levy, 2005).These events include especially tragic occurrences that were often the basis for books, articles, poems, or songs that served as an exposé on poor working conditions or occupational disasters (Block, 2007; Cherniack, 1986; Clark, 1997; Ichimusai, nd; York, 2006).

According to Rose (2003), industrial hygiene as a profession has historical roots that extend back approximately one million years before the common era (BCE). Evidence exists of flint knappers suffering eye injuries while making arrow heads and similar tools. Bison hunters contracted anthrax from skinning their kills. Rose does not tell us what the evidence is, but one might assume it was cave drawings. After this period, very little recorded information addressing work-related health effects was found until approximately 400 BCE. Hippocrates noted in 374 BCE hazards of lead exposure in the mining industry (Clayton, 2000; Rose, 2003). In 50 BCE, Pliny the Elder recommended using respirators (made from animal bladders) to protect workers from airborne lead. Galen, a Greek physician, wrote of the hazards copper miners faced from exposure to acid mist in the second century, A.D., (Clayton). In the 1500s, Georgious Argicola wrote a book on mining that included descriptions of mining hazards and at least two control methods, ventilation to reduce airborne exposure and respirators to filter chemicals from the air (Clayton, Rose). The recommendations for ventilation and respirators made by Agricola are still used today to reduce airborne exposures in mining (Mine Safety and Health Administration, 1996; Mine Safety and Health Administration, 2003).

A 14th century alchemist/toxicologist named Paracelsus also has a place in the history of industrial hygiene (Clayton, 2000). Today Paracelsus is considered the father of toxicology for noting that it was the dose of a material that made it a poison and that all chemicals are poisonous if enough of the chemical gets into the body.

In 1700, a treatise, *De Morbis Artificum Diatriba [Diseases of the Workers]*, by Bernardo Ramazzini, included descriptions of over 200 diseases suffered by workers (Ramazzini). Ramazzini noted the hazards of cotton dust, silica and poor work postures (i.e. ergonomic disorders). These particular hazards have continued to plague the workers of the world to the present time. Ramazzini is considered the father of industrial medicine due in part to his recommendation that physicians ask their patients what trade they worked in. In his book, reissued in English by Hafner and published in 1964, he lists the types of questions physicians typically ask their patients. His exact quote was, “I may venture to add one more question: what occupation does he follow?” (Ramazzini, 1700, p. 13.) He knew that it was often the hazardous exposures endured in the occupational environment that lead to illnesses seen in the physician's office (Clayton, 2000; Rose, 2003). Ramazzini, describing how cotton dust affected textile workers, stated, "A foul and poisonous dust flies out from the materials, enters the mouth, then the throat and lungs, makes the workers cough incessantly, and by degrees brings on asthmatic troubles" (National Institute for Occupational Safety and Health, 1975, p. 22).

Ramazzini (1700) also discussed how workers could develop adverse health effects that more recent scientists have termed as ergonomic disorders. Ramazzini noted that such disorders appeared in workers who moved in violent and irregular motions and assumed unnatural positions. Today these are noted as being among the primary risk factors for developing ergonomic disorders (Kroemer, 2002; Kroemer & Grandjean, 1997).

Percival Pott's studies of scrotal cancer in chimney sweeps led to some of the first legislation to limit the hours worked by employees (Rose, 2003). Due to the small space inside chimneys the majority of chimney sweeps were actually children who were forced to climb into the chimney to clean out the soot (Schneider & Lilienfeld, 2008).

Some chemicals are infamous for their negative impact on the working population of the US and other countries. Among the more infamous chemicals are asbestos, beryllium, coal dust, cotton dust, lead, mercury and silica

(American Industrial Hygiene Association, 2003, National Safety Council, 2002). One of the best examples of a toxic chemical is mercury. It was especially toxic to hat makers. The Mad Hatter from *Alice in Wonderland* was truly mad, but the madness in reality resulted from mercury, Hat makers were exposed to noxious, toxic chemicals used to treat the animal pelts. This exposure led to mental disorders from exposure to mercury (National Institutes of Health, 2010a). On one of their websites, the National Institutes of Health first ask, Why were Hatters MAD?, they explain it this way,

> In Alice in Wonderland (1865), Lewis Carroll selected a hat maker as the demented host for the tea party. Hatters of the time commonly exhibited slurred speech, tremors, irritability, shyness, depression and other neurological symptoms; hence the expression "mad as a hatter." Carroll was probably unaware that the hatter's disabilities were symptoms of mercury poisoning. In the mid-1800s hat makers used hot solutions of mercuric nitrate to shape wool felt hats. They typically worked in poorly ventilated rooms leading to chronic occupational exposure to mercury and neurological damage that followed. (National Institutes of Health, 2010b, History of Mad Hatters Section¶ 1**)**

Mining deserves special recognition in any discussion of the history of working conditions faced by employees. The following quote describes conditions for miners and their families:

> As early as the 1850s, immigrants from Wales, England, and Scotland were brought over to work in the coal mines. As the coal industry grew, most of the mining was supported by out-of-state capital and thus was run by out-of-state superintendents. These men brought in cheap foreign labor, especially from southern Europe, and often abused them with long working hours, poor medical care, and generally inferior living conditions. The poor conditions in the mines brought about the first West Virginia coal

> mining legislation in 1883. (West Virginia Geological and Economic Survey, 2004, ¶ 9)

The phrase “mining towns” was used to designate the control held over miners and their families by the mining companies (Jones, 1999). According to Jones, mining companies owned the houses in which miners lived, along with the only grocery store near the mine. Mine companies also charged the miners for the tools they used. A paragraph from an on-line article by Jones (1999) provides a vivid description of the miners’ plight,

> Life in coal towns was not idyllic. Tom Lowry, a retired miner and former resident of the now abandoned Cumberland Plateau coal town of Wilder-Davidson, succinctly put it: "The company just about owned you." Mrs. Della Mullins, a coal miner’s wife, concurred by saying: "Mining companies were king of the hill. You stooped and you bowed." Indeed, the mining company controlled nearly every essential aspect of community life, from work, shopping, education, retail merchandising, and medical care. The company store became the hub of coal mining community life, while non-denominational and generic wooden frame churches were the general rule for religious expression. The company provided schools and medical facilities as well. Social conditions were feudal and the coal operator was the law-giver. (¶ 46)

There is evidence that companies in other industries had similar control over their workers and the workers’ families. A video, *Song of the Canary* (Hanig & Davis, 1979), includes discussions by former cotton textile mill workers that indicate the company owned the housing where the workers’ families lived (Hanig & Davis). According to one worker interviewed in the video, when children reached working age (14 years) they were expected to take a job in the mill. If they did not work in the mill, then the entire family would be evicted from the company housing (Hanig & Davis).

Historically, mining has been one of the most hazardous occupations, with individual disasters sometimes killing hundreds of miners in the US. A NIOSH website of mining disasters includes more than 700 events, each involving at least five deaths (National Institute for Occupational Safety and Health, 2009). The effects on those friends and family members left behind are long lasting. Newspaper stories provide vivid accounts of the impact of numerous mining disasters (Acton, 2007; Clement, 2000; Geranios, 2005; & Isom,1995). As indicated in these articles, the memory lives on in the surrounding region.

Nineteen disasters (each involving at least 5 deaths) occurred in 1907. Among those were two mining disasters that were among the worst in the history of the United States (National Institute for Occupational Safety and Health, 2009). On December 6, 1907, 362 miners were killed in a series of explosions at the Monongah No. 6 mine in Monongah, West Virginia. Twelve days later, 239 miners died in Jacobs Creek, Pennsylvania when the Darr Mine exploded (National Institute for Occupational Safety and Health). Six hundred miners lost their lives in these two disasters.

China was the site of the worst recorded mining disaster in 1942 (CBC News Indepth, 2006). "In 1942, an accident killed 1,549 miners in Japanese-occupied Manchuria in China's northeast, still the world's deadliest coal mining disaster when an accident killed 1,549 miners in Japanese-occupied Manchuria during World War II" (2006¶ 2).

In the United States, the number of miners killed each year in mining disasters has gone down since the first few decades of the 20th century (National Institute for Occupational Safety and Health, 2009). However, mining continues to be a very hazardous occupation (Mine Safety and Health Administration, 2003). A disaster in West Virginia in January 2006 brought the high risk of working in mines to the attention of the entire nation (Mine Safety and Health Administration, n.d). Twelve miners were killed following an explosion in the Sago Mine in West Virginia (Mine Safety and Health Administration, 2007).

Another mining tragedy in 2007 once again brought the dangers of mining to the forefront of the nation's attention (National Public Radio, 2006; New York Times, 2007). This disaster in Utah's Crandal Canyon Mine resulted in a total of nine deaths. In April of 2010, the worst mining disaster in the United States in over 30 years occurred once gain in West Virginia (Mine Safety and Health Administration, 2010), when 29 miners were killed in an explosion at the Upper Big Branch Mine in Raleigh County, W.Va

Other important events whose impact upon workers, community members and society in general helped spur the public into action include the London Fog during which over 1,000 London residents died during a year-long pollution episode. The pollution from industrial facilities made the air quality much worse than it would otherwise have been (Bell & Davis, 2001). Danora, Pennsylvania was the site of a pollution episode in the United States (Templeton, 1998). Contributing to the pollution were several manufacturing plants, including a zinc smelting plant, a steel production facility, and a sulfuric acid plant. A study by an industrial hygiene team revealed high atmospheric levels of sulfur dioxide, soluble sulfates and fluorides. Emissions from the plants, together with an unusually heavy fog and calm atmospheric conditions, contributed to 19 deaths over a one-week period. Approximately 500 community residents became ill during the same time period (Templeton).

Radium also has a place in the history of toxic chemical exposures. Radium was added to paint to make it luminous. The paint was then applied to watch dials and similar items. Young women and girls were hired to apply luminous paint to dials in the early part of the 20^{th} Century, as girls generally are more dexterous than men. Clark (1997) chronicled the disaster in *Radium Girls: 1910-1935*. Dial painters used a technique called “lip pointing” to help form a fine tip to the paint brush. Lip pointing involved licking the end of the brush to form the bristles into a finer point. Bone necrosis (decay), particularly of the jaw with loss of both bone and teeth, resulted. Many of the girls died and others suffered a horrible disfigurement as a result of their exposure (Clark).

Hawk’s Nest is another sentential event in the history of working conditions (Cherniak, 1986). In the 1940s, a tunnel was drilled through a mountain of rock in southern West Virginia. The tunnel was designed to divert part of the Kanawa River through the mountain in order to generate electricity for a nearby industrial plant. The mountain consisted of a high percentage of crystalline silica. African American workers were given the dustiest jobs, often without the use of available exposure reduction techniques. The company often ignored protective measures such as wet drilling, due to the increased time for drilling and resulting loss of profit (Cherniak). Respirators (masks worn over the nose and mouth to clean the air) were also generally not used. As a result, exposures to crystalline silica were so high that miners who had the highest exposures died within a few months of starting work in the tunnel. Silicosis, a chronic respiratory disease that normally develops over 20 or more years, was the culprit. It is believed that more than 500 workers died as a result of their exposure to crystalline silica while digging the Hawk's Nest tunnel. This event also alerted the medical community to a new form of silicosis, acute silicosis (Cherniak).

In the 1940s, Texas City, Texas suffered an industrial disaster that not only killed hundreds of people but also destroyed much of the town (CNN, 1997; Minutaglio, 2003). The Grandcamp, a cargo ship carrying ammonium nitrate among its cargo, caught fire and exploded, killing over 500 people. A few hours later, a second ship, carrying similar cargo, exploded. Collectively, the two explosions destroyed at least one-third of the city (Minutaglio).

A more recent and more deadly event occurred in Bhopal, India in 1984 (Brelis, 1984; Rosenblatt, 1984; Time Magazine Archive, 1984). A leak of methyl-isocyanate, an ingredient used in pesticides, created a cloud of lethal gas that drifted over the adjacent town killing approximately 2,800 and injuring an estimated 170,000. Amazingly only a few workers were killed due to the prevailing wind that moved the cloud over the adjacent city. Affected individuals continued to suffer and die (Environmental Protection Agency, 2000).

Chernobyl, Ukraine was the site of an industrial disaster that may prove to be the worst of all time. In 1986, an explosion of a nuclear reactor resulted in the accidental release of a massive amount of deadly cesium 137 radiation. Cesium is a type of ionizing radiation. Exposure to ionizing radiation may cause a variety of adverse health effects including cancer, sterility of both males and females, cataracts, and other symptoms. According to the Centers for Disease Control and Prevention, exposure to cesium can cause a number of health effects, (Centers for Disease Control and Prevention, 2004)

> External exposure to large amounts of Cs-137 can cause burns, acute radiation sickness, and even death. Exposure to Cs-137 can increase the risk for cancer because of exposure to high-energy gamma radiation. Internal exposure to Cs-137, through ingestion or inhalation, allows the radioactive material to be distributed in the soft tissues, especially muscle tissue, exposing these tissues to the beta particles and gamma radiation and increasing cancer risk. (p. 2)

The accident has caused approximately 50 deaths so far, but there are fears that thousands of additional cancer deaths may occur as a result of the accident.

“The Chernobyl accident also resulted in widespread contamination in areas of Belarus, the Russian Federation, and Ukraine inhabited by millions of residents.” (Nuclear Regulatory Commission, 2006¶ 6).

Impact of Legislative Action

Legislative actions have been instrumental in promoting the field of industrial hygiene and improving workplace conditions. Among the various safety and health laws passed by the US Government, few have had the impact on working conditions as the Occupational Safety and Health (OSH) Act of 1970 (MacLaury, 1981). This Act created two organizations that have played a key role in improving the health and safety of workers in the United States. Under the OSH Act, NIOSH and OSHA were given specific responsibilities to conduct research, promulgate occupational safety and health standards, and provide information to the public (United States Department of Labor, 2004; United States Department of Labor, 2009).

The impact of the OSH Act on workplace conditions cannot be exactly quantified, but a comparison of the number of deaths on the job from injuries in 1968 and in 2005 is revealing. It is important to compare the size of the workforce in the US during the same time periods. In 1968 approximately 14,500 deaths were recorded in the US in a workforce of approximately 35,000,000. In 2005 there were approximately 5,500 deaths from injuries on the job, but the workforce had increased to approximately 137,000,000. This tremendous reduction is workplace fatalities strongly suggest that the OSH Act played a big part. It would be unwise to imply that the OSH Act was the sole reason for this improvement. However, it is noteworthy that an increasing rate of fatalities from injuries at work during the 1960s was one of the reasons for passage of the OSH Act (National Institute for Occupational Safety and Health, 1995). The OSH Act was passed due to a combination of factors including the support of organized labor in the United States (Goetsch,1998; National Institute for Occupational Safety and Health, 1995).

The U.S. Government has played a key role in the maturation of and growth of the industrial hygiene discipline since early in the 20th Century (Kelly, 1988). A critical step in this maturation was the development of state industrial hygiene programs, fostered by the US Public Health Service. “One major mechanism of developing programs in states was the assignment of U.S. Public Health Service officers to the states.” (Kelly, p. 115). More recently, the establishment of an academic training grant program by NIOSH has resulted in more academic programs in industrial hygiene and subsequently more graduates from these programs (Rentos & Purcell, 1988). The training grant program eventually evolved into a system of Educational Research Centers that have three or more funded programs and are designed for students in industrial hygiene to work with students from other OSH disciplines including occupational nursing, occupational safety, and occupational medicine (National Institute for

Occupational Safety and Health, nd). Passage of the OSH Act (United States Department of Labor, 2004) and other federal OSH laws, followed by the creation of the NIOSH training network, greatly expanded the available pool of trained industrial hygienists (Rentos & Purcell).

Advancement in Sampling and Analytical Techniques

When considering the foundational underpinnings for the improvement in workplace conditions, authors often cite better government regulations, an increase in OSH academic programs, and increased public awareness of poor workplace conditions (Baetjer, 1980; Clayton, 1973; Clayton, 2000; Harris, 2000; Henshaw, 2007; Luxon, 1984; Rose, 2003; Rose, 1988a; Soule, 2000; Yaffe, 1984). Another significant factor has been improvements in sampling and analytical methodology. In order to adequately control a workplace chemical you must be able to measure its quantity. Sampling and analytical methodologies have been in development for almost 100 years.

Prior to the development of detector tubes, humans had devised other techniques to alert workers to hazardous agents. Miners had an ingenious technique to alert themselves to the presence of noxious gases. Mine companies and miners used canaries and mice to warn of the presence of carbon monoxide (Mine Safety and Health Administration, nd). According to a statement from the Mine Safety and Health Administration (Mine Safety and Health Administration, nd) website, "…miners had a preference for canaries over mice, as canaries more visibly demonstrated signs of distress in the presence of small quantities of the noxious gas" (Mine Safety and Health Administration, nd). More recently, Mercedes Benz used canaries to test the gases generated when automotive air bags were deployed (Nova, 1999).

The development of the colorimetric indicator tubes in the 1920s was perhaps the first significant advancement over using human senses and animals for evaluating workplace air. Other significant historical advancements in sampling and analysis included development of the Smith Greenburg impinger in 1922 and the refining of that design to make the midget impinger in 1938 by Littlefield and Schrenk (Rose, 1988a). Development of a hand crank pump that was used with the midget impinger to collect airborne dust samples enabled industrial hygienists to collect air samples from the breathing zone of workers. The subsequent development of battery operated sampling pumps in the early 1970s and development of the charcoal-based sorbent tube by NIOSH researchers also in the early 1970s greatly advanced the ability to collect personal samples of airborne contaminants (Rose; Moffitt & Kupel 1971). Subsequent sampling and analytical developments included the 10 mm nylon cyclone, a variety of different sorbent tubes for gases and vapors, filter cassettes of all varieties and sizes, and finally direct reading instruments that greatly enhanced the number of chemicals and physical agents that can be sampled. One of the earliest and simplest of the passive dosimeters was the Palmes dosimeter for sampling oxides of nitrogen (Douglas & Beaulieu, 1983; Jones, Palmes, Tomczyk, & Millson, 1979; Palmes, 1977). As a result of the developments, the industrial hygiene discipline has seen a tremendous increase in the number of sampling and analytical methods available from organizations such as NIOSH (Rose, 1988a).

In the United States, government agencies developed standard sampling and analytical methods that were made available to the public. This pattern has been followed by The Occupational Safety and Health Administration (OSHA), NIOSH and the Environmental Protection Agency (EPA). These three federal agencies, all established in 1970, have developed sampling and analytical methods that are available to the public (Environmental Protection Agency, 2009; National Institute for Occupational Safety and Health, 2003; Occupational Safety and Health Administration, 2009).

Emergence of standards by European organizations including the International Organization for Standardization (ISO) and the European Union have proven to have a far reaching influence. From an occupational viewpoint this development could be more significant than most of the previous guidelines and standards that have been developed within individual countries. The foundation of these international standards is quality assurance for the products and services being provided (Brauer, 2002). Companies wishing to sell their products in European countries must meet these standards.

Significant Publications

There are many publications that have played a role in either training of OSH professionals or alerting the public to horrendous working conditions (Clark, 1997; Department of Health, Education and Welfare, 1961; Hamilton, 1943; Sinclair, 1906). *The Jungle* by Upton Sinclair was a riveting expose of the horrible working conditions faced by immigrants who secured employment in the Chicago meat packing industry around the start of the 20th century. Sinclair thought he would enrage the public with descriptions such at the following, (Sinclair, 1906)

> On the killing beds you were apt to be covered with blood, and it would freeze solid; if you leaned against a pillar, you would freeze to that, and if you put your hand upon the blade of the knife, you would run a chance of leaving your skin on it. (p. 80)

Sinclair's original intent, to outrage the public over horrible working conditions he described in his book, did not work out quite as he intended. The public did indeed become outraged after reading *The Jungle.* However their outrage was due to information in the book describing how the meat was processed and schemes that were used by the company to fool the public (York, 2006). In *The Jungle*, Sinclair describes the handling of meat.

> There was never the least attention paid to what was cut up for sausage; there would come all the way back from Europe old sausage that had been rejected, and that was moldy and white—it would be dosed with borax and glycerine, and dumped into the hoppers and made over again for home consumption. There would be meat that had tumbled out on the floor, in the dirt and sawdust, where the workers had tramped and spit uncounted billions of

> consumption germs. There would be meat stored in great piles in rooms; and the water from leaky roofs would drip over it and thousands of rats would race about on it. It was too dark in the storage places to see well, but a man could run his hand over these piles of meat and sweep off handfuls of the dried dung of rats. These rats were nuisances and the packers would put poison bread out for them; they would die and then rats, bread and meat would go into the hoppers together. This is no fairy story and no joke; the meat would be shoveled into carts and the man who did the shoveling would not trouble to lift out a rat even when he saw one—there were things that went into the sausage in comparison with which a poisoned rat was a tidbit. (pp. 133-34)

Sinclair later noted to colleagues, the unexpected impact of his book when he stated that he had aimed at the public's heart but had instead hit the public in the stomach. While his aim may have been off, the subsuming impact of his book was apparently what he had hoped for (Dell, 1927; York, 2006).

Alice Hamilton’s autobiography, *Exploring The Dangerous Trade*s, provided insight into the terrible conditions that workers endured to produce the nation’s goods. This book followed Hamilton’s studies from 1910 through the 1930s. Among the industries she conducted studies in were lead enameling, production of viscose rayon, and what she termed the war industries (American Chemical Society, 2002; American Chemical Society, 2010; Gafafer, 1943; Hamilton, 1943).

Patty’s Industrial Hygiene has been a standard industrial hygiene text since it was first published in 1949. The most recent edition, from 2000, has 13 volumes covering a multitude of topics. This collection has expanded, with each new edition containing more topics (Harris, 2000; Patty, 1949).

Another important industrial hygiene publication was produced by NIOSH under contract to Clayton and Clayton in 1973. *The Industrial Environmental: It's Evaluation and Control* was actually the third edition of the original publication from 1958. Originally called the Syllabus (Department of Health, Education and Welfare, 1961), it was also known as the "White Book". The original Syllabus was a collection of training aids that were being used in courses presented by a training group in the Division of Occupational Health of the US Public Health. During the 1960s there were several reorganizations that resulted in name changes for the Public Health Service's OSH group. In 1970 the group was called the Bureau of Occupational Safety and Health (BOSH). The OSH Act resulted in BOSH being subsumed into NIOSH, (Dobbins, 2005). Subsequently, NIOSH collaborated with the AIHA to have AIHA take over responsibility for publishing new editions of the White Book (American Industrial Hygiene Association, 2003). AIHA also renamed the book, calling it the *Occupational Environment: Its Evaluation, Control and Management* (American Industrial Hygiene Association).

Claudia Clark (1997) wrote an expose, *Radium Girls,* on the hazards of women who worked in the dial painting industry. Their job involved painting a radioactive paint on dials to make the dials luminous. *Radium Girls* highlighted the health effects these women, mostly young, experienced from applying the radioactive paint. Alice Hamilton (1943) made mention in her book of this disease. Hamilton wrote of the deaths of young women after several months of suffering a variety of adverse health symptoms (Hamilton).

The Hawk's Nest Incident, by Cherniak (1986), is another important historical book. Cherniak provides a step by step description of the Union Carbide company's project to bore a tunnel through a mountain in West Virginia to divert a river in order to generate electrical power. Cherniak described the terrible working conditions for workers. African American workers were assigned to work inside the tunnel where working conditions were the worst. Although silicosis normally requires 20 years or more to develop, the exposure of the workers to crystalline silica was so high that many of them developed chronic silicosis within a year after their exposure began. (Cherniak).

Another type of book that was critical to improving workplace conditions were compilations of descriptions of various sampling instruments, including their operating principles and how they should be used. The American Conference of Governmental Industrial Hygienists (ACGIH) produced one of the best known publications, *Air Sampling Instruments*. ACGIH produced the first edition of *Air Sampling Instruments* in 1960 (*American Conference of Governmental Industrial Hygienists*), with the most recent and perhaps the last edition of this book being published in 2001 (*American Conference of Governmental Industrial Hygienists*, 2001). Similar compilations of sampling and analytical methods include the NIOSH Manual of Analytical Methods. This publication provides techniques for collecting and measuring hundreds of chemicals (National Institute for Occupational Safety and Health, 2003). Another NIOSH publication that has found widespread use is the *Pocket Guide*. It contains descriptive information on 577 chemicals and chemical groupings, including basic information on sampling methods and personal protective equipment (National Institute for Occupational Safety and Health, 2005). The *Pocket Guide* has been made available in hard copy, in CD/rom format and on-line.

Women and women's social concern groups have also played a role in the development of the discipline of industrial hygiene, via conducting investigations of occupational health effects and campaigning for improvements in workplace conditions. Names that have endured over the decades include Alice Hamilton and Jane Adams. Other women who have also made tremendous contributions in the movement to improve workplace conditions but are not as well known include Victoria Trasco, and Caroline Einert. Trasco and Einert both worked for the federal government and conducted studies of hazardous occupational exposures. All of these women as well as others have played key roles in the development of industrial hygiene and improving workplace conditions (Yaffe, 1984).

Improvements In Workplace Conditions

The issues discussed above all had an impact in improving workplace conditions. In his text, *Security and Loss Prevention*, Purpura (1988) estimated how many workers would die from accidents on the job if workplace conditions in 1998 were the same as they were in 1900. “If one were to compare the industrial fatality rate that existed in 1910 to the present workforce in the United States, over 1.3 million workers would lose their lives each year from industrial accidents” (p. 293). He also discusses the expected worker deaths for certain construction projects.

> In the past a manual worker’s welfare was of minimal concern to management: the loss of life or limb was “part of the job” and “a normal business risk.” In the construction of tall buildings, it was expected that one life would be lost for each floor built. A 20-story building would yield 20 lost lives. During tunnel construction, two worker deaths per mile was the norm. Coal mining experienced exceedingly high death rates. (Purpura, 1998, p. 293)

Improvements in workplace conditions were noted by the Centers for Disease Control and Prevention (CDC) in a 1999 Morbidity and Mortality Weekly Report (MMWR) article. In this article, CDC researchers relate that data from multiple sources reveal how much improvement has occurred in workplace conditions (Centers for Disease Control and Prevention). For example, in one year beginning in June of 1906, 195 steelworkers were killed in Allegheny County, Pennsylvania. By contrast in 1997, 17 steelworkers were killed in the entire United States. The National Safety Council (1998) has estimated that between 18,000 and 21,000 workers were killed in 1912. Similar death totals were determined by Bureau of Labor Statistics, which documented 23,000 workers deaths in 1913 (Corn, 1992). The workforce in that time period was approximately 38 million. By contrast in 2008, with a workforce of over 135 million, 5,214 workers lost their lives on the job (Bureau of Labor Statistics, 2010).

Growth of Industrial Hygiene Academic Programs in the US

With the increased awareness of workplace hazards, as well as government oversight, the need for trained experts grew. Harvard University was recognized as the first academic institution to offer research in industrial hygiene leading to an advanced degree in the early part of the 20th century (Clayton, 2000; Rose, 1988a; Rose, 2003). Rose (1988a) noted, however, that the Massachusetts Institute of Technology had a course in industrial hygiene prior to the industrial hygiene program at Harvard. After Harvard developed their program, academic programs were developed at the University of Pittsburg, the University of North Carolina and Johns Hopkins University (Rose 1988a). Other universities that were among the first to develop IH programs included the University of Cincinnati (University of Cincinnati, 2008), and the University of Iowa (Yaffe, 1984).

Many of the early leaders in industrial hygiene were graduates of Harvard (Clayton, 1973). The growth in academic industrial hygiene programs was slow for the first 50 years after Harvard. That changed in the 1970s after passage of the Occupational Safety and Health Act on December 29, 1970 (Clayton; Rentos & Purcel, 1988; Rose, 1988a). After the passage of the OSH Act the number of

IH programs grew to over 200 by 1979. There was a subsequent decline in the number of academic IH programs, as noted by Clayton (2000). By 1987 the number of IH programs had dropped to 106.

Development of the Industrial Hygiene Program at UCM

The industrial hygiene program at the University of Central Missouri (UCM) began in the Department of Industrial Safety in the early 1970s. It was located within the School of Public Services that had been established a few years earlier. A safety program was developed first, followed shortly thereafter by an industrial hygiene program (Patterson, 1974). Mr. Herbert H. Jones was a Commissioned Officer in the US Public Health Service who had just completed his 24th year of service (IH lab dedicated …, 1997). Mr. Jones joined the faculty of the Department of Industrial Safety and Hygiene in the Fall of 1972 (Patterson). Jones was well known in the IH field, having served as the first chair of the ACGIH Threshold Limit Value committee for physical agents. Jones left the Department in 1980 (IH lab dedicates …).

Originally the curriculum for the industrial hygiene Masters degree included 32 hours (Central Missouri State University, 1974) which full-time students could complete in about 1.5 years. In 1984 the curriculum was expanded to 36 hours (Central Missouri State University, 1984) and in 1994 eight additional hours were added, bringing the current number of required hours to 44 (Central Missouri State University, 1994, University of Central Missouri, 2010).

Full-time students typically completed the program in two years with an internship conducted during the summer after the first year. When the initial IH Masters degree was developed, students were recruited with a solid foundation in biology, chemistry, math and physics. Background requirements were very prescriptive, requiring 15 hours of chemistry, 9 hours of both biology and math, and a semester of physics. Among these courses the prospective graduate student was required to have a course in physiology and organic chemistry (Central Missouri State University, 1974). The requirement for specific science courses has been maintained through the 2010 catalog (University of Central Missouri, 2010). In 2007, the Department of Safety Sciences was asked to conduct an assessment of industrial hygiene masters programs at peer institutions to determine if the 44 hour curriculum was in line with other programs. At 44 hours, the MS-IH curriculum is bigger than most masters programs at UCM (University of Central Missouri, 2010). Subsequently, the IH program coordinator in the department worked with a graduate student to conduct an extensive assessment. The results, presented at the 2008 Safety, revealed that the MS-IH program at UCM had one of the lowest number of credit hours required across the nation (Prince & Zey, 2008).

Program Assessment

Academic programs are facing continuing pressure to demonstrate they are effective. One method of determining effectiveness is to conduct program assessment (Allen, 2004; Anderson, Moore, Anaya, & Bird, 2005; Petersen, 1998). Petersen (1998) offered the following views on the pressure academic institutions face.

> Employers, students, parents and funding bodies all want assurance that colleges and universities are providing quality education. Concerns over the rising costs of higher education and a shift in the skills needed to secure successful employment in the post-Industrial Age have led to a national call for assessment and accountability across higher education. (p. 5)

Program assessment has been used to improve academic programs in many disciplines. Program assessment has been used by departments of criminal justice, communication, geography, human development and family studies, industrial hygiene, medicine, nursing, and psychology among others. A variety of instruments have been used by academic institutions in their assessments (Allen, 2004; Al-Nashash, Khaliq, Qaddoumi, Al-Assaf, Assaleh, Dhaouadi, et al., 2009; Brosseau & Frederickson, 2009; Estaville, Brown, & Caldwell, 2006; Finney, Snell, & Sebby, 1989; Heller-Ross, 2003; Hilton, Kopera-Frye, & Cavote, 2003; Hoyt & Allred, 2008; Ozan, Karademir, Gursel, Taskiran, & Musal, 2005; Tontodonato, 2006). Academic assessment articles are much more common since 1990 than they were previously. This coincides with the increase in pressure for programs to conduct assessment. Estaville, Brown and Caldwell presented a conceptual model for assessment of undergraduate geography programs using external reviews and departmental self studies. Finney, Snell and Sebby conducted a survey of alumni from an undergraduate psychology program to evaluate educational and career attitudes and satisfaction with advising and academic preparation. Hilton, Kopera-Frye and Cavote used computerized senior exams, internship supervisor ratings, focus groups and alumni surveys in their assessment. Heller-Ross used an evaluation of student research bibliographies to compare on-campus and off-campus students. Ozan, Darademir, Gursel, Taskiran, and Musal assessed graduating medical students' perceptions of their own and the school's efficacy. Tontodonato surveyed graduating criminal justice (CJ) students concerning their program satisfaction, careers plans and why students chose CJ as a major. Al-Nashash, et. al., used alumni, employer and graduate advisor surveys to evaluate the program's educational objectives and outcomes. Hoyt and Allred used a survey of alumni to assess a bachelor of general studies degree. Brosseau and Frederickson used surveys of alumni and interviews with employers to assess 42 competencies of their industrial hygiene academic program. The Brosseau and Frederickson study is the first journal article that discussed a research project in which an industrial hygiene academic program was evaluated. Academic programs in industrial hygiene as well as safety and environmental studies are just now beginning to publish assessment articles. Conrad and Wilson (2004) discussed four views of program assessment: reputational view, resources view, outcomes view and value-added view. The research described here-in fits into the outcomes view which includes student achievement following graduation and alumni satisfaction.

Development of Academic Program Accreditation

In the United States, academic institutions may seek voluntary accreditation from private organizations (Higher Learning Commission, 2003). According to the Higher Learning Commission, “There are two types of educational accreditation: Institutional and specialized” (p. 1). The North Central Association of Colleges and Universities was founded in 1895 with a purpose of fostering close cooperation between secondary schools and colleges in their area of responsibility. There are six regional associations that offer institutions accreditation. The Higher Learning Commission is one of two independent corporations that have membership in the North Central Association and accredits higher learning institutions that grant degrees (Higher Learning Commission).

Specialized academic program accreditation has been around since at least the 1930s when ABET (previously known as the Accreditation Board of Engineering and Technology) began offering accreditation to schools of engineering (ABET, 2009a). According to the ABET website, ABET’s creation was based on a needs survey conducted in the 1920s,

> It was 1932 when ABET was established as the Engineers' Council for Professional Development (ECPD). ECPD was formed to fill the apparent need for a “joint program for upbuilding engineering as a

> profession," a need determined through surveys conducted by professional engineering societies in the 1920s. (ABET, 2010¶1)

In 2005, ABET changed their name from the Accreditation Board for Engineering and Technology to simply ABET. ABET currently accredits approximately 2,700 programs at more than 500 colleges and universities (ABET, 2010). In Fiscal year 2007-2008 ABET began accrediting academic programs in countries outside the United States (ABET, 2008). This activity supports the idea of the growing importance of accreditation for academic programs.

Compared to engineering, industrial hygiene academic programs exhibited relatively little interest in external program accreditation during most of the 20th century. Engineering programs had established accreditation via ABET in the 1930s (ABET, 2010). Several authors have written articles about assessment for OSH or IH programs (Cudworth, Craft, Bohl, Buchan, Garber, Kornreich, et al., 1984; Dobbins, 2005; Lerner, 1976; Pendergrass, 1975; and Whitehead, 2007). Lerner and Pendergrass wrote about the Occupational Health/Safety Programs Accreditation Commission (OHSPAC). The OHSPAC was an initial attempt to establish accreditation for industrial hygiene and occupational safety programs. Cudworth, Craft, Bohl, Buchan, Garber, Kornreich, et al. wrote about the collaboration between the Academy of Industrial Hygiene and ABET to establish the accreditation program that is currently held by over 25 different colleges and universities (ABET, 2009b). The University of Cincinnati and the University of Utah were among the first universities to have their IH programs accredited by

ABET (ABET, 2009b). Currently, 26 colleges and universities have accredited IH programs. The program at UCM was originally accredited by ABET in 1998 and reaccredited for six years in 2005 (ABET, 2000b).

One of the primary reasons for pursuing certification or accreditation is for the constituents of an academic program (Brauer, 2002). Brauer includes employers, the government and the public among the constituents that favor program accreditation. Brauer explains that this is true even if the constituents do not entirely understand the assessment process. Higher education programs, which historically had not been under the close scrutiny of secondary and elementary education, are coming under more scrutiny (Patton, 1997; Palomba and Banta, 2001). The academic discipline of OSHE has also come under more scrutiny. External program accreditation has become more important to academic programs in the field of OSH (Boraiko, Zey, & Greife, 2010; Greife, 2007). In 2005 and again in 2007, presentations concerning academic program accreditation were given at the American Industrial Hygiene Conference and Exposition. At the 2007 meeting a platform presentation and a roundtable discussion were devoted entirely to academic program accreditation (Zey, Greife, & Laster, 2007; American Industrial Hygiene Association, 2007). Program evaluation has became more important due to pressure from university administrators, pressure from students and finally pressure from the general public (Greife, 2007; Brauer, 2002).

Summary

This literature review has provided an overview of the history of working conditions, an explanation of what history of industrial hygiene is, individuals who had a significant impact on the development of industrial hygiene, important historical events, advances in sampling and analytical techniques, industrial hygiene academic program development, development of the industrial hygiene program at the University of Central Missouri and a brief review of academic program assessment were discussed. In addition, there was a brief discussion of the development of program assessment for industrial hygiene academic programs and then specifically how the Department of Safety Sciences has embraced program assessment for their industrial hygiene masters program in the last fifteen years.

CHAPTER THREE

RESEARCH DESIGN & METHODOLOGY

The central instrument for this research was an online survey of alumni of the industrial hygiene program. Surveys of alumni have been used for program assessment by academic departments in a variety of disciplines to assess program outcomes, alumni perceptions, evaluate educational and career attitudes, and alumni satisfaction with advising and academic preparation (Al-Nashash et al, 2009; Brosseau & Frederick, 2009; Finney, Snell, & Sebby, 1989); Hoyt & Allred, 2008).

The second primary method of information gathering for this research was a review of historical documents. Specific documents reviewed included 5-year progress reports, minutes of department meetings, and copies of university catalogs going back to the early 1970s. In addition, a dissertation by Patterson from 1984 provided a wealth of information concerning the very early years of the School of Public Services, the Department of Industrial Safety and Industrial Hygiene, and specifically the industrial hygiene program.

Ethical considerations and Human Subjects requirements were addressed by submitting the proposed research through the University of Missouri's Institutional Review Board (IRB) before any data were collected. Study participants were informed of their rights and assured they could withdraw from the research study at any time. Emails, sent to each alumnus, contained a link to the online survey and an explanation that by taking the survey, the alumni was agreeing to participate in the study.

Purpose of the Study

This research provides critical information concerning the strengths and weaknesses of the UCM Masters program in industrial hygiene and will help determine if a trend exists in alumni satisfaction with the program at the time of their graduation. The information collected can be utilized by the Department of Safety Sciences, the Dean of the College of Health and Human Services, the administration of UCM, and other constituents of the department in deciding what changes are needed to sustain and improve the quality of the academic program. This information will also assist the department with internal and external reviews of the industrial hygiene program.

Research Questions

The following research questions guided this study:

1. What topics/courses do alumni view as most important for IH graduate students to take as part of their curricular studies?
2. What skills and knowledge do alumni view as critical for entry level industrial hygienists?
3. How has the satisfaction of alumni with their preparation by the Department of Safety Sciences for their career in industrial hygiene changed since the program began?

Methodology

Evaluating the industrial hygiene program in the Department of Safety Sciences at UCM entailed both qualitative and quantitative research methods. Prior to the development of the survey instrument, input was obtained from faculty and administrative officials of the Department of Safety Sciences and the College of Health and Human Services (CHHS). The purpose of input was to determine the type of information desired by departmental and college personnel. Feedback from this group formed the framework of the questionnaire survey administered to alumni via an on-line survey software program called Survey Monkey®. The basic software program is available to the public free of charge. For this research a slightly enhanced version of Survey Monkey was used.

Population and Sample

The population for this study was the 400 alumni that have graduated from the Department of Safety Sciences since 1974 with a Master's degree in industrial hygiene. This includes alumni who earned their degrees in the early 1970s through graduates who earned their degrees in 2009. This group of individuals represents one of the largest populations of industrial hygiene alumni for any university in the United States. The sample was the number of alumni that the researcher was able to locate and contact using available databases. Until 1994, the department offered both a Masters and a Bachelors degree in industrial hygiene. The Bachelors degree in industrial hygiene was changed to a

Bachelors degree in occupational safety and health. Alumni of both the BS and MS industrial hygiene programs were contacted via the online survey, but only alumni with the Masters degree were asked to complete the entire survey.

Recruitment of Participants

Alumni contact information was obtained using professional membership directories, of which the researcher is a member, in-house resources including business contact information, and a compilation of alumni addresses and emails that were prepared for the University of Central Missouri (2008a) by a contractor in 2008. Many of the industrial hygiene alumni are members of occupational safety and health professional societies including the American Industrial Hygiene Association (AIHA), the American Conference of Governmental Industrial Hygienists (ACGIH), The American Society of Safety Engineers (ASSE) and local chapters of some of these organizations. These professional organizations maintain databases of their members. This researcher began collecting information on industrial hygiene alumni in the early 1990s due to work and personal interests. The researcher is a member of all three professional associations and thus has access to the online data bases. Another very important source of information is a directory of UCM's living alumni. The directory is available in hard copy and on CDRom (University of Central Missouri, 2008a). Home and business addresses and e-mail addresses are included in the directory for many of the alumni. The department also maintains a collection of business cards from alumni. Business cards are collected during professional meetings, on-campus career fairs and during visits to campus by alumni. Old cards are replaced as new business cards are received. Collectively, these information sources enabled the researcher to contact the majority of industrial hygiene alumni. The final recruitment step was the email asking for alumni to participate in the study that contained the link for the online survey.

Data Collection and Instrumentation

An online survey questionnaire was the primary instrument for this research study. Online surveys have grown in popularity and are now a standard method of collecting information (Andrews, Nonnecke, & Preece, 2003). The questionnaire was developed using feedback from faculty and college administration as well as existing surveys instruments used for similar assessments (Brosseau, et al, 2005; Brosseau & Frederick, 2009). Some of these instruments were used in internal assessments at UCM. These data have been presented at national meetings but not published in peer reviewed journals (Rodgers, 2007; Van Dorn & Zey, 2004).

The online survey was used due to its ease of use and data storage capabilities. One advantage of using online surveys for this research is the availability of email addresses for most of the living alumni from the industrial hygiene program. Email addresses are available from at least three sources. The first source of contact information is on-line membership directories of professional associations such as AIHA, ACGIH, ASSE, and the American Board of Industrial Hygiene (ABIH). These directories contain email addresses for many of their members. The second source of contact information is a directory of alumni produced by UCM in 2008 (University of Central Missouri, 2008a). This directory helped locate those alumni who are not members of any professional association. The third source of alumni contact information is the group of business cards maintained by the department.

A second type of assessment technique for this study was a review of historical documents generated by or about the Department of Safety Sciences. Documents reviewed include minutes of department meetings and reports from internal reviews of the department. Two primary locations for documents of this type are the department files and the UCM archives.

Results of this research will be provided to the faculty and administrators of the Department of Safety Sciences, entities that are responsible for the curriculum used in the industrial hygiene Masters program. This information can then be used by these groups to make modifications to existing curricula. The same information will be provided to internal and external review boards and to all other constituents via publications in professional journals, articles in the department’s newsletter and posting information on the department webpage. Internal and external review committees strongly encourage, and in some cases require, program assessment. Thus, the information collected will help the department satisfy those review groups.

Data Analysis

This research involved an on-line survey open to all alumni who have graduated from the industrial hygiene program at the University of Central Missouri. Using questions developed with input from department faculty and college administration, alumni were questioned on their views as to the types of skills and knowledge that are critical for masters level academic programs. Alumni were also questioned on the importance of various courses and topics that could be included in an industrial hygiene masters program. Finally, alumni were questioned concerning their relative satisfaction of the preparation by the department for their career in industrial hygiene. The goal of this question was to determine if perceptions had changed and if so, did those changes coincide with significant changes in the program's curriculum? Demographic information collected included gender, years of experience in the OSHE field, professional certifications alumni had obtained, and what percentage of time alumni work in the main sub-areas of OSHE.

After the initial email was submitted, three "reminder" e-mails were sent over the next 42 days. The survey was closed on June 15, 2010. A response of 25% would have been considered acceptable based on research by Sheehan (2001) that found that since 1986 average response rates for email surveys have fallen to less than 30%. This would only be true of course if characteristics of the response sample were consistent with the overall population. It is the belief of this researcher that a strong salience commitment exists toward the UCM industrial hygiene program by the IH alumni. The importance of salience issues was noted in the Sheehan research. A response rate of 51% was obtained for this study.

Data analysis was performed using available statistical software after it was collected via the online survey. After completion of data collection, the information was downloaded to Excel, compiled, organized and analyzed. Raw data were first loaded into Excel® from Survey Monkey®. Data for survey questions #19, 22, 23 and 27 were ranked from 1 (low or poor) to 4 (high or excellent) in excel and then the data were loaded into SPSS for statistical manipulations. Those survey questions that concerned satisfaction of alumni with their training by the Department of Safety Sciences were analyzed using the Kruskal-Wallis test test to compare perceptions across different time periods of graduation. Other statistical analyses performed include frequency distributions, medians, and means, to better interpret and define the data collected.

All three research questions were addressed by at least one of the survey questions. Research question one was addressed by survey question number 24. Research question two was addressed by survey questions number 21 and

25. Research questions three was addressed by survey questions number 6, 19, 22, 23 and 27.

Summary

The purpose of this study was to determine the skills and knowledge that alumni viewed as important for entry level industrial hygienists, the courses and topics alumni believed were important for masters students to take as part of their curriculum, and to assess if a trend exists in alumni perceptions of how well the industrial hygiene program at UCM prepared them for their first job. In addition, a comprehensive database was compiled of information on what certifications alumni obtained, where alumni work and what their annual salaries are. Data were collected through an on-line survey and from a review of historical documents. The review of historical documents provided information on the creation of and significant developments affecting the Industrial Hygiene program. It also enabled the researcher to triangulate some of the information obtained from the online survey.

CHAPTER FOUR

RESULTS

The focus of this study was to evaluate the relative satisfaction of alumni of the industrial hygiene program at the University of Central Missouri (UCM) with their preparation by the Department of Safety Sciences. In addition, this research assessed the views of alumni concerning the most important courses and topics to be included in the curriculum for an industrial hygiene masters program and what skills and knowledge entry level industrial hygienists should have upon graduation. The study involved both a review of historical documents and a survey of program alumni consisting of 28 questions. The survey was completed using software called Survey Monkey® that enabled the researcher to collect alumni responses via an on-line survey.

Review of Historical Documents

A review of historical documents helped to establish details of the development of the industrial hygiene program at UCM. These documents included minutes of department meetings, internal 5-year progress reports, course catalogs, and assorted other items. Dr. Robert Marshall, who was hired to establish the School of Public Services at Central Missouri State College (the name later changed to Central Missouri State University and then the University of Central Missouri) in the late 1960s, along with those he hired to assist him, managed in just a few years to establish an organization that combined various aspects of safety under the overarching structure of the School of Public Services. The idea of housing so many different but associated programs into one academic unit was ahead of its time. The school of Public Services housed driver's training, criminal justice, consumer product safety, occupational (industrial) safety, and the Missouri Safety Center. Dr. Marshall also served as the first Chair of the Safety Department in the School of Public Services. Almost all of the leaders in the School of Public Services had backgrounds in Driver's Training or Driver's Safety. This was appropriate as the School of Public Services was heavily involved in driver's safety and transportation safety.

A general studies course in safety, Principles of Safe Living, was approved by 1971. In the early 1970s, Dr. Marshall and the other administrators made a decision to expand available degrees to include industrial safety and, later, industrial hygiene (Patterson, 1974). Both programs were housed in a new department, The Department of Industrial Safety and Industrial Hygiene. Dr. Marshall served as the first Chair of this Department. A meeting was held in February of 1972 to establish curriculum for the new MS-IH program. Attending the meetings were representatives of Armco Steel, Ford Motor Company, the Presidents of the St. Louis Chapter of ASSE and AIHA, the President of the Great Plains Industrial Physicians Association, and the President of the Greater Kansas City Association of Industrial Nurses. Also in 1972, Mr. Herbert H. Jones was hired to head the industrial hygiene program. He joined the Department after a 27 year career in the US Public Health Service. Dr. Robert Semonisck was hired as the first full-time chair of the Department of Industrial Safety and Industrial Hygiene. In 1974, six students graduated with masters of industrial hygiene degrees. This number increased rapidly to 31 graduates in 1979, the largest number of graduates for any year.

Mr. Jones left the program in 1980 to enter retirement full time. Dr. David Anglen, a recent graduate of the doctoral program at the University of Michigan, was hired to head the industrial hygiene program in 1981. He lead the IH program until 1988 when he left to accept a position with the United States Department of Energy. Ms. Dianna Bryant, a young industrial hygienist with approximately two years of experience (post-masters) was hired in 1989. Shortly thereafter, Dr. James Pierce was hired to head the IH program. He served approximately two years, then left to serve in Desert Storm and did not return to CMSU. In 1994, Dr. Reg Jordan was hired, but left after one year. For most of the IH program's existence the department had only one full-time IH faculty.

In 1994 the Department lost the approval for the general studies course following university changes to the requirements for general studies courses. This course, originally approved in 1971, may have played a key role in the dramatic increase in student numbers in the department in the mid to late 1970s. With large student numbers, at times over 500, it is unlikely the department faculty appreciated the potential impact this course had on student enrollment. A few years after the course was disapproved, the Department experienced a gradual reduction in student numbers and, thus, students graduating from all programs, including industrial hygiene. The course was re-approved in November 2005 with a different name, Safety: A Societal and Personal Focus.

In the early 1990s Safety Sciences embarked on a mission to acquire ABET accreditation. An application (called a Self Study) was submitted to ABET in 1993 for potential accreditation in 1994. During the site visit, the Department decided to withdraw the application based on a belief that accreditation was unattainable with only one full-time IH faculty member. Two additional industrial hygienists, Alice Greife and John Zey, both having completed 20 years of service with NIOSH, were hired in 1996. For the first time the IH program had three fulltime IH faculty. Two years later the IH masters program was accredited by ABET. The initial ABET Accreditation report contained very few recommendations for improvements to the industrial hygiene program. However, when the program was visited for re-accreditation in 2004, many issues were raised by the ABET site visitors. Due to the concerns by ABET, an interim visit in 2006 was required. In 2006, the IH program was reaccredited through 2011, with no deficiencies and no weaknesses.

In 1998, Mr. Larry Ferguson, a recent retiree from the United States Air Force with extensive laboratory experience, was hired to manage the Department's internal laboratories. Also in 1998, in an effort to meet ABET requirements, an advisory board of external experts in industrial hygiene was established. The first meeting of the IH advisory board was in 1999. In 2005, Dr. Allen Iske was hired. He had a PhD in Chemistry from the University of Nebraska, was certified in both industrial hygiene and safety, and had over 30 years of industrial experience. In 2008, Dr. Georgi Popov, a PhD from Bulgaria, was hired into a tenure track position. He had ten years experience, including work he had done internationally.

The curriculum for the original industrial hygiene masters degree included 32 hours which full-time students could complete in approximately 1.5 years. In 1984, the curriculum was expanded to 36 hours and in 1994 eight additional hours were added to increase the number of required hours to 44. In 2008 through 2009, additional changes were made to the curriculum by reducing the internship requirement from six to three hours and adding a 3-hour research requirement. The 44 hour curriculum was thus maintained. The initial curriculum and the subsequent primary curricular changes are shown in Table 1. Table 2 lists the background requirements and change made to background requirements since the program began.

Table 1

Principal Curricular Changes To MS-IH Program By Year

		Courses Required for MS-IH Degree					
Course Name	**Hrs**	**1974 to 1984**	**1985 to 1995**	**1996 to 2005**	**2005 to 2008**	**2008 to 2009**	**2009 to 2010**
Principles of Industrial Hygiene	3	x	X	x	x	x	x
Organization and Administration Safety Program	3	x	X	x	x	x	x
Current literature and Research	3	x	X	x	x	x	x
Chemical Fund for IH	3	x					
Industrial Environmental Monitoring	3	x	X		x	x	x
Industrial Toxicology	3	x	X	X	x	x	x
Noise and Vibration Measurement	1-2	x(1)	x(2)	x(2)	x(2)	x(2)	x(2)
Radiation & Optics	2	x					
Nuclear Radiation and X-Rays	2	x					
Atomic, Nuclear and Electro Radiation	4		X				

Biology for Industrial Hygiene	3	x					
Industrial Audiology	2	x	X		x		
Environmental Physiology	4		X				
Principles of Epidemiology	3			x	x	x	x
Safety & Health Legislation and Standards	3			x	x	x	x
Internship	3-6			x (6)	x (6)	x (3)	x (3)
Conservation of Natural Resources	3				x		
Noise Measurement	2			X	x	x	x
Individual Research Project or Thesis	3					x	x
Elective Hours	4-9	4	6	9	9	9	9
Total Hours Required		32	36	44	44	44	44

Table 2

Background Requirements for entry into MS-IH

	1974 to 1984	1985 to 1995	1996 to 2005	2005 to 2008	2008 to 2009	2009 to 2010
Undergraduate GPA	2	2.25	2.25	2.25 with 2.5 in Science	2.25 with 2.5 in Science	‘3.0 overall
Chemistry	1 Year	1 Year with Organic	15 Hours	15 Hours With Organic	2 Semesters with Organic	1 year with Organic
Biology	1/2 Year	1Year with Physiology	9 Hs	9 Hs-with Physiology	1 year with Physiology	1 year with Physiology
Math			9 Hours	9 Hours with Calculus	1 Year with Statistics	1 Year With Statistics
Physics	1 Year	1Year with Organic	10 Hours	2 Sem	1 Sem- with lab	1 Sem- With lab

Full-time students typically complete the current MS-IH program in two years, with the internship conducted during the summer after the first year. Other changes that occurred over the 36 years of the program include a reduction in physical agent credit hours, a requirement that students take the GRE and submit the score as part of their application, and that students without a significant amount of field experience are required to complete an internship.

The review of historical documents revealed other information concerning the history of the department. Among the data gleaned from this review are the numbers of total students graduating by year, including BS, MS and Educational Specialists. The number of total graduates from the Department of Safety Sciences between 1970 and 2009 is shown in Figure 1. Over 2,900 individuals have earned degrees from the Department of Safety Sciences. There have been two time periods when the numbers of students graduating peaked and then dropped off. Figure 2 shows the number of MS-IH graduates by year.

After the first peak in IH graduates the numbers gradually decreased and then peaked in the early 1990s. IH graduate numbers then began another reduction that has remained below 10 graduates since 1999. However, based on these figures, the department and the IH program appear to be heading into a third period of high student numbers. From these two figures, one can see a very similar pattern of the number of graduates by year. Thus, the ebbs and flows in student numbers were consistent for both the IH program and for the

Department. This suggests that the number of students in the department's undergraduate programs may strongly influence the number of IH graduate students.

Figure 1

Total Graduates (BS, MS & Ed Sp) By Year

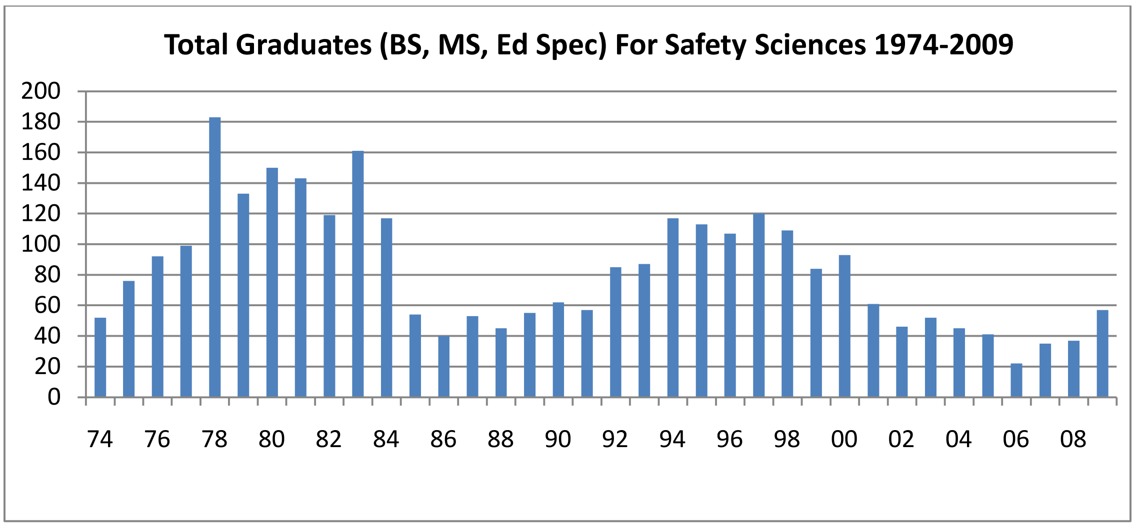


Figure 2

MS-IH graduates by year.

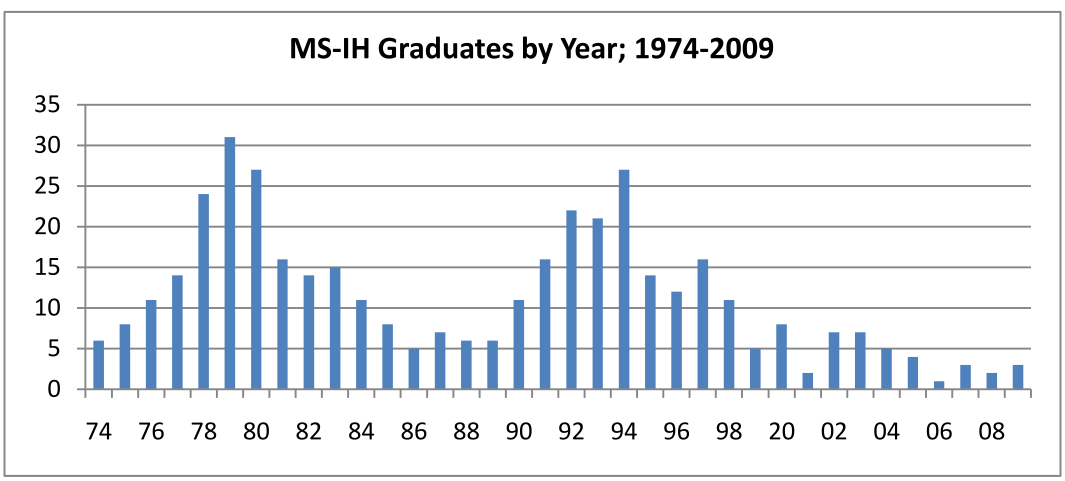


Figure 3 contains a timeline for important dates and events affecting the IH masters program. Key events depicted include approval, disapproval and the re-approval of the general studies course, adding or removing specific courses from the curriculum, expansion in the total IH hours required, the almost constant turnover of Department Chairs that occurred in two separate time periods, and ABET accreditation actions, as well other items. In Figure 3, curriculum changes are noted in green, personnel changes are noted in burgundy, department chair changes are delineated in blue and accreditation actions are noted in brown.

Figure 3 – Timeline of key events for UCM MS-IH

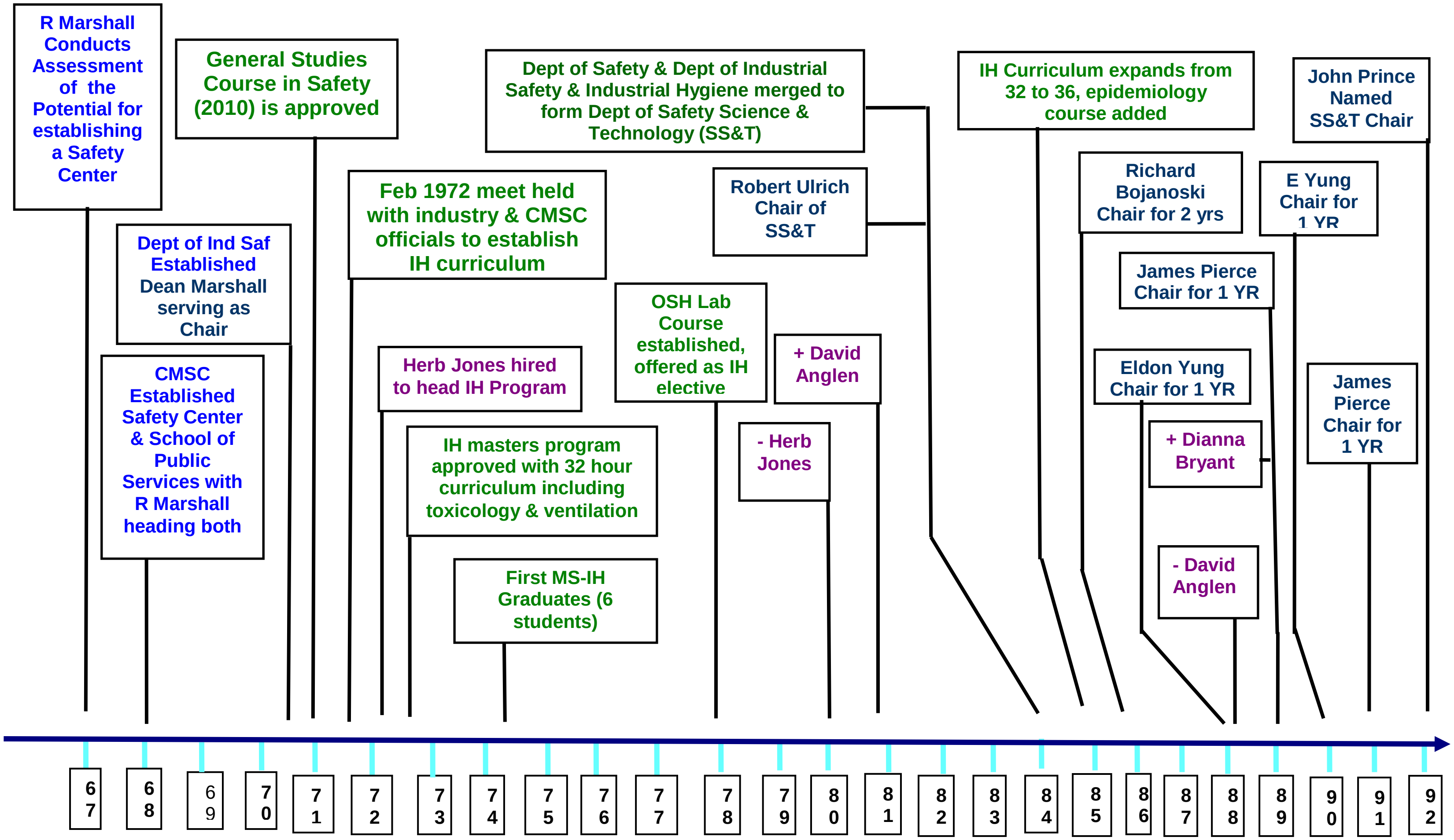
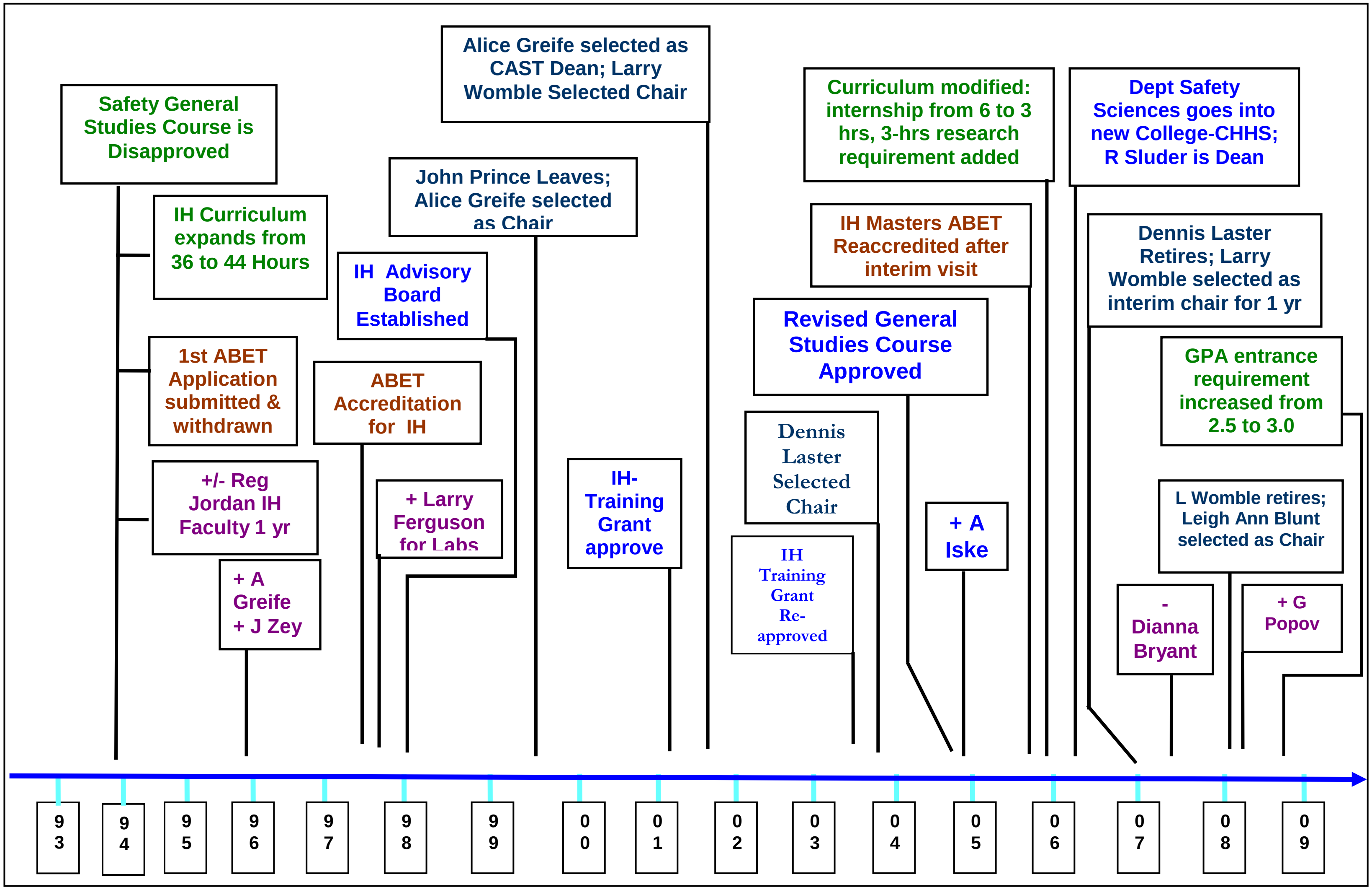


Figure 3 – Timeline of key events for UCM MS-IH



Since Spring Semester of 2007, the Department has offered 6-7 sections of Safe 2010 each Fall and Spring Semester. This course helps increase awareness of the department and its programs throughout the University. This could increase the number of students in the IH program. Another important item taken from the review of documents concerns the number of MS-IH students who took courses at Central before enrolling in the MS-IH program. Twenty eight percent (112) of the 400 MS-IH alumni had at least taken some classes and 106 of them had earned a BS degree at UCM before obtaining the MS.

The review of historical documents also evaluated the certifications earned by graduates. This review revealed that 211 of the 400 alumni had obtained a masters degree in industrial hygiene obtained either the certified industrial hygienist (CIH) designation or the Industrial Hygienist in Training (IHIT) during their professional careers. The IHIT was discontinued by the American Board of Industrial Hygiene in the 1990s. Fifty alumni obtained the Certified Safety Professional (CSP) designation, 32 obtained the Certified Hazardous Materials Manager designation and 17 alumni were certified in some other specialty. These results are shown in Table 3. For the alumni with the CIH designation, the researcher evaluated the average time for alumni obtain certification. The average was 6.4 years and the range was 1 year (earned certification during the year of graduation) to 30 years.

Table 3

Alumni Attainment of Certification – from Historical Document Review

	Number	%
Total Alumni	400	100%
CIH	211	52.5%
CSP	58	14.5%
CHMM	32	8.0
Other	17	4.3
Alumni with 1 or more certifications	233	58.3

Other items of note taken from reviewing historical documents include the approval of a general studies safety course in the early 1970s, which was disapproved in 1994 and the number of IH alumni who obtained certification. In 2005, the Department achieved approval for a revised general studies course.

Survey Results

A total of 136 individuals responded to the series of emails inviting them to participate in the online survey, resulting in an overall response rate of 50.7% Those 136 alumni answered at least one question. One individual did not wish to take the survey, 11 did not have a Masters degree and ten reported that they did not have an academic degree from UCM/CMSU. For most questions, 118 -122 alumni gave responses. The overall response rate was 50.7%, but a more realistic response rate for individual questions was 44% - 45.5%.

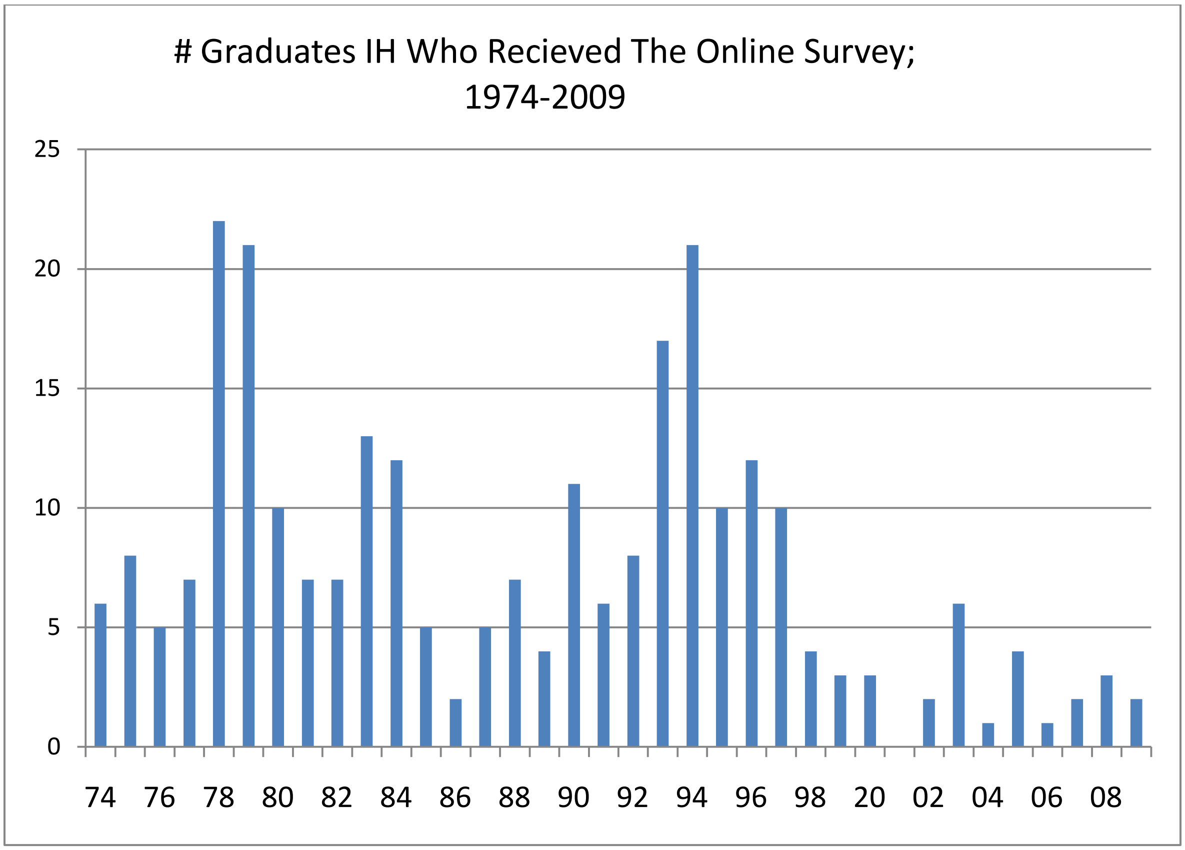
This software program allowed tracking of responses by the day received. A review of the responses by day shows that responses were received on 30 of the 42 days the survey was open. Most responses were received on the days the original or a “reminder” email was sent out. The size of the response was smaller for each succeeding email: initial email = 35, first reminder email = 18, second reminder email = 12, and 8 responses were received on the day the fourth (third reminder) and final email was sent out. Responses were less for each of the succeeding days. This response rate is higher than typically reported for online surveys, probably due to the salience aspect of this study.

The internal database maintained by this researcher had 506 names in 2009. Triangulation with other databases resulted in reducing this list to 448 alumni, of which approximately 444 were still living. Forty-four of these alumni had obtained the BS-IH but not the MS-IH degree. That left 400 alumni with the MS-IH, but four of these alumni have passed away, leaving 396 living alumni with the MS-IH. The researcher had emails for 267 (approximately67%) of those living alumni who had MS-IH degrees from UCM.

Figure 4 shows the number of alumni who received the online survey by year. The shape of the data in Figure 4 is very similar to that for both total graduates (Figure 1) and graduates (Figure 2) from the MS-IH program. This is not definitive proof that those alumni are truly representative of the entire population, but it does suggest the sample of IH alumni who received the survey is generally representative of the total population. This combined with other factors provides stronger evidence that the sample of IH alumni is indeed representative.

Figure 4

Number of IH Alumni Who Received the On-Line Survey



All recipients of the online survey were asked to complete five questions. Survey question number one, asked if the recipient wanted to participate in the on-line survey. Sur vey questions two through five asked each recipient their gender, age, the type of degree they obtained from UCM, and if they had indeed obtained an MS-IH degree from the University. If they had an MS-IH degree from UCM they were asked to complete the entire group of 28 questions. Ten of the respondents indicated they did not have a degree of any kind from UCM. One individual did not wish to take the survey and, thus, only answered the first question.

Survey question number six asked what time period the alumni had graduated from UCM. The time periods in question (1974-1984, 1985-1995, and 1996 through 2009) were established based on significant changes in curriculum. The second and third time periods follow expansions in the total number of credit hours required for the Masters degree (Table 1). The breakdown for the number of respondents by time period was 53 (1974-1985), 38 (1985-1995) and 29 (1996-2010). More important than the actual numbers of responses are the percentages of alumni from each time period who responded. The percentages for the number of alumni who responded from each of the three time periods divided by the number of alumni for whom emails were available (from that time period) give the following results: 46.5% for 1974-1984, 39.6% for 1985-1995, and 54.7% for the time period from 1996-2009 (Table 4).

Table 4

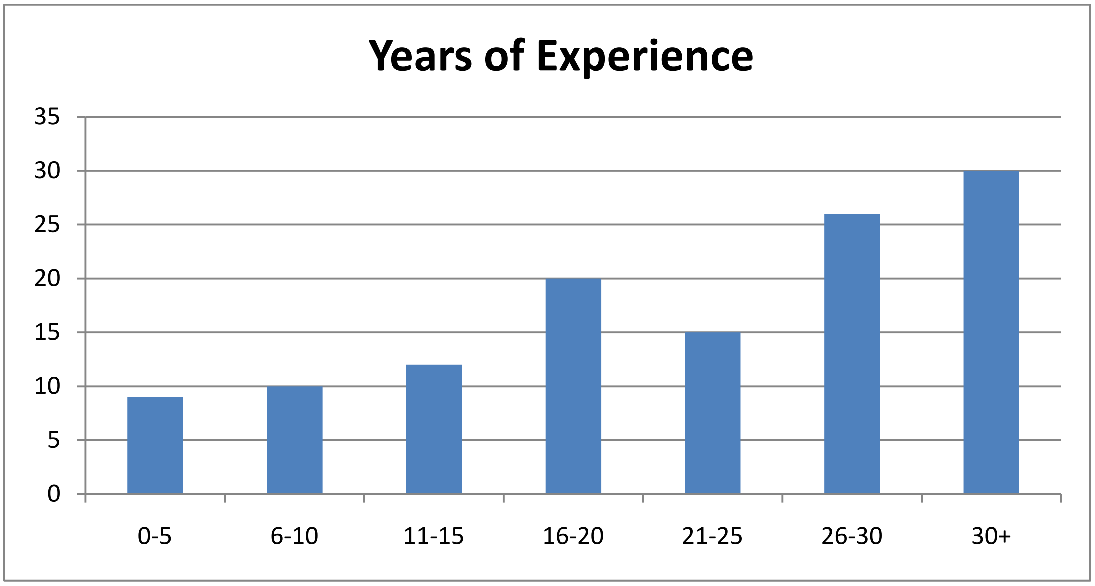
Number of Alumni By Time Period & Number that received the Survey

	Total # of alumni			Alumni With E-Mail Addresses		
Time Period	**Alumni**	**# Responded**	**% of Total Alumni**	**# of Alumni**	**# Responded**	**% Responded**
1974-1984	181	53	29.3	114	53	46.5
1985-1995	144	38	26.4	96	38	39.6
1996-2009	83	29	34.9	53	29	54.7

Survey question number seven asked for the number of years of professional experience each recipient had (Figure 5). Only nine alumni had ten or fewer years or experience. One hundred and three alumni had 11 or more years experience. Ninety-one alumni had 16 or more years of experience, and 30 alumni had 31 or more years of experience. This is consistent with the data from survey question six. Over 75 percent of the alumni who responded to question number six graduated before 1996.

Figure 5

Years of Experience For MS-IH Alumni



Survey questions number 8 and 9 asked about certifications held by the alumni. Seventy six alumni (64.4%) reported having the CIH (certified industrial hygienist), 31 (26.3%) reported having the CSP (certified safety professional) and 18 alumni (15.3%) indicated they had obtained the Certified Hazardous Materials Manager (CHMM) certification. Other certifications obtained by alumni included the Registered Occupational Hygienist (ROH), Professional Engineer (PE), Certified Professional Environmental Auditor (CPEA), Certified Environmental Trainer (CET) and Associate Risk Manager (ARM). These results are shown in Table 3. Reasons for not having obtained certification included: the company did not support it, took the test but did not obtain a passing score, did not consider it worth the time and effort, and have not yet sat for the exam.

Table 5

Alumni Certification by Survey Results

Certification Obtained	Number	Percentage
CIH	76	64.4
CSP	31	26.3
CHMM	18	15.3
Other Certification	23	19.5
Have Never Been Certified	21	17.8

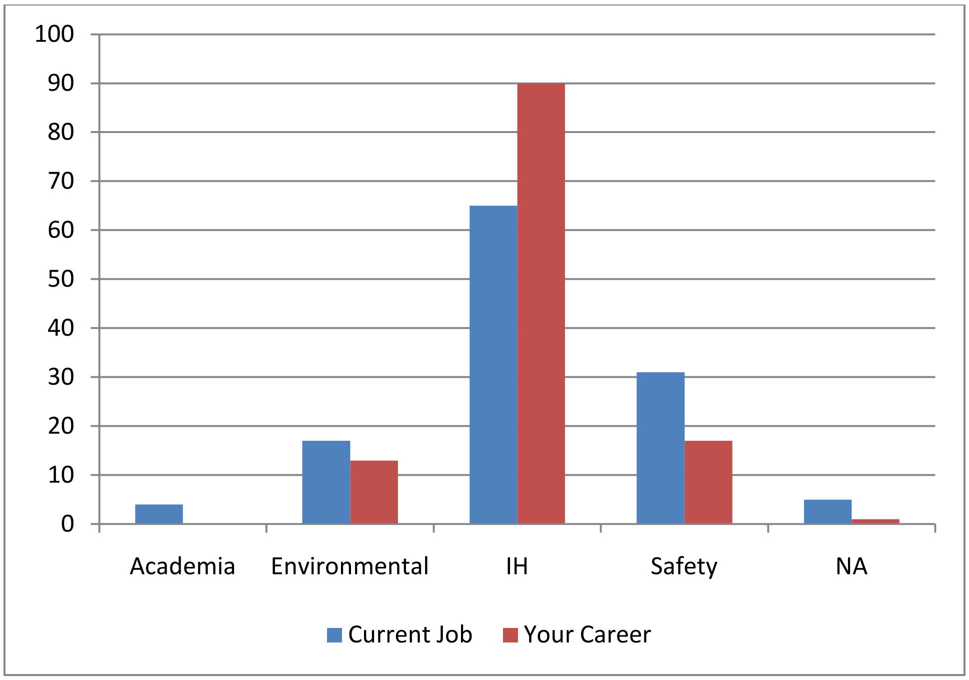
Survey question 10 asked about each alumni's current job status. One hundred and twenty two alumni responded to this question. One hundred and two alumni (83.6%) were employed full-time, seven (5.7%) were employed part-time, five were not employed in OSHE, and eight alumni were retired.

Survey question 11 asked where alumni were employed. Most alumni are employed in four primary areas: general industry, government, consulting, and academia. Almost half work in general industry (45.8%), 23.1% were with the government and 16.2% worked in consulting.

Survey questions 12 and 13 were similar, asking first (question 12) what primary area of practice alumni worked in during their current or most recent job in OSHE and then (question 13) which area was primary for their career. The results for both questions are shown in Figure 8. Most alumni indicated that industrial hygiene was their primary area of practice. Safety was next, followed closely by environmental. A few alumni indicated they worked primarily in academia.

Figure 6

Primary Area of Practice: Current Job & Career



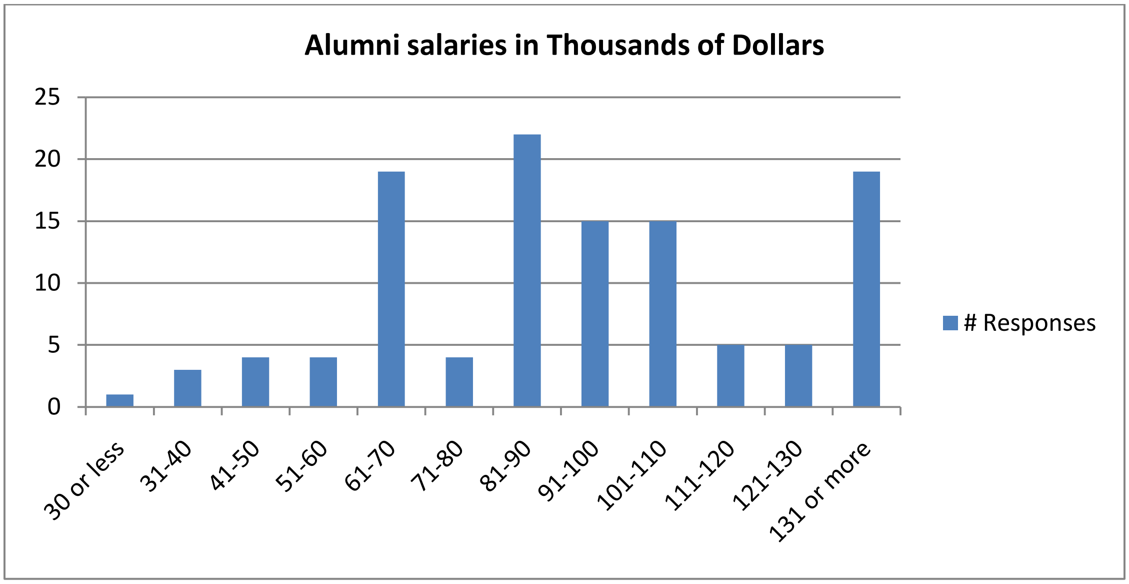
Responses for these two survey questions were very consistent for both the most recent job and for their career. Industrial hygiene has been the primary job responsibility for both the current (or most recent) job and for most alumni's career.

Survey questions 14 and 15 asked what percentage of time alumni were involved in specific types of activities. Survey question 14 asked what percentage of time alumni spend doing OSHE activities. More than 90% of alumni reported spending over 51% of their work time on OSHE activities. Sixty-four alumni reported spending over 90% of their work time on these activities. Survey question 15 asked which job duties alumni spent at least 10% of their time on. The five highest job related activities included industrial hygiene (90.2%), safety (65.6%), training (60.7%), environmental (49.2%) and ergonomics (44.3%).

Survey question 16 inquired about the alumni's annual income (Figure 7). Twelve (10.3%) alumni reported making $60,000 or less, meaning that approximately 89% of the alumni were earning over $60,000 per year. Sixty alumni (51%) reported making between $61,000 and $100,000, 25 alumni (21.4%) reported making between $101,000 and $130,000, and 19 (16.4%) reported making over $131,000 per year. Most of the alumni making higher salaries had been out of school the longest. Twenty-nine of the 43 alumni making more than $101,000 per year graduated in the first time period (1974-1985). The results are shown in Figure 9.

Figure 7

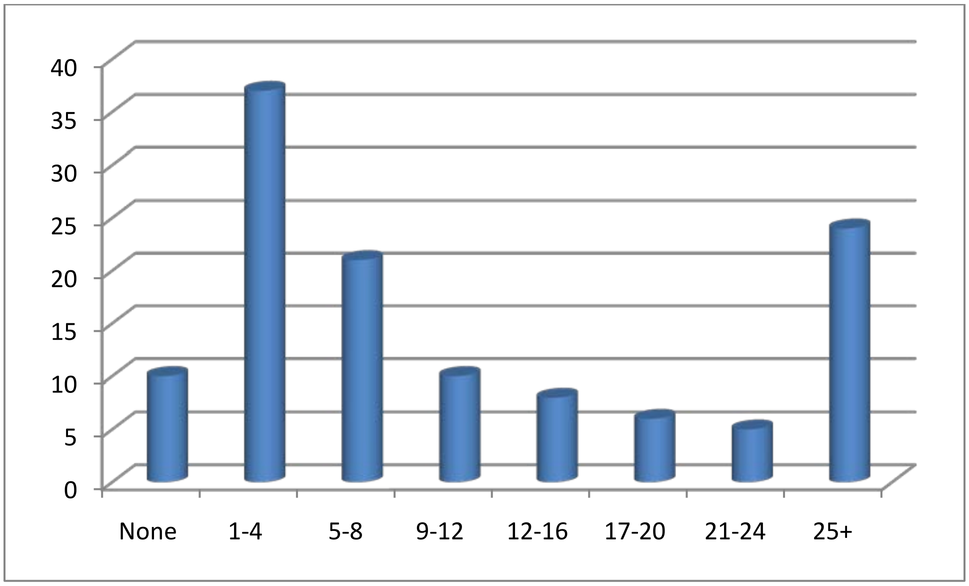
Annual Salary Reported by Alumni



Survey question 17 asked alumni how many other OSHE professionals they worked with. The results are shown in Figure 8. These results indicate that very few alumni are working by themselves. Only ten alumni reported not working with any other OSHE professional. Fifty-three (43.8%) alumni reported working with at least nine other OSHE professionals.

Figure 8

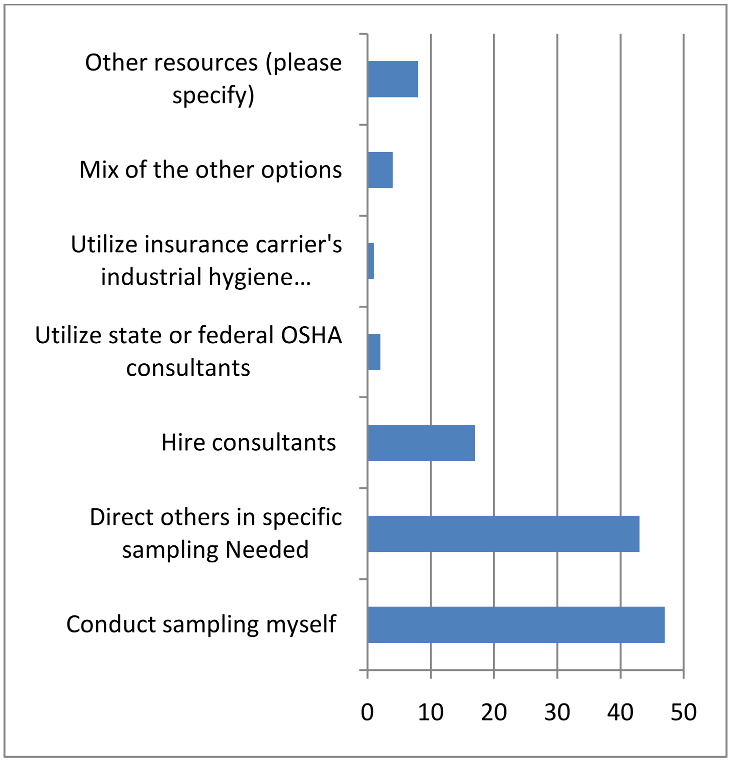
Number of other OSHE Professionals Alumni work with



Sur vey question 18 asked how the alumni's industrial hygiene sampling needs were accomplished. Forty seven (48.5%) reported they conducted the sampling themselves,43 (35.3%) direct others in conducting the industrial hygiene sampling, and 17 (13.9%) hire consultants to conduct the sampling. Four alumni indicated they used a mix of the various options, three alumni utilized federal or state industrial hygienists consultants or insurance company industrial hygienists. Eight alumni indicated they used other options to accomplish their industrial hygiene sampling needs. The results are shown in Figure 9.

Figure 9

How IH sampling needs are accomplished



Survey question 19 asked each alumnus to rate their satisfaction with their preparation by the department. Satisfaction has been high through all three time periods, with 90.1% ranking their preparation as above average or excellent. This is also supported by the Kruskal-Wallis test, which showed no significant difference among the time periods (Table 6). The test revealed a p value of 0.261 between the three time periods.

Table 6

Satisfaction with Preparation By Department (Q 19)

N	Time Period	Mean (by time period)	‘p value
53	1974-1884	3.3019	
38	1985-1995	3.1842	0.261
29	1996-2010	3.1429	
119	Total	3.2269	

Responses for overall satisfaction with preparation for a career in industrial hygiene were very consistent over all three time periods. The majority of alumni believe their preparation was very good. Across time periods, almost 90% of the alumni ranked their preparation by the Department of Safety Sciences as above average or excellent (Figure 10). This included 69 (58%) who ranked their preparation as above average and 38 (31.9%) who ranked it as excellent. There is a slight dip in satisfaction during the second time period, but the results are still very good. When the data are evaluated by time period, the results are similar (Figure 11). The responses are evaluated using the Kruskal-Wallis test. It showed no significant difference across the three time periods (p value = 0.261). The means were almost identical.

Figure 10

Overall Satisfaction With Preparation by Department (Q19)

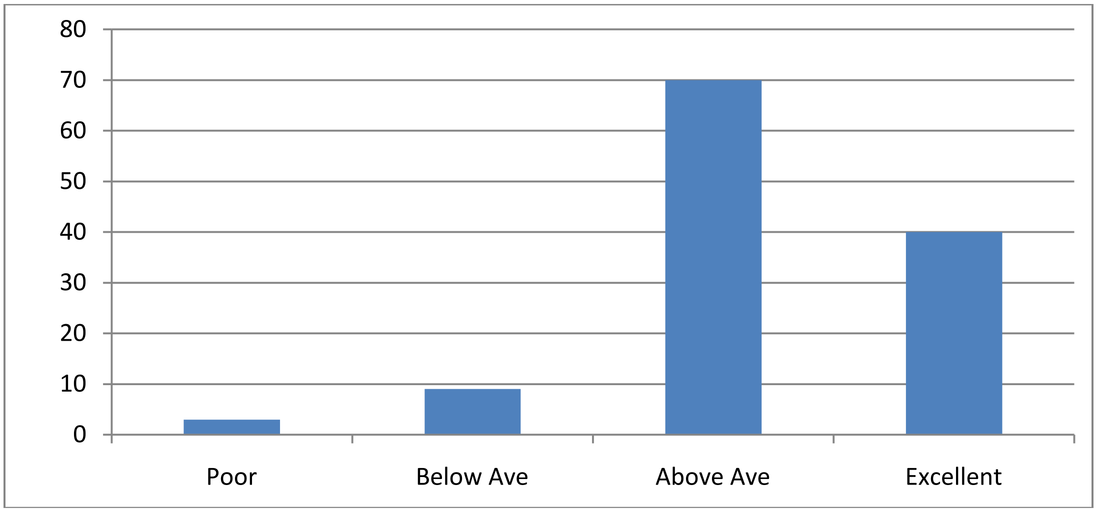
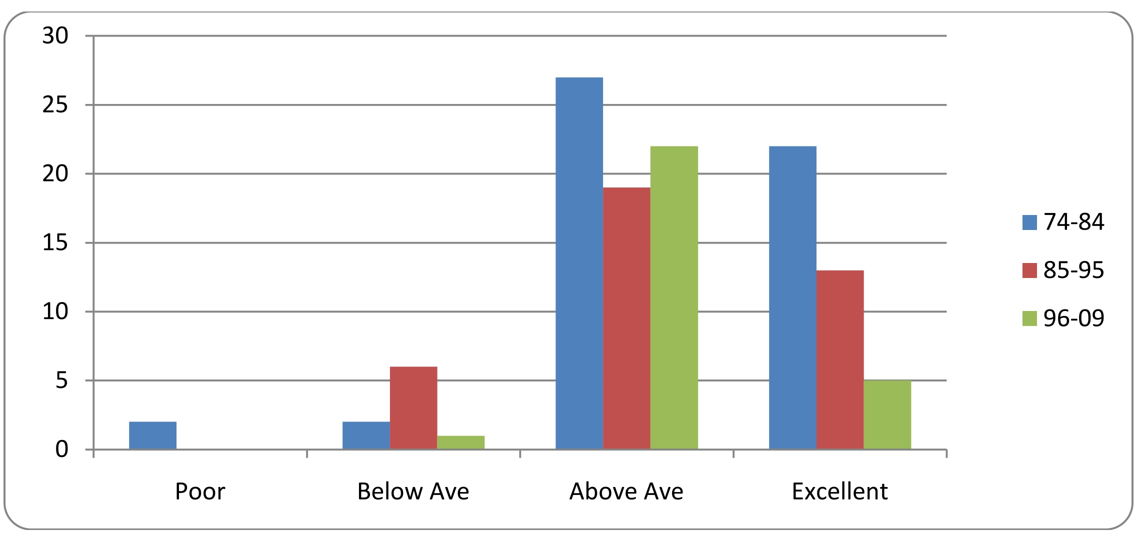


Figure 11

Alumni Satisfaction With Preparation by Dept, by Time Period



Survey question number 20 asked how alumni found out about the industrial hygiene program at UCM (Figure 12). A friend or relative was selected by 55 alumni (45%). College or high school advisor was selected by 14 alumni (11.5%), and the UCM website was selected by 6 alumni (4.9%). Other sources were low, indicating that advertisements were not how most alumni learned of the program. Thirty-nine “other” answers were given for this question. The other responses were evaluated and grouped to better understand what information sources alumni had used.

Figure 12

Source of Information about IH Program

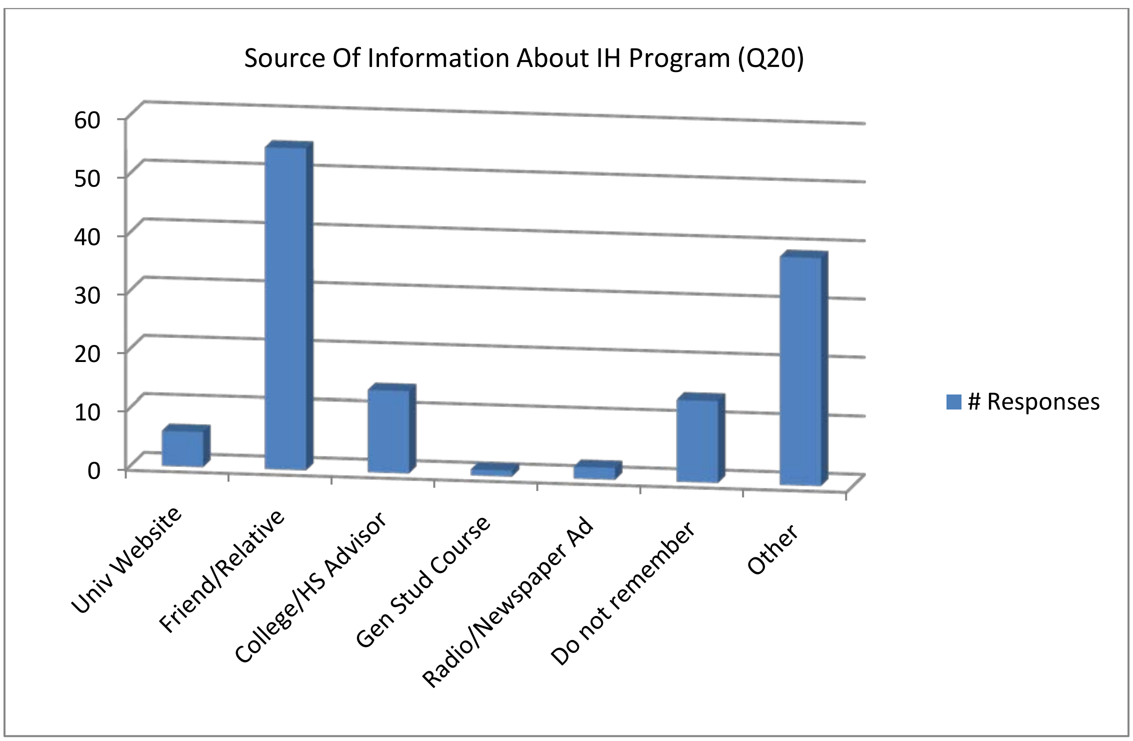
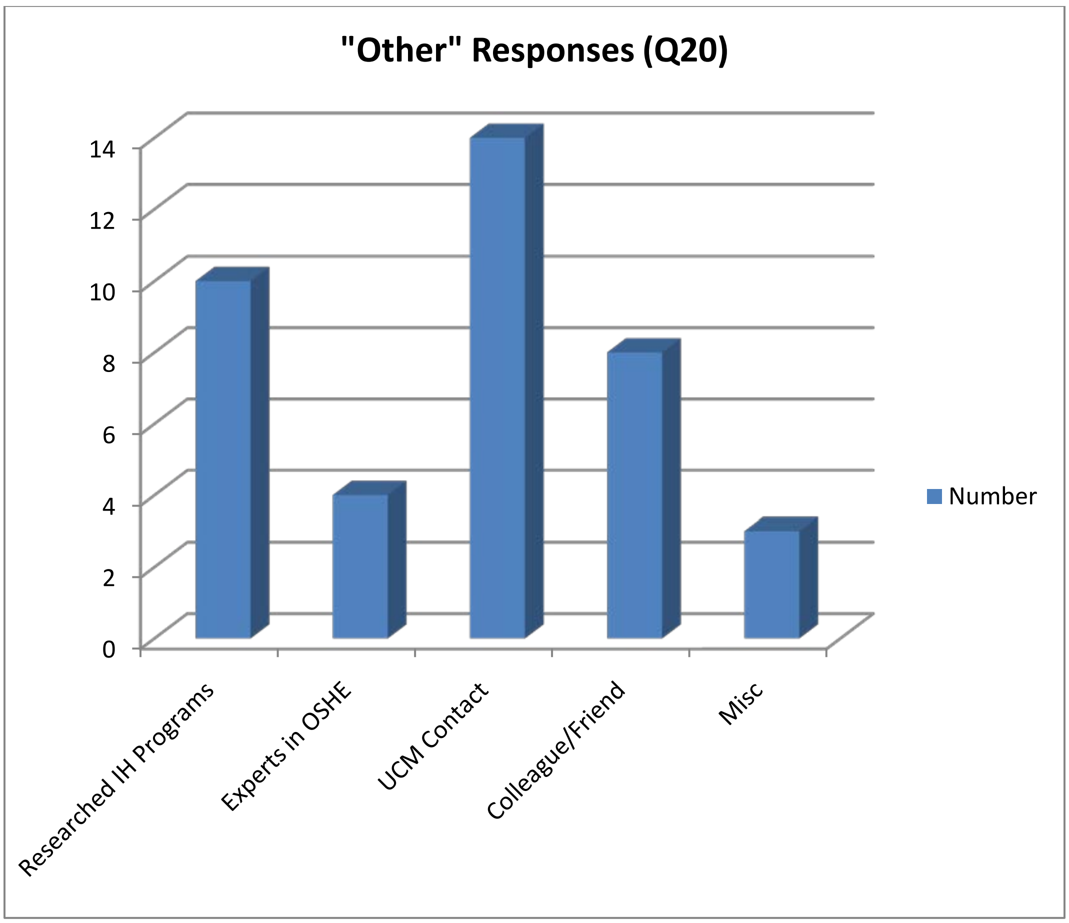


Figure 13 shows the breakdown of these “other” responses for survey question 20. Most of those identified some type of research activity (e.g., reviewing college catalogues). Highest is this category was contact with UCM alumni, faculty or students (35.9%). Friend or colleague was picked by eight alumni, and four (10%) alumni found out about the IH program from experts in the OSHE field. Only one person reported having learned about the program in the general studies course. Approximately 25% reported not remembering how they found out about the industrial hygiene program.

Figure 13

Breakdown of “Other” Responses for Question 20



Survey question 21, asked, “How important are eight MS-IH program outcomes as they relate to your current or most recent OSHE job?” Seven of the eight program outcomes were selected as essential (the highest rating) by more alumni than any other category (Table 6). One program outcome, awareness of contemporary, global and societal issues as they pertain to OSHE, was selected as important (the second highest category) by the largest group of alumni.

Table 7

Importance of IH Program Outcomes

Survey Question 21: How important are the following MS-IH program outcomes as they relate to your current or most recent OSHE job?	Not necessary	Useful	Important	Essential
The ability to communicate professionally both verbally and in writing	0.0% (0)	0.8% (1)	10.8% (13)	**88.3% (106)**
Knowledge of professional integrity & ethics	0.8% (1)	10.0% (12)	31.7% (38)	**57.5% (69)**
Awareness of contemporary, global and societal issues as they pertain to OSHE	5.9% (7)	36.1% (43)	**41.2% (49)**	16.8% (20)
The ability to develop, coordinate, and participate in multidisciplinary teams	0.8% (1)	8.3% (10)	41.7% (50)	**49.2% (59)**
The ability to anticipate, identify and evaluate agents and stressors in occupational and non-occupational settings	0.8% (1)	5.8% (7)	33.3% (40)	**60.0% (72)**
The ability to collect and analyze data using qualitative and quantitative methods and procedures	0.8% (1)	8.3% (10)	34.2% (41)	**56.7% (68)**
The ability to recommend, evaluate, and design a hygiene program that mitigates chemical, biological and physical agents	2.5% (3)	5.9% (7)	37.0% (44)	**54.6% (65)**
The ability to apply techniques of using instrumentation to discover/identify hazards, prioritizing, and implementation of strategies to control or minimize the risks of exposure	3.4% (4)	12.6% (15)	41.2% (49)	**42.9% (51)**

Survey question 22 stated, “Considering your Master's degree from UCM, please rate the quality of your education in each of the following IH Program Outcomes” (Table 7). For each of the eight program outcomes, more alumni selected “above average” than any of the other three categories. When evaluated using the Kruskal-Wallis test the following results, shown in Table 7, were obtained. Of the eight program outcomes only the third one, awareness of contemporary, global and societal issues as they pertain to OSHE, showed a significant difference with the middle time period (1985-1995) having the highest rating.

Table 8

Quality of Education for 8 Program Outcomes

Survey Question 22: Considering your Master's degree from UCM, please rate the quality of your education in each of the following IH Program Outcomes.	Low	Below average	Above average	High
The ability to communicate professionally both verbally and in writing	2.5% (3)	14.3% (17)	57.1% (68)	26.1% (31)
Knowledge of professional integrity & ethics	1.7% (2)	13.4% (16)	52.9% (63)	31.9% (38)
Awareness of contemporary, global and societal issues as they pertain to OSHE	5.9% (7)	37.3% (44)	43.2% (51)	13.6% (16)
The ability to develop, coordinate, and participate in multidisciplinary teams	4.2% (5)	31.7% (38)	45.0% (54)	19.2% (23)
The ability to anticipate, identify and evaluate agents and stressors in occupational and non-occupational settings	1.7% (2)	6.7% (8)	46.7% (56)	45.0% (54)
The ability to collect and analyze data using qualitative and quantitative methods and procedures	1.7% (2)	12.5% (15)	50.8% (61)	35.0% (42)
The ability to recommend, evaluate, and design a hygiene program that mitigates chemical, biological and physical agents	1.7% (2)	15.8% (19)	54.2% (65)	28.3% (34)
The ability to apply techniques of using instrumentation to discover/identify hazards, prioritizing, and implementation of strategies to control or minimize the risks of exposure	2.5% (3)	10.8% (13)	58.3% (70)	28.3% (34)

Table 9

Kruskal-Wallis Results (by time period) for Survey Question 22

Question 22 Considering your Master's degree from UCM, please rate the quality of your education in each of the following IH Program Outcome	Time Period	Mean Averages	p Value
The ability to communicate, both orally and in writing	1974-1984	3.1892	0.136
	1985-1995	3.2143	
	1996-2010	2.9216	
Knowledge of Professional Integrity and Ethics	1974-1984	3.0980	0.686
	1985-1995	3.2432	
	1996-2010	3.1786	
Awareness of contemporary, global and societal issues as they pertain to OSHE	1974-1984	2.4706	0.027
	1985-1995	2.9189	
	1996-2010	2.5926	
The ability to develop, coordinate, and participate in multidisciplinary teams	1974-1984	2.6538	0.144
	1985-1995	3.0000	
	1996-2010	2.7857	
The ability to anticipate, identify and evaluate agents and stressors in occupational and non-occupational settings	1974-1984	3.4423	0.342
	1985-1995	3.3514	
	1996-2010	3.2500	
The ability to collect and analyze data using qualitative and quantitative methods and procedures	1974-1984	3.2115	0.201
	1985-1995	3.3243	
	1996-2010	3.0357	
The ability to recommend, evaluate, and design a hygiene program that mitigates chemical, biological and physical agents	1974-1984	3.1346	0.859
	1985-1995	3.0811	
	1996-2010	3.0714	
The ability to apply techniques of using instrumentation to discover/identify hazards, prioritizing, and implementation of strategies to control or minimize the risks of exposure	1974-1984	3.0577	0.588
	1985-1995	3.2162	
	1996-2010	3.1786	

Survey question 23 asked alumni to rate the quality of the education they received from UCM/CMSU in each of 24 topic areas by the industrial hygiene program. Per the Kruskal Wallis test, eight topic areas showed a significant difference. Those are shown in Table 8. In looking at trends for the eight significant topics all three time periods were rated higher for at least one of the topics. In general, alumni tended to rate the more recent time periods a bit higher than the earliest time period. Two exceptions to this trend are for physics and ecology. Possible reasons for this will be discussed in the next chapter.

Table 10

Kruskal-Wallis Test for Quality of Education Specific Topics by Time Period

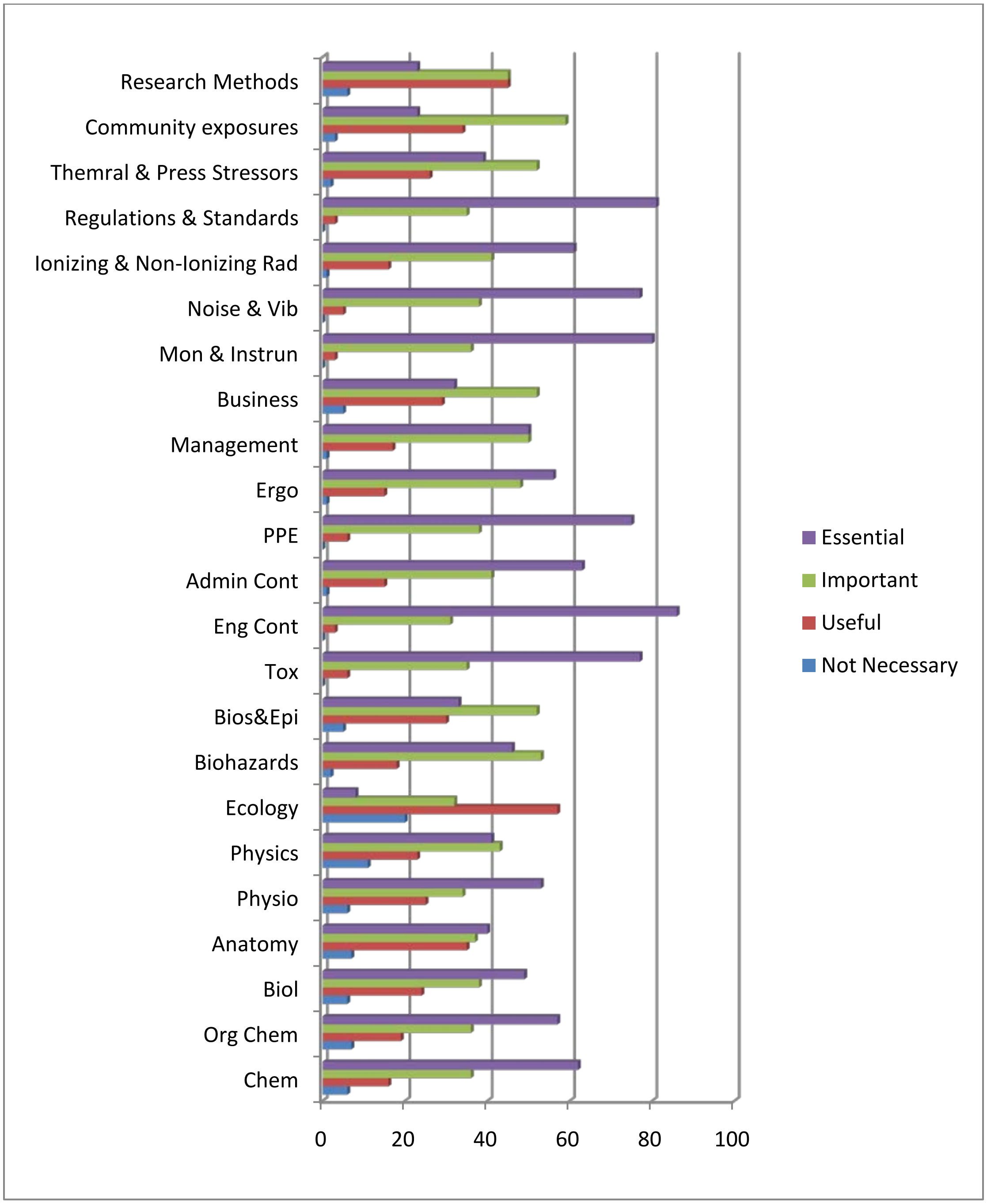
Topic	Time Period	Mean Ranks	p-Value
Physics	1974-1984	2.9020	0.039
	1985-1995	2.7667	
	1996-2010	2.4400	
Ecology	1974-1984	2.1250	0.050
	1985-1995	2.5926	
	1996-2010	2.1250	
Biostatistics/Epidemiology	1974-1984	2.0800	0.000
	1985-1995	2.9706	
	1996-2010	2.8889	
Ergonomics	1974-1984	2.1400	
	1985-1995	2.6970	
	1996-2010	2.7200	
Non-Ionizing & Ionizing Radiation	1974-1984	2.9231	0.000
	1985-1995	3.1622	
	1996-2010	3.1429	
Toxicology	1974-1984	2.9231	0.000
	1985-1995	3.3889	
	1996-2010	3.6071	
Community Exposure	1974-1984	1.9608	0.000
	1985-1995	2.7143	
	1996-2010	2.3571	
Research Methodology	1974-1984	2.0980	0.001
	1985-1995	2.7838	
	1996-2010	2.3214	
Chemistry	1974-1984	3.0980	0.102
	1985-1995	2.9092	
	1996-2010	2.6800	
Organic Chemistry	1974-1984	2.8980	0.461
	1985-1995	2.7500	
	1996-2010	2.6000	
Biology	1974-1984	2.9808	0.458
	1985-1995	3.0000	
	1996-2010	2.7500	
Anatomy & Physiology	1974-1984	3.0200	0.159
	1985-1995	3.0313	

	1996-2010	2.7200	
Technology Knowledge	1974-1984	3.2692	0.896
	1985-1995	3.2500	
	1996-2010	3.2500	
Biohazards	1974-1984	2.2754	0.091
	1985-1995	2.7353	
	1996-2010	2.3750	
Engineering Controls	1974-1984	2.9231	0.388
	1985-1995	3.0556	
	1996-2010	2.8462	
Administrative Controls	1974-1984	2.8654	0.063
	1985-1995	3.1622	
	1996-2010	2.9615	
Personal Protective Equipment	1974-1984	2.8269	0.060
	1985-1995	3.2162	
	1996-2010	3.0385	
Ethics	1974-1984	2.6200	0.057
	1985-1995	3.0286	
	1996-2010	2.9615	
Management	1974-1984	2.5490	0.418
	1985-1995	2.7778	
	1996-2010	2.5556	
Business	1974-1984	2.0962	0.454
	1985-1995	2.3438	
	1996-2010	2.0800	
Monitoring & Instrumentation	1974-1984	3.0769	0.232
	1985-1995	3.2703	
	1996-2010	3.3214	
Thermal & Pressure Stressors	1974-1984	2.3922	0.159
	1985-1995	2.7273	
	1996-2010	2.3929	
		2.9231	
Regulations & Standards	1974-1984		0.184
	1985-1995	3.1622	
	1996-2010	3.1429	
Noise and Vibration	1974-1984	3.3725	0.188
	1985-1995	3.4054	
	1996-2010	3.1071	

Survey question 24 asked how important 23 topic areas were for IH masters students to take during their program. Fifteen of the 23 topic areas were selected as essential by the biggest group of alumni. Those areas selected as important include physics, biohazards, biostatistics and epidemiology, management, business, thermal and pressure sensors, and community exposures. Ecology was selected useful while research methodology was rated as useful and important equally. Figure 14 shows the results for question 24. Five topics were selected as essential by 60-80% of the respondents. The five topics were: non-ionizing and ionizing radiation, noise and vibration, personnel protective equipment, administrative controls and chemistry. Three topics (regulations and standards, monitoring and instrumentation and engineering controls were selected as essential by 80% or more of the respondents.

Figure 14

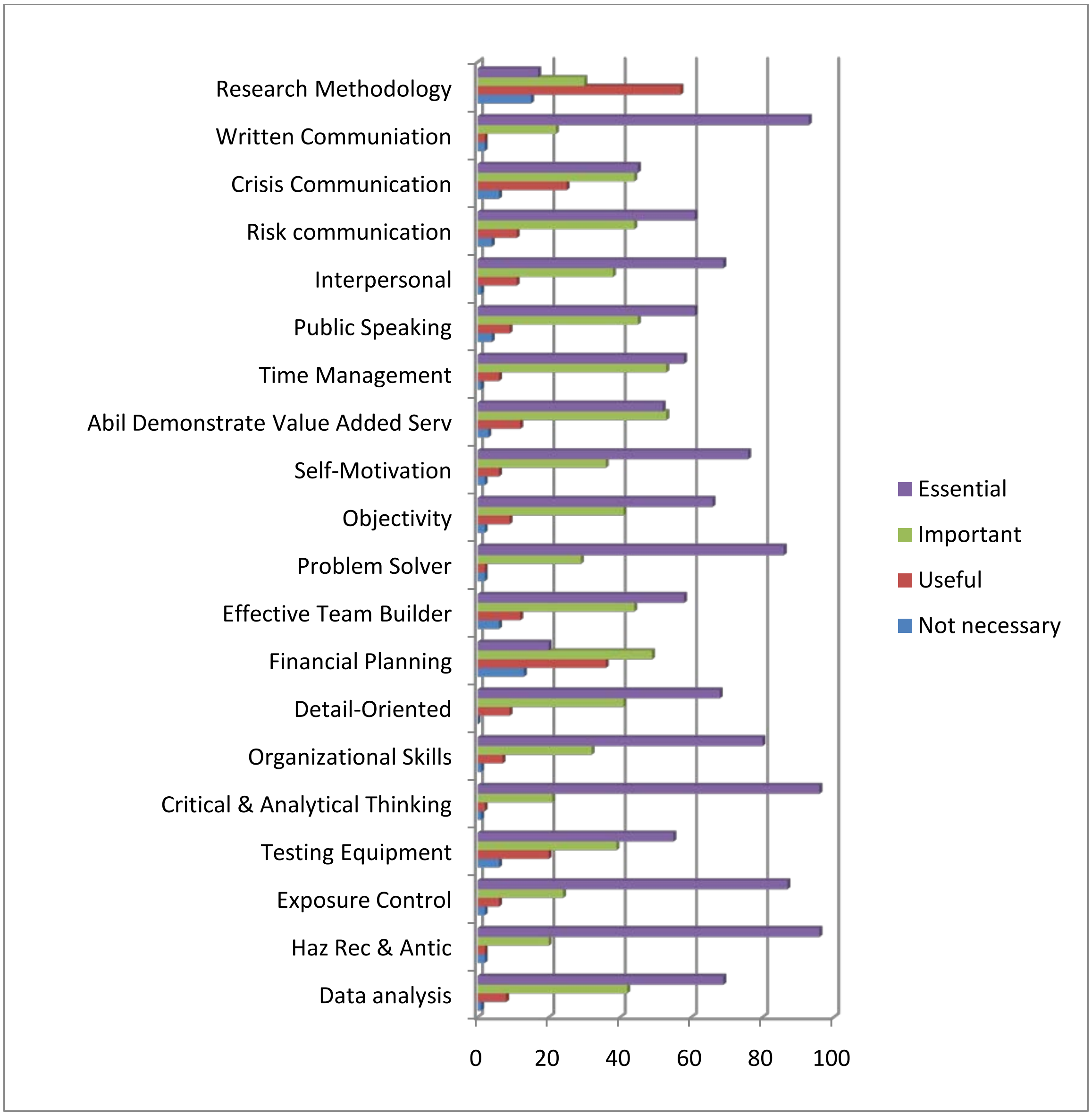
Importance of Specific Topics for an MS-IH Program



Survey question 25 asked alumni to rate the importance of 20 different types of knowledge and skills asked how often alumni use specific types of sampling and analytical equipment (Figure 15). Those receiving the most “essential” rating include written communication, problem solver, critical and analytical thinking, exposure control, and hazard recognition and anticipation. Only three (financial planning, ability to demonstrate value added services, and research methodology) of the 20 skills and knowledge were not selected as essential by the largest group of alumni. Financial planning and ability to demonstrate value added services were rated as important and research was rated as useful.

Figure15

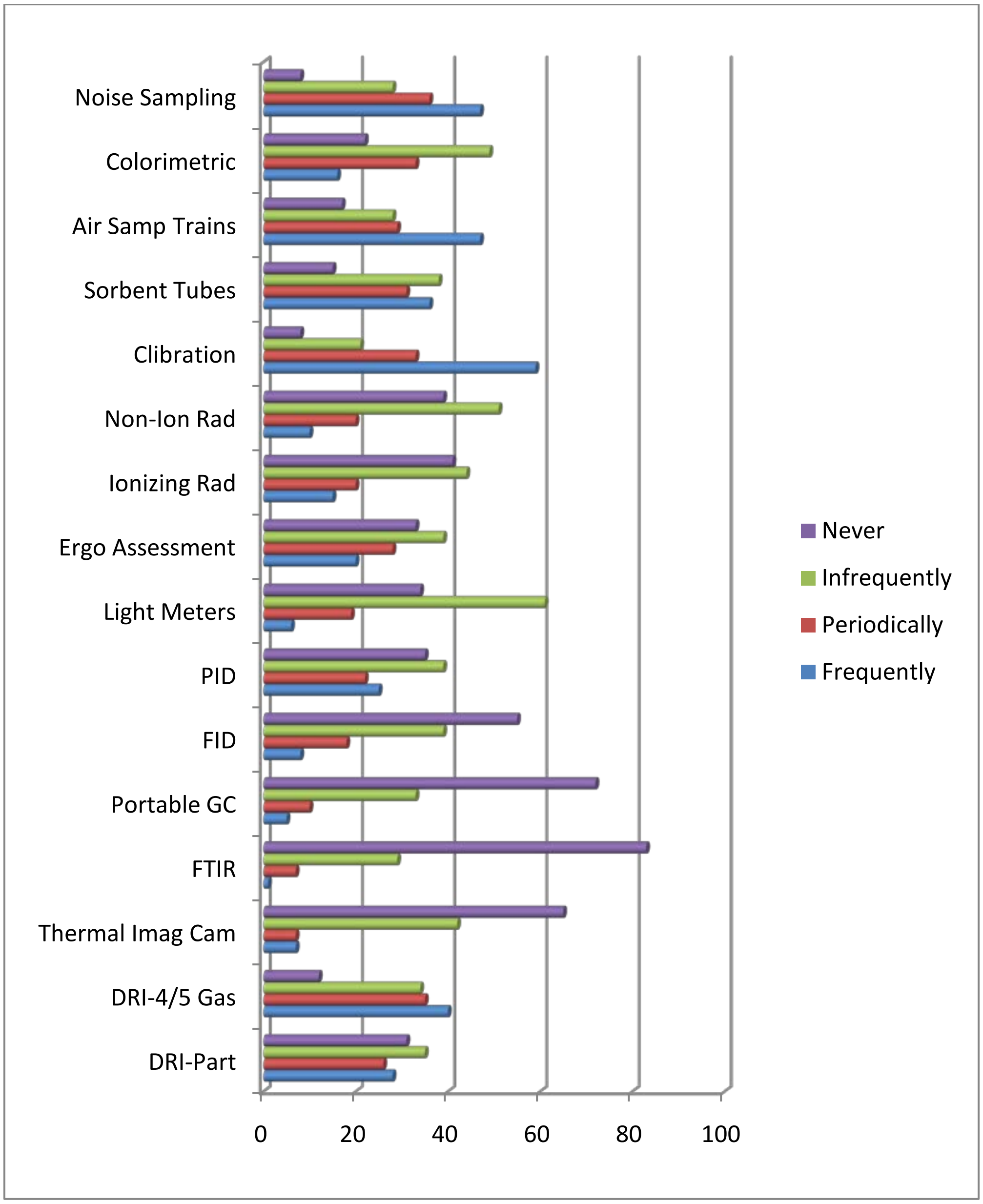
Importance of Skills/Knowledge



Survey question 26 asked alumni how often they used 16 different types of sampling equipment (Figure 16). Equipment used frequently included noise, air sampling trains, sorbent tubes, calibration, photoionization detector (PID) and 4-5 gas direct reading instruments. Four types of equipment (fourier transform infrared analyzer, portable gas chromatograph, flame ionization detector, & Thermal Imaging Camera) were selected as never being used by at least 50% of the respondents.

Figure 16

How often do you use the following Equipment?



Survey question 27 asked alumni to rate the quality of the education they received on 16 different types of sampling equipment. Of the 16 types of sampling equipment, five were found to be significantly different over the three time periods, The results are shown in Table 11. One issue that arose is the fact that some topics were not covered during certain time periods. This resulted in many alumni using a fifth choice (not covered during my academic careers). For three types of sampling equipment, over 40% of the alumni selected this designation, and no significance was found in any of these categories.

Table 11

Results For Kruskal-Wallis Test (Q27) By Time Period

Topic	Time Period	Mean Ranks	p-Value
Air Sampling Trains	1974-1984 1985-1995 1996-2010	3.1961 3.5429 3.4444	0.039
Calibration	1974-1984 1985-1995 1996-2010	3.2642 3.4444 3.6923	0.017
Ionizing Radiation	1974-1984 1985-1995 1996-2010	2.8574 2.8788 2.3810	0.015
Noise	1974-1984 1985-1995 1996-2010	3.2830 3.5833 3.7037	0.007
Sorbent Tubes	1974-1984 1985-1995 1996-2010	3.0566 3.5143 3.4615	0.004
Colorimetric Devices	1974-1984 1985-1995 1996-2010	3.0784 3.2813 3.2857	0.357
Nonionizing Radiation	1974-1984 1985-1995 1996-2010	2.7907 2.6452 2.4091	0.272
Ergonomics	1974-1984 1985-1995 1996-2010	2.2903 2.5667 2.5000	0.431

Light Meters	1974-1984 1985-1995 1996-2010	2.7381 2.8125 2.8696	0.942
PID	1974-1984 1985-1995 1996-2010	2.4688 2.8000 2.9167	0.279
FID	1974-1984 1985-1995 1996-2010	2.4848 2.7241 2.7083	0.681
Portable Gas Chromatograph	1974-1984 1985-1995 1996-2010	2.2667 2.3333 2.1765	0.964
FTIR	1974-1984 1985-1995 1996-2010	2.0455 1.9545 2.1111	0.816
Thermal Imaging Camera	1974-1984 1985-1995 1996-2010	1.6667 1.5882 1.8182	0.616
Direct Reading Instruments - Gas	1974-1984 1985-1995 1996-2010	3.0000 3.1212 3.3750	0.135
Direct Reading Instruments - Particulate	1974-1984 1985-1995 1996-2010	2.5862 2.8867 3.2174	0.086

Females represent 18.5 % of the respondents, slightly lower than the researcher’s original database suggests. However, a higher percentage of females responded in the two most recent time periods. Of the 24 females who responded, 4 were in the first time period, 8 in the second time period, and 10 in the most recent time period. Of the total respondents (by time period), females represented 7.5% from 1974-1984, 21.1% from 1985-1995 and 34.5% from 1996-2009. Table 12 presents the percent of female respondents by time period.

The difficulty of tracking females from the early time period may be due to several having left the profession and the university having lost contact with them.

Table 12

Percent Female Alumni and Percent Responding, by Time Period

Percentage of Women Alumni (MS-IH) By Time Period					
Time Period	Total Alumni	% of total female alumni By Time Period	# of female alumni	# of Females who responded by time period	% of respondents Who Were Female by time period
1974-1984	181	12.1	22	4	7.5
1985-1995	144	20.1	29	8	21.1
1996-2009	83	36.1	30	10	34.5

The last survey question (#28) asked for any other comments the respondent would like to share about the UCM Industrial Hygiene program. Forty-eight individuals added comments. Several alumni provided multiple comments. Most of these concerned sampling equipment (e.g., Many of the above types of equipment were not available at the time of my education.), faculty (e.g., The instructors that I had displayed a genuine interest in the achievement of their students (including the low achievers of which I was one. Additionally, I have always been able to count these people among the first of my problem solving network.), curriculum (e.g., Add content about safety management systems and human performance improvement, balanced scorecard metrics.), and overall program quality. (e.g., I am very satisfied with the preparation I received for an IH career. CMSU/UCM has a great reputation among the people I know.).

Summary

The purpose of this study was to evaluate the view of alumni from the Department of Safety Sciences' industrial hygiene masters program. Alumni were questioned concerning their views on which topics and courses should be included in the curriculum for a masters level industrial hygiene program. In addition, they were asked to identify, from a list, what skills and knowledge entry level industrial hygienists should possess after completion of their masters degree. Finally, alumni were asked for their relative satisfaction for the education they received from the Department of Safety Sciences. The second part of this research included a review of historical documents pertaining to the establishment of the Department of Safety Sciences and the industrial hygiene program, and key occurrences that may have impacted the industrial hygiene program.

Alumni opinions were collected using an online survey program. One hundred and thirty-six individuals responded to the survey and answered at least one question. Items pursued in the review of historical documents included minutes of department meetings, internal progress reports produced by the Department of Safety Sciences or its predecessors, graduate catalogs, as well as other documents. Chapter 5 includes a discussion of these results, limitations, implications for practice, and suggestions for future research.

CHAPTER FIVE

DISCUSSION AND CONCLUSIONS

Program assessment is a mainstay of academic programs that desire to demonstrate to their constituents the quality of their product (Brauer, 2002; Petersen, 1998). Academic program assessment began in the education field and expanded to include medicine, business, law and engineering programs, among others. Education programs have been actively involved in program assessment for decades, while academic programs in occupational safety, health and environmental sciences (OSHE) are just now beginning to widely embrace program assessment (Greife, 2007; Patton, 1997). Although ABET began accrediting engineering programs in the 1930s, the first industrial hygiene programs to receive ABET accreditation did not occur until the late 1980s (ABET, 2010). OSHE academic programs have lagged behind other disciplines in the area of program assessment, but that is changing (Boraiko, Zey, & Greife, 2010; Greife, 2007) as the need for validity of academic programs increase. Additional OSHE academic programs are likely to seek accreditation in the future as accreditation becomes an expected norm.

Research Questions Answered

In considering the three research questions, the following results were obtained. Research Question One asked what topics/courses alumni view as most important for industrial hygiene graduate students to take as part of their curricular studies. This question was addressed by survey question 24. Fifteen of the 23 categories were rated as essential (the highest rating) by more alumni than any of the other three ratings. Nine categories were selected by over 50% of the alumni as essential. Five categories received ratings of essential by at least 63% of responding alumni, including engineering controls (71.7%), monitoring and instrumentation (67.2%), regulations and standards (68.1%), toxicology (65.3 %), and noise and vibration (64.2).

Research Question Two asked what skills and knowledge alumni view as critical for entry level industrial hygienists. This research question was addressed by survey questions number 21 and 25. Survey question 21 asked how important the eight MS-IH program outcomes are as they relate to the alumni's current or most recent job. Seven of the eight program outcomes were rated as essential by the alumni. Those seven program objectives were the ability to communicate, both orally and in writing, knowledge of professional integrity and ethics, the ability to develop, coordinate, and participate in multidisciplinary teams, the ability to anticipate, identify and evaluate agents and stressors in occupational and non-occupational settings, the ability to collect and analyze data using qualitative and quantitative methods and procedures, the ability to recommend, evaluate, and design a hygiene program that mitigates chemical, biological and physical agents, and the ability to apply techniques of using instrumentation to discover/identify hazards, prioritizing, and implementation of strategies to control or minimize the risks of exposure. The third program objective, awareness of contemporary, global and societal issues as they pertain to OSHE, was rated as important by the highest percentage of alumni. The first program objective, the ability to communicate professionally both verbally and in writing was rated as essential by 88.3 of the alumni. This was the highest percentage, by far, for the eight program objectives.

Survey question number 25 asked alumni to rate the importance of 20 different analytical, management, and communication skills and knowledge. Seventeen of the 20 different skills and knowledge categories listed were selected as essential by the biggest group of alumni. Five of the options were selected by more than 70% of the respondents: hazard recognition and anticipation (80%), critical and analytical thinking (80%), written communication (78.2%), exposure control (73.1%), and problem solving (72.3%). The three skills and knowledge not selected as essential were financial planning, the ability to demonstrate value-added services, and research methodology. Alumni rated financial planning as important (41.5%), the ability to demonstrate value-added services as important (42.2%) and research methodology was selected as useful (47.9%).

Research Question Three asked "How has the satisfaction of alumni with their preparation by the Department of Safety Sciences for their career in industrial hygiene changed since the program began?" This research question was addressed by survey questions number 19, 22, 23 and 27. Overall satisfaction (survey question 19) of alumni with Departmental preparation has remained high over all three time periods assessed. The Kruskal-Wallis test indicated no significant difference among the three time periods.

Survey question 22 asked alumni to rate the quality of their education by the department in the eight industrial hygiene program outcomes. For each of the eight program outcomes, over 56% of the respondents rated the quality of their education as above average or high. For six of the program outcomes, 82% or more of the respondents rated their education as above average or high.

For survey question 23, alumni were asked to rate the quality of education received in 24 topic areas. For 14 of the 24 topic areas, 68% or more of the alumni rated their education as above average or high. The highest ratings were for the topics the department has concentrated on over the years. Survey question 27 asked how well the department had trained alumni in using 16 types of sampling and analytical equipment. The training provided by the department for five types of sampling and analytical equipment was rated as above average or excellent by between 80% and 91.7% of respondents. The five types of equipment receiving high ratings (for training by the department) were colorimetric devices, air sampling trains, sorbent tubes, noise sampling equipment, and calibration equipment.

Discussion

The MS-IH program at UCM has remained viable by concentrating on the practitioner skills aspect of industrial hygiene. Since the late 1970s, the number of industrial hygiene academic programs in the United States has decreased significantly. Over 200 industrial hygiene programs were identified in 1979 but the number dropped to slightly over 100 by 1987 (Clayton, 2000). Perhaps the decrease in student numbers seen in the late 1980s in the Department of Safety Sciences was occurring at other academic programs. This researcher had experience with the NIOSH training grant programs in the early 1990s as a NIOSH employee, and from 2002 to 2009 as a recipient of a NIOSH training grant. That experience confirmed that many programs were experiencing low student numbers in the first half of the current decade (Talty, 2007). Many academic programs were unable to remain viable after 1979. The experience of other industrial hygiene programs also highlights the potential for future problems in the area of low student enrollment for the Department of Safety Sciences. Only by diligently assessing the program's strengths and weaknesses can the Department of Safety Sciences hope to remain viable for the foreseeable future. This may prove to be a difficult task as budget constraints are likely to continue to plague OSHE academic programs.

The low number of accredited industrial hygiene programs should signal a bit of concern for the Department of Safety Sciences, the College of Health and Human Services and UCM. In August of 2009, less than 30 programs held ABET accreditation (ABET, 2009b). Trained industrial hygienists are a critical need for the nation's workforce. UCM's academic units need to work collaboratively if the industrial hygiene program is to remain viable. The history of both the Department of Safety Sciences and the industrial hygiene program reveal that high student enrollment numbers can decrease within a short time period. The industrial hygiene program has averaged more than 20 graduates per year for a three-year time period in two different decades. Program graduates averaged 27 from 1978 through 1980 and 23.3 graduates from 1992 through 1994 (Figure 4). In both instances the average number of graduates dropped to less than ten within five years. In the most recent example (1992-1994) the average number of graduates has remained under ten since 1999. Since 2004, the Department of Safety Sciences and the Industrial Hygiene program have both experienced an increase in student numbers. In the Spring of 2010, the department expects to have more than 20 active industrial hygiene students. Once again, the history of both the department and the industrial hygiene program suggest that within a few years, these numbers could decrease dramatically. However, the decrease in enrollment numbers for IH programs nationwide presents growth opportunities for viable MS IH programs. There is a strong employer demand for MS IH graduates. With the current limited number of accredited IH programs nationwide and internationally, it is likely that potential students will select one of the few remaining strong programs in the country.

Business and research are two topics that are often mentioned as important for graduate industrial hygiene programs. In this study, business was ranked as not necessary by 4.2%, useful by 24.6%, important by 44.1% and essential by 27.1%. Research methodology was ranked as not necessary by 5.0%, useful by 37.8%, important by 37.8% and essential by 19.3%. These results suggest that business and research should be covered in the curriculum but not be the focus on the industrial hygiene program.

These results suggest the Department of Safety Sciences should continue emphasizing the practitioner skills of occupational safety and health. Critical issues include internships, field projects, team work, walk-through surveys, and the Health and Safety laboratory course. The department has been focusing on practitioner skills over the first 36 years of the existence of the industrial hygiene masters program. This is consistent with previous studies on what industrial hygiene professionals view as critical for entry level (MS) positions (Brosseau, Raynor, & Lungu, 2005; Rodgers, 2007). Considering the results of this research and the results obtained in previous studies there are no dramatic changes to be recommended for the Department of Safety Sciences.

One modification the Department of Safety Sciences should consider is changing the status of the laboratory course (Safe 4140) from an elective to a required course for those students who do not have extensive practical experience in industrial hygiene. Historically, Safe 4140 has been an elective course that is strongly recommended for most students. Department faculty have advised students without extensive sampling experience to take the laboratory course as one of their electives. This has worked well as the majority of students who entered the MS-IH program without extensive practical experience have taken the laboratory course. However the financial constraints currently being experienced by UCM and thus the Department of Safety Sciences, may result in increased workloads for the faculty. In a few instances, students who should have taken the laboratory course were identified and the laboratory added to their program of study. There may well have been some students who were inadvertently allowed to complete the MS-IH program without taking the laboratory course, even though they should have taken it. Making the laboratory course required would help reduce the potential for this to happen.

A second possibility exists that external review organizations may question a practitioner program designating the laboratory course as an elective. Making the course a required course would enhance the documentation of the department's commitment to practitioner's skills.

Once again, these results highlight the importance of practitioner skills for graduates of a masters industrial hygiene program. The Department of Safety Science has focused on practitioner skills since the early years of the program. That focus has been enhanced in the last decade by incorporating more presentations, writing assignments and teamwork into courses. This focus on practitioner skills is consistent with what the department alumni believe, as indicated by the results of this research. The high rating given to communications skills, especially writing skills, is noteworthy. The increased emphasis placed on communication skills in the late 1990s was appropriate per these results. This information is critical for the department in providing feedback to internal and external review organizations. There are many potential measures of success for academic programs. This researcher believes one of the most meaningful measures of success is the success of program alumni. For an OSHE program, producing graduates who are able to, and do, obtain initial employment and then remain in the discipline 30 or more years is an indication that the program has provided quality education to the graduates they have produced.

According to the results for the first two research questions, practitioner skills are where the Department should be concentrating their efforts. This means the department should continue to focus on activities that enhance the practical nature of the industrial hygiene curriculum. Internships, field projects, walkthrough surveys, and teamwork are among the activities that help enhance the practitioner side of industrial hygiene. The high percentage of respondents who have 10 or more years of experience in industrial hygiene adds credibility to this issue. Over 84% of the alumni who responded to survey question seven had over ten years of experience in the OSHE field. Few industrial hygienists stay with one company for their entire careers. Thus, OSHE professionals must have the skills and knowledge that other companies desire if they are to successfully move from one organization to another as the need or desire arises.

The results found for survey question 27 could be of concern. This question asked alumni to rate the quality of the education they received for 16 different types of equipment. Only five types of sampling equipment were rated as above average or high by a majority of alumni. Of note for survey question 27 is that several types of sampling equipment listed on the survey were not covered historically. For one-half of the 16 types of equipment between 25% and

59% selected a fifth option. The fifth option that alumni could choose was, “this equipment was not covered in the program.” This is a relatively low number of different types of sampling and analytical equipment being rated in the “highly” category. This fact is probably due to the laboratory course (Safe4140) having not been established until in the late 1970s and the inadequate quality and availability of sampling and analytical equipment in the laboratory until the late 1990s. However, the quality of the education by the department for five of the equipment classifications (noise sampling – 91.8%, calibration equipment – 91.7%, air sampling trains – 88.5%, sorbent tubes – 86.7%, and colorimetric devices -80.9%) was rated by at least 80% of the alumni as “above average” or “excellent”.

One aspect of these results suggests a future potential problem for the Department of Safety Sciences. The recent increase in student numbers experienced by the Department of Safety Sciences is encouraging. The industrial hygiene program might once again experience the high number of students present in the late 1970s or early 1990s. The downside to this expansion is the workload on department faculty. Currently, students give multiple presentations and write papers and article critiques in most of their required courses. The workload on faculty to grade the increased amount of student work could become unmanageable. To add to this concern, the significant increase in credit hours generated by the Department of Safety Sciences over the last five years has occurred while the number of department faculty has decreased. In addition, the research component added to the curriculum in 2005 requires more faculty time than before the research hours were required. The Department of Safety Sciences and the College of Health and Human Services should carefully evaluate this conundrum. If increases in faculty positions are not possible for the department, it may be necessary to limit the number of students the department accepts in the industrial hygiene program and the other three academic programs in the department. All students in the Department do multiple assignments in classes, not just the industrial hygiene students.

This brings up the question of what is the appropriate number of students for the industrial hygiene program. UCM administrators might desire to see student numbers increase to levels equal to those in the late 1970s. However, for the faculty such an occurrence could have drastic consequences. The current total of 44 hours is more demanding on faculty than the original 32 hours. The number of hours in the program has created some concern by administrators that the program requires a lot more courses to complete than average MS program on campus. However, the recent increase in industrial hygiene students suggests the 44 hour curriculum is not too much. Supporting this opinion is the research by Prince and Zey (2008) showing that a 44 hour curriculum is among the lowest for IH masters programs in the nation. From a financial standpoint, the University gets more revenue from eleven students completing a 44 hour degree (484 credit hours) than from 15 students completing a 32 hour degree (480 credit hours). In essence, if you have a good product, the student will come to participate in it. This of course is only true, if students are informed of the program.

When looking at the quality of training for the three time periods in certain topics and with specific types of sampling equipment, some significant differences were found. For survey question 23, the quality of training for eight of the 24 topics listed showed a significant difference (Table 4) among the three time periods. Preparation by the department for physics and ionizing/non-ionizing radiation was rated higher during the first (1974-1984) and the second (1985-1995) time periods. Biostatistics/epidemiology and ergonomics were rated higher for the second (1985-1995) and the third (1996-2010) time periods. Ecology, community exposures, and research were rated higher during the second (1985-1995) time period. Finally, toxicology was rated higher in the third time period. The physics and radiation difference can be explained by changes that occurred in the curriculum. In 1974, the original curriculum included two courses in physics. By the third time period, those courses were no longer in the curriculum. It is difficult to explain most of the other categories for which a significant difference was found by time period. The difference could have been the result of different faculty in the different time periods. This is unlikely, as two of the principal industrial hygiene faculty taught in two of the three time periods. For the safety courses, there has been less turn over in the faculty as four of the faculty taught courses in the Department for 30 years or more.

It is interesting to evaluate how alumni satisfaction changed over the three time periods. However the most impressive aspect of that survey question is that alumni satisfaction has remained high over all three time periods. For the Department of Safety Sciences this suggests that the original program was developed very well and that subsequent changes to the curriculum occurred at appropriate times. This is excellent news for the Department of Safety Sciences. These results mean that alumni were generally pleased with the quality of education they received from the Department of Safety Sciences over almost four decades. An academic department should strive for satisfied alumni, but until those alumni are surveyed the issue of their satisfaction remains in question.

This does not mean that the Department of Safety Sciences should remain static. On the contrary, the Department must continue to evolve and reinvent itself if it is to prosper in the next 36 years. Of note is the willingness of the Department to respond to changing times. The changes to curriculum both in total number of hours and in the specific courses required are key components to the alumni satisfaction. For example, moving the chemistry, biology and physics topics out of the masters curriculum and making them components of the required background for acceptance into the MS-IH program resulted in recruiting industrial hygiene students with better foundations in the sciences. One aspect of this that may go unnoticed by many people is the combined impact of increasing the required hours from 32 to 44 and taking approximately 10 hours from the curriculum and making them background requirements. Thus, the 44 hour curriculum is equivalent to a much larger curriculum if those courses were still required courses. The overall effect is to help maintain a lower number of required hours than many other masters programs in industrial hygiene require (Prince & Zey, 2008).

Alumni ratings showed a significant difference among the three time periods for five of the 16 types of sampling equipment listed in survey question number 27. Ionizing radiation was rated highest during the first time period. The other four types of equipment (air sampling trains, calibration, noise and sorbent tubes) were rated higher in the second and third time periods. Some of these results can be explained by curriculum changes. As discussed previously, removing the radiation courses from the curriculum helps explain a higher rating for earlier time periods. The higher ratings for air sampling trains, calibration, noise, and sorbent tubes probably is related to the lack of a laboratory course during most of the early years of the program. The safety and health laboratory course (Safe 4140) was first taken by a student in the MS-IH program, as an elective course, during the summer of 1978. A second aspect of this question of alumni satisfaction is the quality of the laboratory course over the duration of the IH program's existence. The laboratory in 1996 was inadequate in the quality of sampling equipment available. In 1998, Mr. Ferguson was hired to focus on improvements to the laboratory. Subsequently the department was able to add newer equipment and increase the percentage of equipment with current calibrations.

Other useful information obtained via this research project include the average annual salaries of alumni, how alumni accomplish their industrial hygiene sampling needs, the number of other OSHE professionals with whom alumni work, the certifications alumni have obtained, the industry segment in which alumni work, and the OSHE responsibilities alumni have in their current or most recent job.

Survey question 16 asked alumni what their approximate annual salary was. Alumni salaries ranged from below $30,000 to over $131,000. One hundred and four (89.7%) were earning over $60,000 per year and 44 (37.9%) were earning over $100,000 per year. Slightly over 16% reported making over $131,000 per year. Such salaries are impressive for potential recruits, and should help with, recruiting efforts. Most students probably do not go into industrial hygiene to make money, but the high salaries may cause more students to consider this field of study.

Two survey questions concerned certification. Survey question number 8 asked alumni what certifications they possessed. Seventy-six alumni (64.4%) were certified industrial hygienists (CIH), 31 (26.3%) were certified safety professionals (CSP) and 18 (15.3%) were certified hazardous materials managers (CHMM). Twenty-one (17.8%) indicated they had never been certified and 22 (18.6%) indicated they had a certification not among the options on survey question number 8. Among the other certifications that were listed more than once by alumni were Professional Engineer (PE), and Certified Professional

Environmental Auditor (CPEA). Among the more well-known certifications listed were Registered Occupational Hygienist (ROH), Certified Environmental Trainer (CET) and the certification in Leadership in Energy and Environmental Design (LEED).

Survey question number 9 asked those alumni who were not certified why they had not obtained certification. Various reasons were chosen by alumni with no specific reason outweighing the other possibilities. “I am not eligible” and “I am eligible to sit for the exam but I have not taken the exam” was selected by 15 alumni (14.5%) each. Nine (10.8%) alumni indicated their company did not support certification, and six (7.2%) alumni indicated they did not view certification as being worth the time and money involved. An equal number (7.2%) of alumni indicated they had been certified but dropped the certification due to changes in their job duties.

Survey question 18 asked how alumni accomplish their industrial hygiene sampling needs. Over 73% of the alumni reported either doing the sampling themselves or directing others in specific sampling needs. Approximately 1% of the respondents indicated they hired consultants to do their sampling. Approximately 3% of alumni utilize state or federal OSHA industrial hygienists or industrial hygienists from their insurance carriers, while 10% reported using some other method.

Very few UCM IH alumni work individually. Survey question number 17 asked alumni for the number of other OSHE professionals they work with. Only ten(8.3%) alumni indicated they worked individually. Thirty-seven (30.6%) alumni reported working with one to four additional OSHE professionals. Forty-five alumni reported working with between five and twenty-four other OSHE professionals and 24 alumni reported working with over 25 additional OSHE professionals.

Survey question number 11 asked in what business sector the alumni worked. Forty-nine (40.8%) alumni worked in general industry, 20 (16.7%) worked in consulting, 29 (24.2%) worked in the government sector, and 11 (9.2%) worked in academia. Eleven alumni reported working in other business sectors.

Several survey questions (questions 12, 13, 14 and 15) inquired about job duties of the alumni. When evaluated as a group, it was apparent that most alumni spend considerable portions of the job working in OSHE tasks. Survey question 15 asked which job duties alumni spent at least ten percent of their time on. The five highest activities included industrial hygiene (90.2%), safety (65.6%), training (60.7%), environmental (49.2%), and ergonomics (44.3%). Survey question 14 asked what percentage of time alumni spend doing OSHE activities. Over 90% of alumni reported spending more than 51% of their worktime on OSHE activities. Sixty-four alumni reported spending over 90% of their worktime on these activities.

Review of Historical Documents

The review of historical documents provided a wealth of information about the development of the School of Public Services, the Department of Safety Sciences (originally called the Department of Industrial Safety and Industrial Hygiene), and finally the industrial hygiene program. Since 1970, when the School of Public Services was established, a series of reorganizations resulted in The Department of Safety Sciences being housed in at least three different colleges or schools. Technological advancements over the same time period transformed record keeping from primarily paper copies of forms to a combination of paper and electronic data. Over the years the records were moved, downsized, and sometimes discarded. During the last 36 years, department records for over 2,900 alumni have been housed in various academic units. As a result there are some inaccuracies in the databases that are available. The list of IH alumni gathered by this researcher over the last 15 years contained 506 names in 2009. During the review of historical documents the original list was compared to other lists of alumni. UCM has recently developed an online grouping of unofficial transcripts. In some instances the registrar's office was contacted for information on specific individuals. These resources enabled this researcher to determine that some names in the database were not actually IH alumni. Some individuals had taken a few classes, but not earned a degree. This is supported by ten individuals who indicated in the on-line survey that they did not earn a degree from UCM.

Checking the various sources at UCM resulted in the elimination of 58 names from the original data base, leaving 448 names on the revised list of alumni. Names were removed from the list due to individuals having earned a safety (not IH) degree, not having completed a degree, and there being no information to indicate the person had ever attended UCM. The reasons for errors in the database of names include the department not maintaining a complete list of IH alumni, the reorganizations that occurred over a 40 year time period, the loss of some files over the years, and the technological changes that occurred in record keeping such that originally only paper files were maintained by the Department to the current time, when online databases contain alumni information. Of the 448 industrial hygiene alumni, 48 had earned the BS in industrial hygiene but not the MS-IH. This left 400 alumni who earned a masters degree in industrial hygiene. The 400 MS alumni are those that were included in this research.

Also of interest to the Department of Safety Science, the College of Health and Human Services, and hopefully to UCM administrators is the number of personnel changes in the Department Chair position during two separate time periods. Between 1984 and 1992, the chair position changed eight times. This was followed by a period of stability as the next chair remained in that position for eight years. Then another period of rapid changes in the Chair position resulted in six changes in the Chair position in an eight year period (2000-2008). Such rapid change in the lead departmental position suggests a lack of stability that could have negatively impacted the department.

Perhaps the most significant change during the 40 year history of the Department of Safety Sciences occurred in 1984, when the predecessor of the Department of Safety Sciences (the Department of Industrial Safety and Industrial Hygiene) was merged with the Department of Safety to form the Department of Safety Sciences. Several faculty members from the Safety Department with backgrounds in Drivers Training Safety were joined with the faculty from Industrial Safety and Industrial Hygiene. Reportedly, there was considerable animosity among some faculty that lasted into the current decade.

One issue that has plagued the Department over the years is the rise and subsequent decline in student numbers. This increase and subsequent decrease was dramatic for both the industrial hygiene program and the entire department (Figures 3-4). UCM has also experienced a rise and fall in student numbers, but on a more modest scale (Figure 5). While a definite explanation for this is well beyond the scope of this research, certain facts have been brought to light. This researcher believes the numerous increases and decreases in student numbers is a multi-factorial problem. A combination of the loss of the general studies safety course, rapid fluctuations in the position of Department Chair, as well as the merging of two separate departments and the apparent animosity that existed among the faculty for years afterwards likely affected the Department. All of these events likely negatively impacted the student numbers.

The general studies safety course that was disapproved in 1994 and then re-approved in 2005 probably played an indirect role in the student numbers in the industrial hygiene masters program. The initial offering of Safe 2010 during Spring Semester of 2006 had an enrollment of 20 students. Almost 400 students have taken the course in both 2008 and 2009. Such a dramatic increase in student numbers hints at the potential impact this course had on department recruiting. This helps increase the awareness of the department among students currently enrolled at UCM, as well as their family and friends. Before the department can increase student numbers, those students must be aware of the academic programs the department offers. The low number of first semester freshmen who come to UCM as safety majors, combined with the number of students who switch to safety from some other major after they arrive on campus, suggest that students switch to safety after becoming aware of the existence of the Department of Safety Sciences.

Increasing the visibility of the Department of Safety Sciences to more students is directly related to increasing student numbers in the department. In turn, the fact that at least 28% of the MS-IH alumni had previously taken undergraduate courses and most had earned a BS degree at UCM demonstrates the potential impact of increasing the awareness of the Department, on the industrial hygiene. This possibility is supported by the popularity of the Department of Safety Sciences General Studies course (Safe 2010). The number of sections offered has risen dramatically since the course was re-approved in

2005, with 12 sections offered in 2008-2009, 14 sections in 2009-2010, and seven sections are being offered for Fall 2010. The increased awareness about the department and its academic programs could increase the number of students in the IH program. The increased student numbers in the undergraduate programs provides a larger pool from which industrial hygiene students could emerge. Several issues support this possibility. At least 28% (112) of the 400 MS-IH alumni took other classes at UCM before obtaining their masters degree. In fact, the great majority (106) of these alumni earned a BS degree from UCM before working on their MS-IH. The number could be higher, as it was not feasible for the researcher to view every transcript for the MS-IH alumni.

Historically very few freshmen (less than 10 per year) have come to UCM as Safety majors. Most of the students find out about the Department of Safety Sciences and its academic programs after they arrive on campus. The presence of the general studies course helps inform undergraduates of the availability of safety as a profession. This suggests that the Department of Safety Sciences should focus most of their recruiting efforts for the IH program on current students. Collectively, the results suggest that on-campus undergraduate students are where a significant percentage of recruits for the industrial hygiene program can be found.

Another finding of significance for the department is the large percentage of alumni who learned about the IH masters program from other UCM contacts or their friends and colleagues. This combined with the knowledge that over one-fourth of the alumni had earned an undergraduate degree before they worked on the masters degree has significance for the Department's efforts in the area of recruiting. This means the Department must continue to keep alumni and others informed of the department's programs.

Another item of importance concerns the number of MS-IH alumni who obtained certification during their careers. The review of historical documents included databases and business cards collected over the years. This also allowed the researcher to compare certification information from the online survey and from the review of historical documents. The percentage of alumni earning certification designations was higher in the data from the survey (64.4%) than in the results obtained from the review of historical documents (52.8%). The population of 400 MS-IH alumni includes some who chose to leave the field of industrial hygiene due to a variety of issues. Some left to raise families, some to pursue medical or law degrees, at least one who returned to farming, and at least one who went into the computer information services field. The department has been unable to remain in contact with many of these individuals who left the field of industrial hygiene. The alumni represented in the online survey, probably includes a higher percentage of alumni who remained in the profession throughout their careers. This is probably the reason the percentages of certified industrial hygiene is a separate database are lower than the percentages of certified industrial hygienists in the survey. It is noteworthy that so many of the alumni are still active in the IH discipline. This triangulation of information does support the validity of the online survey data.

Limitations

It is hoped that others will benefit from the experiences of this researcher. Issues that arose include two misspelled words in the survey questions and questions that were appropriate for some time periods, but not as suitable for other time periods. The survey questions that asked what topics were most important for an MS-IH program included biology, chemistry and physics. Those were required courses in the original MS-IH curriculum. Those courses were later removed from the curriculum and those classes were included in the background requirements for the MS-IH. Some of the alumni provided comments about those very questions. None of these issues are deemed critical but it may impact negatively on the individual's reputation. One survey question had two options that were identical. This occurred even though a number of individuals reviewed the survey questions. Again, not a critical mistake but not something the researcher would ever have chosen to have happened.

An alternative aspect of the researcher's familiarity with the industrial hygiene program is that it may have helped provide better results for this research. Advantages of being familiar with the Department of Safety Sciences and the industrial hygiene program include insight into where historical documents were located. The researcher was acquainted with contacts in the registrar's office and the alumni office. Records and other information was obtained from both locations. Additionally, departmental files of interim reports, five year program reviews and department faculty meeting minutes were readily available to the researcher. Having the availability of these records within the department proved invaluable. Having taught in the Department of Safety Sciences for almost 15 years provided intimate knowledge of the animosity existing between some faculty members. This animosity was still evident when this researcher joined the faculty in 1996. Someone unfamiliar with the history of the Department would have had a difficult time extracting that bit of information. Finally, the database of alumni previously compiled by the researcher proved invaluable in assessing the overall success of program alumni.

Implications For Practice

The primary information to be gained from this research study is that the Department of Safety Sciences has more than adequately prepared students for a career in industrial hygiene over the past 36 years. Over two-thirds of responding alumni rated the training they received from the Department of Safety Sciences as “above average.” The Department of Safety Sciences should continue the focus on practitioner skills and knowledge, as practitioner skills have been found to be preferred in not only the current study, but also in other similar studies that has been reported (Brosseau, 2005, Rodgers, 2007). Communication skills were very highly rated by alumni in several survey questions. Those activities that emphasize communication skills (writing and presentations) should continue to be among the primary activities that industrial hygiene students engage in.

Research and business skills and knowledge are rated as important but not essential by most of the alumni. While research did not receive the highest rating, alumni viewed this skill and knowledge as important. The Department of Safety Sciences modified their curriculum in 2008 by reducing internship hours from six to three and adding a requirement of three hours of a research class (Individual Research or Thesis) to the curriculum (University of Central Missouri, 2008b). Since that change, industrial hygiene students still typically work a full summer and thus receive the same amount of field experience. Now they only pay for three hours of internship, not six. These results validate the direction the Department has guided the industrial hygiene program over the last 36 years. No one event stands out as more important than any other. But, the overall effect has been maintaining the quality of the program (MS-IH graduates) even though the demands on entry level industrial hygienists is much higher than is was in the early mid-1970s.

For survey question 19, 90.2% of the alumni rated their satisfaction with the overall preparation for their career as “above average” or “excellent.” For question 23, 18 of the 24 categories for skills and knowledge were rated above average or high by 50% or more of the alumni. Eight of the 24 categories, all of which are considered practitioner skills (noise and vibration - 93.3%, technical knowledge-91.5%, monitoring & instrumentation - 85%, regulations and standards - 80.8%, engineering controls – 77.6%, personal protective equipment - 77.7%), received over 77% for either “above average” or “high”.

This research also points out that word of mouth activities have been very important and effective for recruiting purposes for the Department of Safety Sciences. A critical aspect of this issue is keeping constituents informed of department activities. Almost 78% (95 of 122) of those alumni who reported a specific avenue for information about the industrial hygiene program selected a category involving talking with another individual. Friend, colleague and relative were selected by 63 alumni (51%) and a UCM contact (professor, alumni, and current student) was selected by 14 (11.4%) respondents. Researching available academic programs and getting information from the Department website was selected by 16 (13.1%) respondents. With increasing budget constraints, and a past history of cyclic increases and decreases in student numbers, Value Stream Mapping (VSM) careful utilization of money and time will be even more important in the future.

This research also suggests that the general studies course may have had a tremendous impact on the student numbers in the industrial hygiene program. It is the researcher’s belief that the impact of the general studies course at UCM has been indirect but still very dramatic. The impact is not direct as only one respondent indicated learning of the IH program via the general studies course. Rather, the researcher believes Safe 2010 helps increase student numbers in the undergraduate programs in the department, which subsequently favorably impacts the numbers of students in the masters programs. It is noteworthy that the original approval for a general studies course in the early 1970s and the re-approval of the general studies course in 2005 were followed within a few years by rapid expansions in the student numbers in all academic programs in the Department of Safety Sciences. In both instances the number of industrial hygiene students increased along with the number of students in the other department programs. The high percentage of MS-IH alumni who earned a BS degree at UCM before beginning their MS-IH program supports the possibility that awareness of the academic program offered by Safety Sciences programs is a key component to student recruitment for the industrial hygiene program.

Based on the fact that 11 of the individuals on the list of alumni from UCM did not have a degree from the Department, it is advisable that the department of Safety Sciences maintain their own list of graduates. This should be easier with so much information being available on line. Keeping alumni up to date on activities in the department and with the MS-IH program should prove beneficial for recruiting and other activities.

This research also lays the foundation for the Department of Safety Sciences to continue assessing their academic programs using online surveys. Plans are already underway for similar assessments of one other academic program in the Department of Safety Sciences. University administrators are looking for validation of the quality of academic programs they offer. Such assessments are valuable for both internal and external reviews. In the current state of financial difficulties and constant reviews by internal and external constituents, such research is not only useful but vital.

Suggestions for Future Research

Many potential avenues of research are suggested by the results of this research project. Other OSHE academic departments can use the assessment instruments and the processes as a guide for similar assessments of their in-house academic programs. They will be able to improve upon the process for their own needs. There are some definite advantages of online surveys for OSHE academic programs. One advantage of online surveys is the relatively low financial cost for investigating critically important issues for academic programs. Online surveys allow academic programs with severely limited research budgets to produce research studies of excellent quality. For this research, financial costs were approximately $150 total due to paying for a slightly advanced version of Survey Monkey. This researcher could not estimate the human cost of this research as it involved a seven year time period by the researcher, reviews and meetings with the advisor and the hours that the additional reviews and meetings required. For this researcher it was certainly worth it. For the twenty plus reviewers only they can say for sure.

As a larger percentage of the public becomes aware of program accreditation for OSHE program, the pressure will increase for similar assessments. An additional factor in considering this research track is the limited number of previous publications that discuss these issues. The only academic program that has reported on studies such as this one, is with the University of Minnesota (Brosseau, Raynor, & Lungu, 2005; Brosseau & Frederickson, 2009). It is advisable that this research track should be explored by other academic departments and programs.

Another avenue for future assessments is the issue of rapid turnover in the Department Chair position. Assessments specifically evaluating the impact of frequent personnel changes in the department chair position on student numbers would be both interesting and valuable. Programs that offer unique degrees may be more heavily impacted by rapid turnover in the Chair position than more standard academic disciplines are. For departments with atypical academic programs, having stability in the Chair position may be vital to maintaining healthy student numbers.

A third area for exploration is the best way to keep alumni and other constituents informed of department activities. Technology offers a multitude of possibilities including a departmental website, a departmental newsletter, or periodic email updates of important activities.

Another area of research is the potential impact of general studies courses on student numbers in academic departments such as the Department of Safety Sciences at UCM. For highly specialized departments that are rare and in fact not found at most academic institutions, a general studies course similar to Safe 2010 could be extremely important to future and long term viability of the department. Such research could be invaluable to academic programs similar to the industrial hygiene program at UCM.

Conclusion

Industrial hygiene academic programs have played a prominent role in efforts to improve working conditions for the nation’s employees. Had the discipline of industrial hygiene not developed, the nation would have experienced much higher rates of illnesses and disease from the workplace. In order for industrial hygiene programs to become the best that they can be, assessment by external organizations is important. Program assessment of academic programs is becoming more common as administrators and constituents look for validation of program offerings. Educational academic programs have a long history of program assessment. Academic programs in occupational safety and health are now under increasing pressure to participate in assessment activities. ABET began accrediting industrial hygiene program in the 1980s. Today there are still less than 30 accredited industrial hygiene programs in the United States. The UCM industrial hygiene masters program first achieved accreditation in 1998 and has gone through one re-accreditation cycle so far. A second ABET re-accreditation process is imminent. The attainment of accreditation provides visibility and validation for the Department of Safety Sciences industrial hygiene program.

The Industrial Hygiene masters program at the University of Central Missouri produced approximately 400 alumni between 1974 and 2009. This study is the first comprehensive assessment of the industrial hygiene program. This assessment evaluated how the satisfaction of alumni with the education they received from the Department of Safety Sciences had changed over the years, what skills and knowledge alumni view as important for entry level industrial hygienists, and what courses and topics alumni believe should be included in a masters degree program.

The results of this research show that alumni are pleased with the quality of the training they received from the Department of Safety Sciences. Changes in the curriculum were timely, as those changes enabled the program to continue producing graduates who successfully gained employment in the discipline and for the most part remained within the OSHE field. In addition, the alumni, as a group, are overwhelmingly in favor of practitioner skills being the focus of the industrial hygiene program. This research sets the ground work for the Department of Safety Sciences to assess other programs within the department. The methods used to assess the industrial hygiene can be used by other researchers at other universities to assess other academic programs.

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1. Informed Consent

Identification of Researchers: This research is being done by John N. Zey, a doctoral student in the Department of Educational Leadership and Policy Analysis at the University of Missouri – Columbia.

Purpose of the Study: The purpose of this research is to assess the satisfaction of alumni of the UCM industrial hygiene program with their preparation for a career in industrial hygiene.

Request for Participation: We are inviting you to participate in this study. It is up to you whether you would like to participate. If you decide not to participate, you will not be penalized in any way. You can also decide to stop at any time without penalty. If you do not wish to answer any of the questions, you may simply skip them.

Exclusions: You must be a graduation of the University of Central Missouri to participate in this research.
Description of Research Method: The research involves completing a short on-line survey. The survey will ask you about when you got your IH degree, what equipment you use on a regular basis, how well the IH program prepared you' for a career in IH and what topic IH masters student should take. This survey will take approximately 20 minutes to finish. You can ask questions of the researcher, the professor or the University of Missouri IRB office. If you would like to know the results of this study, please contact Dr. Sandy Hutchinson. She can be reached at hutchinson@ucmo.edu or at (660) 543-4720 or John N Zey at jzey@ucmo.edu or at 660 543-4410.

Privacy: All of the information we collect will be anomymous. I will not use any information that will identify you.

Explanation of Risks: The risks to this study are similar to the risks of everyday life.

Explanation of Benefits: You will benefit from participating in this study by getting firsthand experience in industrial hygiene research. You can also read the results in journal article and reports from the Department of Safety Sciences.

Questions about Your Rights: If you have any questions about your rights as a research participant, please contact the MU IRB office at (573) 882-9585.

Your completion of this survey signifies your informed consent.

* 1. Do you wish to particiapte in the UCM/CMSU IH alumni survey?

- ◯ Yes, I wish to participate
- ◯ No, I choose to not participate

2. Non Participation In Survey

You have chosen not to participate in the UCM/CMSU IH Alumni Survey. Thank you for your time.

3. Survey Participation

You have chosen to participate in the UCM/CMSU IH alumni survey. Please proceed to question #2 and continue with the survey.

2. what is your age?

- 22-30
- 31-40
- 41-50
- 51-60
- 61 or older

3. What is your gender?

- Female
- Male

4. Did you obtain an academic degree from UCM/CMSU?

- Yes in Safety
- Yes in some other disclipline
- No

5. Did you obtain a masters degree in industrial hygiene from UCM/CMSU?

- Yes
- No

6. During what time period did you obtain your MS-IH degree from UCM/CMSU?

- 1974-1984
- 1985-1995
- 1996-2010

7. How many years of professional experience in OSHE do you have?

- 0-5
- 6-10
- 11-15
- 16-20
- 21-25
- 26-30
- 31 or more

8. Which of the following certifications do you possess (please check all that apply)?

- CIH
- CSP
- CHMM
- QEP
- REM or equivalent
- Other {please list the certification(s)} ______________________________

9. If you do not currently possess one of the certifications listed in the previous question, please indicate the reason. Please check all that apply.

- Company did not support certification
- Took the test to become certified, but did not obtain the required passing score
- Was certified but I dropped it as my job duties changed
- I have never viewed certification as worth the time and money involved
- I am eligible to set for the exam but I have not taken the exam yet
- I am not yet eligible to sit for the exam
- I am currently certified

10. Regarding the OSHE field, are you currenlty _____

- Employed full-time
- Employed part-time
- Not employed in OSHE
- Fully retired

11. Which of the following best describes the business sector you are currenlty working in?

- General industry
- Consulting
- Government
- General industry
- Academia
- None of the above

12. In your current or or most recent position in OSHE, which of the following is your primary area of practice?

- Industrial hygiene
- Safety
- Environmental
- Academia
- NA

13. During your OSHE professional career, which of the following was your primary area of practice?

- Industrial Hygiene
- Safety
- Environmental
- Academia
- None of the Above

14. In your current or most recent position, what percent of time do/did you spend doing OSHE activities?

- Less than 25%
- 26-50%
- 51-75%
- 76-90%
- Over 90%

15. Which of the following issues do you currently have responsibility for, or did you have responsibility for, in your most recent job (requiring at least 10% of your time). Please mark all that apply.

- ☐ Training
- ☐ Safety
- ☐ Environmental
- ☐ Ergonomics
- ☐ Industrial hygiene
- ☐ Loss control/insurance
- ☐ Research

16. What is your approximate current annual salary?

- ○ Less than $30,000
- ○ $31,000 to $40,000
- ○ $41,000 to $50,000
- ○ $51,000 to $60,000
- ○ $61,000 to $70,000
- ○ $71,000 to $80,000
- ○ $81,000 to $90,000
- ○ $91,000 to $100,000
- ○ $101,000 to $110,000
- ○ $111,000 to &120,000
- ○ $121,000 to $130,000
- ○ $131,000+

17. In your current or most recent OSHE position, how many other safety and health professionals do or did you work with?

- ◯ None
- ◯ 1-4
- ◯ 5-8
- ◯ 9-12
- ◯ 12-16
- ◯ 17-20
- ◯ 21-24
- ◯ 25+

18. How are most of your industrial hygiene sampling needs handled in your current or most recent OSHE position?

- ◯ Conduct sampling myself
- ◯ Direct others in specific sampling needed
- ◯ Hire consultants
- ◯ Utilize state or federal OSHA consultants
- ◯ Utilize insurance carrier's industrial hygiene capabilities
- ◯ Other resources (please specify) ____________________________________

19. How well did the MS-IH program at UCM/CMSU prepare you for your career in OSHE?

- ◯ Poorly
- ◯ Below average
- ◯ Above average
- ◯ Excellently

20. How did you hear about the industrial hygiene program as UCM/CMSU? Please check all that apply.

- [ ] friend/relative
- [ ] college advisor or high school advisor
- [ ] UCM/CMSU general studies course website
- [ ] Radio/newspaper advertisement
- [ ] Other, please specify ________________________________
- [ ] I do not remember

21. How important are the following MS-IH program outcomes as they relate to your current or most recent OSHE job?

	Not necessary	Useful	Important	Essential
The ability to communicate professionally both verbally and in writing	◯	◯	◯	◯
Knowledge of professional integrity & ethics	◯	◯	◯	◯
Awareness of contemporary, global and societal issues as they pertain to OSHE	◯	◯	◯	◯
The ability to develop, coordinate, and participate in multidisciplinary teams	◯	◯	◯	◯
The ability to anticipate, identify and evaluate agents and stressors in occupational and non-occupational settings	◯	◯	◯	◯
The ability to collect and analyze data using qualitative and quantitative methods and procedures	◯	◯	◯	◯
The ability to recommend, evaluate, and design a hygiene program that mitigates chemical, biological and physical agents	◯	◯	◯	◯
The ability to apply techniques of using instrumentation to discover/identify hazards, prioritizing, and implementation of strategies to control or minimize the risks of exposure	◯	◯	◯	◯

22. Considering your Master's degree from UCM, please rate the quality of your education in each of the following IH Program Outcomes.

	Low	Below average	Above average	High
The ability to communicate professionally both verbally and in writing	◯	◯	◯	◯
Knowledge of professional integrity & ethics	◯	◯	◯	◯
Awareness of contemporary, global and societal issues as the pertain to OSHE	◯	◯	◯	◯
The ability to develop, coordinate, and participate in multidisciplinary teams	◯	◯	◯	◯
The ability to anticipate, identify and evaluate agents and stressors in occupational and non-occupational settings	◯	◯	◯	◯
The ability to collect and analyze data using qualitative and quantitative methods and procedures	◯	◯	◯	◯
The ability to recommend, evaluate, and design a hygiene program that mitigates chemical, biological and physical agents	◯	◯	◯	◯
The ability to apply techniques of using instrumentation to discover/identify hazards, prioritizing, and implementation of strategies to control or minimize the risks of exposure	◯	◯	◯	◯

23. Please rate the quality of the education you received from UCM/CMSU in each of the following areas during your academic program.

	Low	Below average	Above average	High
Technical Knowledge	◯	◯	◯	◯
Chemistry	◯	◯	◯	◯
Organic Chemistry	◯	◯	◯	◯
Biology	◯	◯	◯	◯
Physics	◯	◯	◯	◯
Anatomy & Physiology	◯	◯	◯	◯
Ecology	◯	◯	◯	◯
Biohazards	◯	◯	◯	◯
Biostatistics & Epidemiology	◯	◯	◯	◯
Engineering Controls	◯	◯	◯	◯
Administrative Controls	◯	◯	◯	◯
Personal Protective Equipment	◯	◯	◯	◯
Ergonomics	◯	◯	◯	◯
Ethics	◯	◯	◯	◯
Management	◯	◯	◯	◯
Business	◯	◯	◯	◯
Monitoring and Instrumentation	◯	◯	◯	◯
Noise & Vibration	◯	◯	◯	◯
Ionizing & NonIonizing Radiation	◯	◯	◯	◯
Regulations & Standards	◯	◯	◯	◯
Thermal & Pressure Stressors	◯	◯	◯	◯
Toxicology	◯	◯	◯	◯
Community Exposures	◯	◯	◯	◯
Research Methods	◯	◯	◯	◯

24. How important are the following courses and subjects for IH-Masters students to take during their masters program?

	Not Necessary	Useful	Important	Essential
Chemistry	◯	◯	◯	◯
Organic chemistry	◯	◯	◯	◯
Biology	◯	◯	◯	◯
Anatomy	◯	◯	◯	◯
Physiology	◯	◯	◯	◯
Physics	◯	◯	◯	◯
Ecology	◯	◯	◯	◯
Biohazards	◯	◯	◯	◯
Biostatistics & Epidemiology	◯	◯	◯	◯
Toxicology	◯	◯	◯	◯
Engineering Controls	◯	◯	◯	◯
Administrative Controls	◯	◯	◯	◯
Personal Protective Equipment	◯	◯	◯	◯
Ergonomics	◯	◯	◯	◯
Management	◯	◯	◯	◯
Business	◯	◯	◯	◯
Monitoring and Instrumentation	◯	◯	◯	◯
Noise & Vibration	◯	◯	◯	◯
Ionizing & Non-ionizing Radiation	◯	◯	◯	◯
Regulations & Standards	◯	◯	◯	◯
Thermal and Pressure Stressors	◯	◯	◯	◯
Community Exposures	◯	◯	◯	◯
Research Methods	◯	◯	◯	◯

25. In your current or most recent job in OSHE, how essential are the following analytical, management, and communication skills/knowledge?

	Not Necessary	Useful	Important	Essential
Data Analysis	○	○	○	○
Hazard Recognition & Anticipation	○	○	○	○
Exposure Control	○	○	○	○
Operation of Testing Equipment	○	○	○	○
Critical and Analytical Thinking	○	○	○	○
Organizational Skills	○	○	○	○
Detail-oriented	○	○	○	○
Financial planning	○	○	○	○
Effective Team Builder	○	○	○	○
Problem Solver	○	○	○	○
Objectivity	○	○	○	○
Self-motivation	○	○	○	○
Ability to Demonstrate Value-added Services	○	○	○	○
Time Management	○	○	○	○
Public Speaking	○	○	○	○
Interpersonal	○	○	○	○
Risk Communication	○	○	○	○
Crisis Communication	○	○	○	○
Written Communication	○	○	○	○
Research Methodology	○	○	○	○

26. Please indicate how often you use the following instruments in your current or your most recent OSHE job.

	Never	Infrequently	Periodically	Frequently
Colorimetric Devices	◯	◯	◯	◯
Air Sampling Trains	◯	◯	◯	◯
Sorbent Tubes	◯	◯	◯	◯
Noise Sampling Equipment	◯	◯	◯	◯
Calibration Equipment	◯	◯	◯	◯
Non-Ionizing Radiation Sampling Equipment	◯	◯	◯	◯
Ionizing Radiation Sampling Equipment	◯	◯	◯	◯
Ergonomic Assessment Instruments and Tools	◯	◯	◯	◯
Light Meters	◯	◯	◯	◯
Photoionization Equipment	◯	◯	◯	◯
Flame Ionization Equipment	◯	◯	◯	◯
Portable Gas Chromatograph	◯	◯	◯	◯
Fourier Transform Infrared Analyzer	◯	◯	◯	◯
Thermal Imaging Camera	◯	◯	◯	◯
Direct Reading Instruments (4-5 gas meters)	◯	◯	◯	◯
Direct Reading Instruments (particle samplers)	◯	◯	◯	◯

27. How well did the IH program at UCM/CMSU train you in using the following types of equipment?

	Poorly	Below Average	Above Average	Excellently	This Equipment Was Not Covered in my Program
Colorimetric Devices	◯	◯	◯	◯	◯
Air sampling trains	◯	◯	◯	◯	◯
Sorbent Tubes	◯	◯	◯	◯	◯
Noise Sampling Equipment	◯	◯	◯	◯	◯
Calibration Equipment	◯	◯	◯	◯	◯
Non-Ionizing Radiation Sampling Equipment	◯	◯	◯	◯	◯
Ionizing Radiation Sampling Equipment	◯	◯	◯	◯	◯
Ergonomic Assessment Instruments and Tools	◯	◯	◯	◯	◯
Light Meters	◯	◯	◯	◯	◯
Photoionization Equipment	◯	◯	◯	◯	◯
Flame Ionization Equipment	◯	◯	◯	◯	◯
Portable Gas Chromatograph	◯	◯	◯	◯	◯
Fourier Transform Infrared Analyzer	◯	◯	◯	◯	◯
Thermal Imaging Camera	◯	◯	◯	◯	◯
Direct Reading Instruments (4-5 gas meters)	◯	◯	◯	◯	◯
Direct Reading Instruments (particle samplers)	◯	◯	◯	◯	◯

28. Please add any other comments you have about the UCM IH program below.

4. Survey Complete

Thank your for your time and efforts in completing this survey. You will be able to view results of this study in the future via the Department of Safety Sciences web-page, the department newsletter, The Safety Net and in journal articles.

John N. Zey

Appendix 2

Other Comments to Opened Ended Questions

Other comments to question #8, Which of the following certifications do you have?
PG
CMC
Hazadous Waste and Emergency Response
CPEA
CPSI
did have CIH; retired.
MT(ASCP)
Certified Utility Safety Administrator via Utility Division, National Safety Council; Certified Loss Control Professional through National Rural Electric Cooperative Assn.
P.E.
EPA Asbestos Building Inspector
CMRS, CMC
IHIT
National Registry of Certified Chemists- Chemical Hygiene Officer
CET, CIT
CPEA
ARM
Certified envirnomental auditor
ROH
LEED Professional
CUSA from NSC
in indoor air quality
PE, PMP

Appendix 2

Other Comments to Opened Ended Questions

Other comments to question #18, How is most of your sampling handled?
Na
I direct a product safety program that includes human and envirtonmental exposure, toxicology and risk assessment experts.
Contractor
Conduct some myself and use consultants to collect samples. I write the reports.
A co-safety engineer is responsible for IH.
Company corporate IH or field staff under the instruction of the corp IH
Only involved with sampling as a student activity in IH lab.
Myself; direct others; hire consultants
Sandia National Lab.
Currently I do not support IH sampling; however for my company the sampling is done by IH technicians.
I have collected samples myself, and I have directed a technician.
Mix of the above

Appendix 2

Other Comments to Opened Ended Questions

Other comments to question #20, How did you hear about the IH program at ucm/cmsu?
Found CMSU catalog at my undergraduate school
Career aptitude survey
College catalogs and programs listing on IH programs
College index book at Library
Professor
Was chem major at cmsu; decided to change programs.
While taking Principles of Industrial Hygiene Course from a CMSU IH Professor for an Industrial Safety Master's Degree (switched to MS-IH afterwards)
I was in graduate school at SIU Edwardsville and a fellow classmate told me about this program
Friends who worked in safety-related fields at CMSU
IH professional when calling alumni to give money to foundation.
CMSU Graduate Catalog Associate
I attended a NIOSH training class and learned about the CMSU program from Mr Herb Jones, Director of IH at CMSU.
Students already in the IH program
Web search on graduateschools.com I searched for programs. Located about a dozen. Applied to two.
It had a trimester and was cheap!

Renovated department chair's house

Diana Bryant- she was excellent!
I
was looking to further my career and went to the Area OSHA office who gave me information concerning IH and the schools that provide advanced degrees in the field.

Word of mouth.
John Zey

A professor from Texas A&M recommended that I contact CMSU for a quality program.

I initially learned of then CMSU's Industrial Safety program from friends and former classmates (this would have been in the late 1970's to early 1980's). I then enrolled in the Industrial Safety program in 1982, subsequently learning of the IH program at that time. I returned to CMSU in the mid-90's to complete a graduate degree in IH.

Colleagues

Researched options. I did not go directly from undergraduate studies into the program.

NIOSH listed schools that provided IH training

Catalog...don't know if they had a website back then.

St. Louis AIHA section

read up on the degree after graduating with MA in Economics at CMSU.

My husband taught IH at CMSU. Tried to combine IH/Safety with my previous training in Agriculture (MS), but could not find the right job.
Personal conversation with head of the chemistry department(I have a BS in Chemistry from CMSU)
My supervisor informed me.
Contact with alumni

Through a conversation with an industry expert on ES&H

Researched program availability

Appendix 2

Other Comments to Opened Ended Questions

Other comments to question #28, Do you have any other comments?
30+ years ago, my Masters IH education at CMSU (UCM) enabled me to walk into an IH working environment, understand the knowledge and concepts being presented, and contribute immediately. The teachers and counselors of CMSU (UCM) had thoroughly prepared me to meet the IH challenges at the start of my career and for that I will be forever in-debted to them. Microbiological sampling equipment should be covered (spore traps, culture plates, microbial surface swabs, water sampling, etc.) When I went through the program the lab portion was not a strong point. However, the theoritical aspects were very well done. For instance, the specific subject areas were taught as graduate courses in departments such as physics, biology and chemistry. I feel this was very strong. Many of the above equipment were not available at the time of my education. Dump the deadweight instructor(s). Tenure for some has become a ticket to quit learning. In the field, one should be on top of their game if they are to instruct. The field is evolving. Instruction on yesterdays subjects do not prepare us for tommowrrow. Ensure instructors have real world expericene that can be passed on. Develop more alliances with local industry and bring in speakers. Have a safety conference for the benefit of the students where you bring in alumni to speak on subjects that repare the students to enter the job market. For example, talking about ISO Managemt Systems or cutting edge research/practices. Program has great technical program content, but overall should improve on statistical data analysis and methods for effective communicaiton with non-OSHE management. One of the best in the world! Because of my degree from CMSU I was able to leave the field of clinical microbiology and move to a safety coordinator position within the SSM Healthcare organization. Although my degree was in IH, this program allowed me to take several industrial safety classes including an OSHA regulatory class which proved to be extremely valuable to me as I worked in that field. Right now I am more clinically focused by working in the field of infection prevention, but these classes and this experience has never left me and I am so extremely glad that I embarked on this phase of my professional growth. I don't practice IH full time, but as an adjunct to my safety management position. The UCM IH program prepared me well for handling those IH issues that do arise,

however. I would add that as a non-traditional student (active duty USAF at the time), UCM accommodated me nicely with evening and weekend classes.

The IH Lab course was great- but it would be great if other courses incorperated the use of instramentation as well.

IH companies continue to create better and new equipment that help in the field of industrial hygiene.

I took my classes in St. Louis as part of the CMSU IH extension program. We had some excellent instructors from industry and govt. I felt that the classroom discussions among the students/teachers who were already working in industry were just as valuable as the content of the coursework and brought a practicality to the program that would have been missed had it all been younger students without industry or other significant work experience or instructors that had not worked in industry.

Regarding the questionaire: Question 4. Did you obtain an academic degree from UCM/CMSU? seems to imply that "academic" equals "undergraduate", when considering the wording of Question 5. Did you obtain a masters degree in industrial hygiene from UCM/CMSU? Was this the intent???

Question 11- had "General Industry" listed twice, Question 22- "the" should have been "they". Thank you and I am glad to have participated.
Most of the heavy dusty trades have been exported leaving a greater portion of industrial employment in pharmaceuticals, food processing, etc. I recommend UCM IH Deptartment offer classes in Food Processing Hygiene / Safety.

I do not clearly recall all the equipment covered in the program.
Hopefully, it has improved. The principal instructor at the time liked ventilation, and apparently that was all he knew.

Excellent program! I feel privileged to have been a part of it.
Due to budget contraints UCM did not have all of the equipment listed above; however, Diana expected us to learn about them from the textbook. She was an excellent professor and mentor.

My education at UCM is somewhat dated (it was CMSU then and Roscoe the fighting mule was the actual live mascot) but it provided me a solid educational experience that prepared to enter the field and develop proficiency for the issues at the time. For instance ergonomics was a term seldom heard in 1978. Do not take my below average answers as a criticism. Some of the subjects now critical to the field were not issues during my time at Warrensburg. The experience at UCM and my commitment to the field enabled me to address those emerging issues when they arose.
Herb Jones headed up the program back in 1977. He ws a great teacher. I currently am Director of OH&S at a major biothech company and his teachings and ethics contributed heavily to where I am today.

The instructors that I had displayed a genuine interest in the achievement of their students (including the low achievers of which I was one). Additionally, I have always been able to count these people among the first of my problem solving network.

Overall the MS in Industrial Hygiene gave myself a solid background and education.

The program proovided me with networking. The program was underfunded by the University.

A class using ACGIH "quantitative industrial hygiene" as core curriculum.

All of my classes were taken at the St. Louis extension campus.
on question 27, a number of the devices were not yet on the market when I went through the program '81

In today's business climate, it is absolute imperitative that the program must cover safety and environmental aspects because of the diversified role that an individual must be able to function in a company or consulting firm. The IH field is no longer one dimensional. So, the more diverse the educational background, the greater the opportunity for employment. Also, within the consulting arena, it is absolutely imperative that an individual is able to communicate via written and oral ways.

These questions to not give the option for average. This is going to skew the data. The questions do not really seem to be able to segregate between the BS IH and Masters IH programs consistently. Some of us have both and our classes in the MS IH were different than most because of the course selections we already completed in the BS IH program.

in 1987 there was a 2 hour lab on sampling..that was it...I hope that this has been greatly expanded......

Equipment we used in the lab and in the field was not real reliable when I was in school. Most of the experience I have with IH equipment has come in the field through trial and error. The only GC I used at UCM/CMSU was in the Chemistry Department.

When it comes to question 24, I think students should have completed the basic science courses prior to entering the IH Masters Program. It is very critical that students have the strong science background so they can better understand how and why certain equipment is used. Having the science background is also very important to understanding the effects of hazards on the human body, especially toxicology. I really felt that to many students were allowed to take IH courses when I was in school who did not have a strong enough chemistry/science background, thus the courses like toxicology, noise and environmental monitoring were a little more watered down.

I would suggest that more analytical courses be given to allow students the opportunity to work on the skills needed to obtain certification and that are used to analyze sampling data.

During the early 90's, there was little advanced field analytical gear available in the IH lab.

Have used portable GC-MS and FTIR in the field--just not in my current job.

There was no training on most of the equipment listed above. Therefore I placed poorly. It would have been better to have an area stating no training provided. There was minimal training on the use of any equipment.

I feel it would be beneficial for graduates to be exposed to related disciplines such as risk management and insurance, emergency management, and leadership.

I was there in 1977, some devices were only presented in books.

Only worked in the IH/Safety field 1990-1992. Back to running the farm, remind fellow farmers & firefighters about PPE & guarding.

Although I have rated the program as poor overall I was in the first class and the program was really still in development

More time could be spent on real time sampling and exercises with researching appropriate standards.

Great program. Great professionals have graduated from this program. Do all that you can to keep it active.

Some of this equipment did not exist when I was in graduate school.
UCM IH is among the best in the nation. I will suggest that Environmental Health Risk Assesment should be added into the IH program as the work environment is changing.

I received my MS from the St. Louis Program. Our instructors were experienced in industry and provided excellent instructions and guidance.

am very satisfied with the preparation I received for an IH career. CMSU/UCM has a great reputation among the people I know.

The basic life sciences and chemistry courses are a prereque for the MS IH program. If you dont have them you take them...

It is important for the program to keep up with current technology and its use. I found my internships helped more than the program did with current methods and technology.

Many of these intrument were not standard field instruments when I went through the MS program. Alsomost all y critical knowledge and skills came from my USAF training as a Bioenvironmental Engineer so the MS program was a refresher at best.

Godspeed John Zey

Add content about safety management systems and human performance improvement, balanced scorecard metrics.

I was in the program more than 30 years ago, so a lot of the instruments and skills listed in the survey were not as important back then.

I now have a management position that does not require me to personally do sampling or analysis, but I still use the knowledge to direct the folks who work for me.

Good program. Some of the older professors have left..they had very little practical experience and their ability to relate to issues students currently encounter. Believe the department has upgraded talent to recent years.
The time period I was at UCM some above technology was not available.

VITA

John Nicholas Zey was born at his parent's farm home to Eugene and Dorothy May (Fisher) Zey on May 9, 1952. He is the 11th of 14 children. For the first 18 years of his life he lived on a farm in central Missouri and attended one of the smallest schools in the State of Missouri, Prairie Home R-V School. He attended college at Central Missouri State University (now the University of Central Missouri) from 1970 to 1976. At school he met his future wife, Alice Lee Greife. He completed a BS in Biology and an MS in Industrial Hygiene while at Central. He completed his doctorate of Educational Leadership in 2010. He and his wife, Alice, have two daughters, Sarah and Kathleen (Kat).