

# **FINAL PERFORMANCE REPORT**

## **University of Michigan Educational Resource Center**

**Center for Occupational Health and Safety Engineering  
1205 Beal Avenue  
The University of Michigan  
Ann Arbor, MI 48109**

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**NIOSH Grant            OH07207  
Grant Period: July 1, 1990 through June 30, 1994**

**NIOSH Grant #T42/CCT510428  
Grant Period: July 1, 1994 through June 30, 1995**

**October 1995**



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## **Abstract**

The University of Michigan Center for Occupational Health and Safety Engineering was established as a NIOSH Educational Resource Center (ERC) in 1981. For the five-year period covered in this report, we have provided professional (Masters) and research (Doctoral and post-Doctoral) training in Industrial Hygiene, Occupational Health Nursing, Occupational Medicine, and Occupational Safety Engineering and Ergonomics. A program in Hazardous Substances Academic Training was added in 1993 to complement the program in Industrial Hygiene. In addition, our Continuing Education and Outreach programs are large, highly-regarded activities that serve all of the academic programs. All of our programs are based at The University of Michigan's Ann Arbor campus, facilitating interdisciplinary activities for faculty and students.

The Director of the Michigan ERC is W. Monroe Keyserling, Ph.D. He is a faculty member in Industrial and Operations Engineering and is also the Program Director for Occupational Safety Engineering and Ergonomics. Directors of the other academic programs are: Richard Garrison, Ph.D. (Industrial Hygiene), Sally Lusk, Ph.D. (Occupational Health Nursing), Thomas Robins, M.D. (Occupational Medicine), and Stuart Batterman, Ph.D. (Hazardous Substances Academic Training). David Garabrant, M.D. serves as the Associate Center Director. Randall Rabourn, M.S.E. serves as the Director of Continuing Education and Outreach.

The University of Michigan provides fully-equipped training facilities for all ERC activities, including classrooms; laboratories, clinical facilities; libraries; computing facilities; and faculty, staff, and student offices. The University of Michigan also provides substantial General Fund support for the salaries of all tenure track faculty.

During our most recent site visit in December 1994, The University of Michigan was approved for an additional five years as a NIOSH Educational Resource Center for the period July 1, 1995 through June 30, 2000.

## Structure and Center Administration

The Michigan Center for Occupational Health and Safety Engineering (COHSE) is managed by an Executive Committee comprised of the Center Director, the five Academic Program Directors, and the Director of Continuing Education. See Figure 1. This committee meets formally four to six times per year. In addition, there is regular communication (typically several times per week) among members of the Executive Committee through electronic mail.

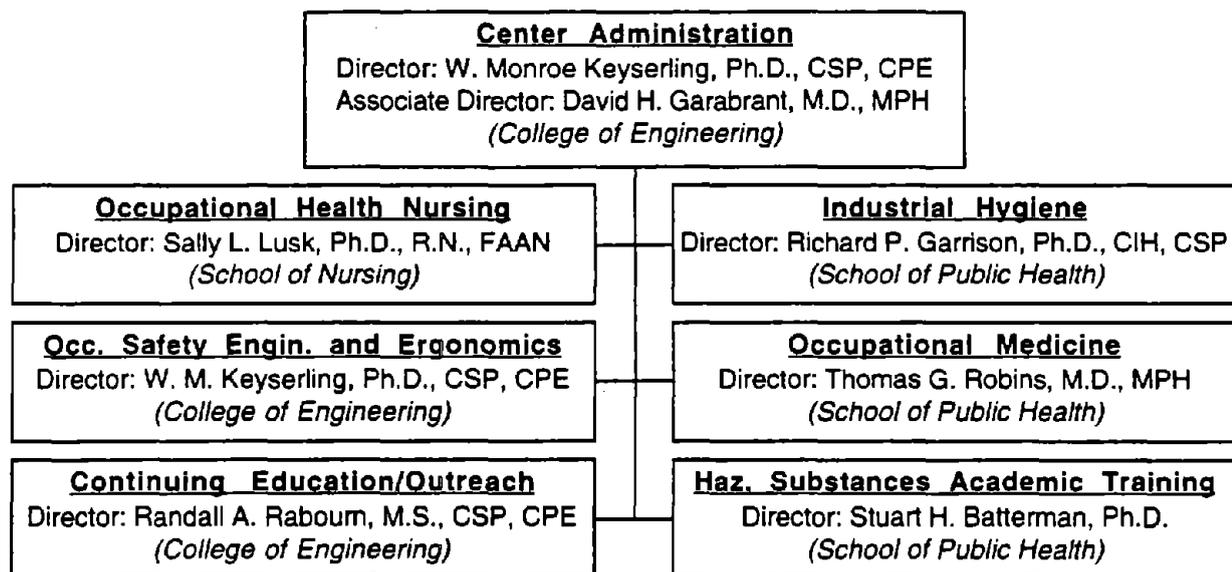


Figure 1. Executive Committee Organization Chart for The Michigan Center for Occupational Health and Safety Engineering -- a NIOSH Educational Resource Center.

The Center is also guided by an external Advisory Committee composed of representatives from the five core disciplines. Members of the committee (see listing of current members in Appendix A) come from industry, labor and government. The Executive Committee meets with the external Advisory Committee at least biennially to review progress and future directions.

The University of Michigan, through its Rackham School of Graduate Studies encourages a multi-disciplinary approach to teaching, research, and service. Because all programs in the Michigan COHSE are located on the Ann Arbor campuses, it is quite easy and convenient to integrate training activities across the core academic programs. The Medical campus (site of the Schools of Public Health and Nursing) is located about one mile from the North campus (site of the College of Engineering). A free bus service connects the two campuses, allowing students from all academic cores to participate in courses and seminars. Students from all core disciplines participate in the following four courses: EIH 550 -- Industrial Hygiene, EPI 503 -- Strategies and Uses of Epidemiology, IOE 539 -- Occupational Safety Engineering, and IOE 837 -- Seminar in Occupational Health and Safety Engineering. Students also participate in interdisciplinary research and clinical activities. For example, Industrial Hygiene students participate in the Occupational Medicine Clinic.

## **Director's Overview**

The Michigan Center for Occupational Health and Safety Engineering has functioned as a NIOSH Educational Resource Center for 13 years and has reached a stage of maturity characterized by outstanding academic productivity and efficiency; a stable, tenured faculty; an extensive curriculum; a strong national reputation and a demonstrated ability to recruit outstanding students; outstanding research productivity in a wide range of areas; and a large number of alumni who are leaders in their field. The Center enjoys very strong support from the University; a substantial portion of faculty and staff salaries are supported through the University's General Fund. A summary of major accomplishments is presented below, followed by brief reports from each core program.

### **Productivity of Academic Programs**

Table 1 presents detailed enrollment and graduation data for the five academic programs for the period September 1, 1990 through August 31, 1995. (For convenience, these statistics are presented by academic year instead of fiscal year.) Enrollment has remained fairly stable over the five year period at slightly more than 100 students. Likewise, graduation rates have remained stable, averaging about 45 students per year. The apparently large fluctuation in graduation rates in Occupational Medicine and Industrial Hygiene is influenced by the fact that many students in these two programs are enrolled in our On Job/On Campus (OJOC) degree programs. The OJOC format runs in a two-year cycle, resulting in a high number of graduates every other year. We expect to see a similar trend in the future for Occupational Health Nursing which adopted the OJOC format in 1993 and graduated its first cohort of students in 1995.

We are pleased with our ability to maintain stable enrollments and graduation rates during a period of increasing educational costs (tuition, fees, etc.) and decreasing NIOSH support for trainees. We attribute this stability to three factors: 1) the quality and reputation of our programs, 2) the success of faculty in developing research funds to help support students, and 3) the availability of an OJOC teaching format that allows students to pursue an advanced degree in occupational safety and health while holding down a full-time job. (Many OJOC students receive financial assistance from their employers to cover tuition and travel expenses.)

### **Productivity of Continuing Education Programs**

Table 2 presents statistics for our continuing education programs. During the five-year period, we presented a total of 105 courses, an average of 21 courses per year. Total enrollment in continuing education courses has been quite steady, averaging slightly over 2,200 participants per year. While most participants in our continuing education courses come from the core disciplines of Industrial Hygiene, Occupational Medicine, Occupational Health Nursing and Occupational Safety Engineering, we enroll a substantial number of students from other disciplines. Within this "other" group, participants include: managers, engineers, representatives of organized labor, and representatives of related health professions such as physical and occupational therapy.

Faculty members from the five academic cores are actively involved in the planning, preparation and delivery of all continuing education courses. While this policy limits the number of courses we are able to offer, we believe that it assures the quality and attractiveness of our programs. A typical continuing education course at Michigan attracts slightly more than 100 students. This statistic demonstrates that we are presenting programs that are timely, relevant, and highly regarded.

Table 1. Productivity of Academic Programs at The Michigan Center for Occupational Health and Safety Engineering, 1990-1995.

	1990-91	1991-92	1992-93	1993-94	1994-95	TOTAL
<b>Academic Enrollments</b>						
Industrial Hygiene	44	40	42	53	44	223
Occ. Health Nursing	9	6	4	9	6	34
Occ. Medicine	22	31	25	21	24	123
Occ. Safety/Ergonomics	30	29	25	33	26	143
HSAT			2	4		6
<b>TOTAL</b>	<b>105</b>	<b>106</b>	<b>98</b>	<b>120</b>	<b>100</b>	<b>529</b>
<b>Students Receiving NIOSH Support</b>						
Industrial Hygiene	21	12	16	15	10	74
Occ. Health Nursing	5	3	3	7	4	22
Occ. Medicine	4	3	4	4	4	19
Occ. Safety/Ergonomics	6	5	5	6	7	29
HSAT			2	4		6
<b>TOTAL</b>	<b>36</b>	<b>23</b>	<b>30</b>	<b>36</b>	<b>25</b>	<b>150</b>
<b>Number of Graduates</b>						
Industrial Hygiene	18	35	11	21	31	116
Occ. Health Nursing	4	2	1	0	4	11
Occ. Medicine	12	3	15	3	15	48
Occ. Safety/Ergonomics	13	8	16	16	7	60
HSAT			0	0		0
<b>TOTAL</b>	<b>47</b>	<b>48</b>	<b>43</b>	<b>40</b>	<b>57</b>	<b>235</b>
<b>Other Students Taking OSH Courses</b>						
Industrial Hygiene	40	20	6	5	8	79
Occ. Health Nursing	6	0	0	0	0	6
Occ. Medicine	0	0	1	0	0	1
Occ. Safety/Ergonomics	47	53	40	85	90	315
HSAT						
<b>TOTAL</b>	<b>93</b>	<b>73</b>	<b>47</b>	<b>90</b>	<b>98</b>	<b>401</b>

### Program Faculty

Appendix B lists faculty who have contributed to the core academic programs at the Michigan ERC during the reporting period. A total of 36 faculty members have been involved. During this time, we have experienced a small amount of growth. In general, this has been a period of great stability in our core faculty. Major faculty developments include the following:

- Addition of a new tenure-track faculty position in Occupational Health Nursing, filled by Dr. Mary Hogan

Table 2. Productivity of Continuing Education Programs at The Michigan Center for Occupational Health and Safety Engineering, 1990-1995.

	1990-91	1991-92	1992-93	1993-94	1994-95	TOTAL
<b>Courses Offered</b>	20	23	20	22	20	105
<b>Enrollees by Profession</b>						
Industrial Hygiene	358	341	327	391	300	1717
Occ. Health Nursing	210	336	200	287	156	1189
Occ. Medicine	327	503	357	399	424	2010
Occ. Safety/Ergonomics	422	371	393	422	372	1980
Other	937	953	896	728	906	4420
<b>TOTAL</b>	<b>2254</b>	<b>2504</b>	<b>2173</b>	<b>2227</b>	<b>2158</b>	<b>11316</b>

- Addition of a new tenure-track faculty position in Occupational Safety and Ergonomics
- Recruitment of six new faculty members:
  - Dr. Al Franzblau (Occ. Med.)
  - Dr. Bernard Martin (Occ. Safety/Ergo.)
  - Dr. Yili Yu (Occ. Safety/Ergo.)
  - Dr. Stuart Batterman (HSAT)
  - Dr. David Hamby (HSAT)
  - Dr. J. Nriagu (HSAT)
- Promotion to Associate Professor (with tenure) of three faculty members:
  - Dr. Tom Robins (OM)
  - Dr. Edward Zellers (IH)
  - Dr. Stuart Batterman (HSAT)
- Promotion to Full Professor of three faculty members:
  - Dr. Tom Armstrong (IH/Occ. Safety/Ergo.)
  - Dr. Steve Levine (IH)
  - Dr. Sally Lusk (OHN)

We are particularly pleased with the success of our faculty in obtaining promotions and tenure. This development reflects the high quality of our faculty and the commitment of the University of Michigan toward maintaining stable programs in all academic core disciplines.

### Significant Developments in Academic Programs

Major developments and successes of our academic programs are highlighted in the bullets below. Additional details are available in the Core Program Reports in the following section.

### New Academic Programs

- On Job/On Campus practicum in Occupational Medicine (est. 1991)
- On Job/On Campus program in Occupational Health Nursing (est. 1993)
- New program in Hazardous Substances Academic Training (est. 1993)
- New degree in Occupational Safety Engineering and Ergonomics, the Master of Engineering in Occupational Ergonomics (est. 1994)
- New Ph.D. program in Occupational Health Nursing (est. 1994)

### Accreditation of Programs

- Occupational Medicine accredited by American Council of Graduate Medical Education for On Job/On Campus pathway, 1993. (Note: the full-time pathway was accredited in 1982.)
- Occupational Health Nursing accredited by National League of Nursing, 1993
- Industrial Hygiene accredited by American Board of Engineering Training, 1993

### National Recognition of Academic Programs

- Department of Industrial and Operations Engineering (home of Occupational Safety Engineering and Ergonomics) ranked No. 1 in the U.S. in the 1993 Gourmann Report
- School of Nursing ranked No. 2 in the U.S. in the 1993 Gourmann Report

### **Program Funding**

Program faculty in tenured and tenure track positions are primarily supported during the academic year through the University General Fund (funds provided by the State of Michigan plus funds collected from student tuition payments). A relatively small fraction (typical range is 10-30 percent) of faculty academic year salary is derived through grants and contracts from sponsors in the public and private sectors. Faculty salaries during the summer (typically two months) are supported exclusively through research grants and contracts (i.e., "soft" money). Support staff are funded through a combination of the General Fund and external grants and contracts. In general, the General Fund supports staff activities related to academic functions while grants and contracts support staff activities devoted to research.

Financial aid to students through the NIOSH training grant is critical for the continued success of our ERC programs. Tuition at the University of Michigan is high. Tuition and fees for Michigan residents during 1995-96 are approximately \$13,000 for 2.5 terms of enrollment, the minimum time required to obtain the Masters degree. For non-Michigan residents, the cost rises to over \$25,000. While program faculty have been successful in developing research funds to cover the tuition and living expenses of advanced Doctoral students, the NIOSH traineeship continues to be the major source of financial assistance for Masters students and first-year Doctoral students. In recent years, we regret that we have not had the financial resources to support all qualified students who wish to attend The University of Michigan to prepare for careers in occupational safety and health. As a result, a number of excellent students have been unable to attend because of financial constraints. We look toward the future somberly in light of increasing educational costs at a time of decreasing support from NIOSH.

## **Supply and Demand**

Demand for graduates of all ERC academic programs remains strong. Although we have not performed a formal survey to project future career opportunities in occupational safety and health, we have had outstanding success in placing graduates from all of our core programs. Masters students generally have received multiple offers of employment. Ph.D. students are also successful in their job searches. However, in recent years, an increasing fraction of Ph.D. graduates have pursued careers in the private sector instead of in academic institutions. For additional information on placement of our graduates, refer to reports from the program cores in the following sections.

We continue to attract a steady number of well-qualified students to all core programs. As mentioned above, our biggest challenge is providing financial assistance to students who wish to study at The University of Michigan. Our On Job/On Campus professional programs in Industrial Hygiene, Occupational Medicine and Occupational Health Nursing provide a special opportunity for students who must attend graduate school on a part-time basis due to financial and/or family constraints. The OJOC format is extremely popular and attracts students from across the U.S.A.

## **Core Program Reports**

### **Industrial Hygiene**

The Industrial Hygiene Program at the University of Michigan began in 1943, three years after the formation of the School of Public Health. The Michigan program was the second university IH program to be formed in this country. In its first 50 years, the program has produced over 500 graduates.

A significant number of IH Program faculty and alumni have served as Presidents of the AIHA, probably more than any other academic program. The program has conducted annual Industrial Hygiene Discussionals for over 30 years. These meetings bring together leaders of IH programs from many industries to discuss a wide range of issues directly among themselves.

The IH Program experienced steady growth for about 30 years, until the early 1970's. The introduction of NIOSH funding in the 1970's was a major cause for a dramatic increase in the number of students (from an average below 10 to over 20 per year). Reduction in NIOSH funding in the 1980's was the major cause of reductions in student numbers during the 1980's.

The number of students in the IH program is, once again, relatively high (averaging 20 graduates per year since 1989). The cause of this growth was the development of the On Job/On Campus (OJOC) Program, beginning in 1987. The OJOC Program is an integral part of the IH Program. It is currently in its fifth class of IH students (who will graduate in 1997).

### **Major Accomplishments and Changes**

The IH Program achieved significant strength and development during the past 5-year funding period, as summarized below:

- Steady numbers of graduates have kept the program at or near the top nationally for both Masters and Doctoral degree students. Masters (MS/MPH) graduates from 1990 through 1995 totaled 107. There were 14 Ph.D. graduates during this period.
- The OJOC MS program has been a great success. The past three classes, in 1991, 1993 and 1995, graduated 20, 13 and 12 students respectively, for a total of 45 MS graduates. The current (1995-1997) has 15 students.
- The high quality of the program was recognized and awarded by receiving an initial ABET accreditation for the maximum period of six years -- the first, and possibly the only, IH program to be awarded the maximum accreditation period upon first application.
- The quality of individual students has been recognized by organizations bestowing competitive national awards for scholarship, such as four Master's students being selected 3M Company Scholars (more than from any other school), two Master's students winning the Semiconductor Safety Association International Scholarship Competition, and a doctoral student earning the 1990 and 1992 John M. White Awards, from the American Industrial Hygiene Association (AIHA).

- Four full-time primary IH faculty positions have been maintained and all IH faculty are now tenured. Professors Garrison and Zellers became tenured and Professors Armstrong and Levine were promoted to Full Professor during the 1990-95 training grant period. Dr. Garrison replaced Dr. Armstrong as IH Director in 1992.
- The IH faculty continue to serve the profession beyond academic activities. All four are members of editorial boards for major journals. Other service includes: AIHA Board of Directors, National Study sections, and AIHA and ANSI technical committee chairmanships.
- The IH curriculum has been improved in several important ways, including the addition of a field experience course, a management course (Business School), a clinical practicum "pilot" course, and the interdisciplinary HSAT-IH track. Considerations are always underway for other actions to enhance student training.
- Continuing education activities included the development of the Comprehensive IH Review course offered twice each year since 1990 and co-sponsored with the AIHA and the Michigan IH Society.
- Research activities keep the IH program in a position of national prominence and have supported the development and graduation of Ph.D. students. The number of research grants have been consistently strong, among the highest in the country, and numbers publications by faculty and students probably are highest among university programs.
- The program has sought and attracted supplemental student financial support from various sources. These have included federal government (NIOSH-HSAT; DOE), university (School of Public Health), and limited corporate industry scholarships.
- The University of Michigan Industrial Hygiene Student Association (UMIHSA) became the first chartered graduate-level student group. UMIHSA is an active part of the IH program, affecting not only current students, but also new prospective students, alumni, curriculum, and student associations at other universities.
- Graduates of the program have found and continue to find full-time jobs all across the country. Students are securing summer IH positions. These are significant accomplishments during the recently tight job market.

### **Research Training**

All of the IH faculty have established programs and reputations in core areas of IH; principal examples include Dr. Armstrong in areas of ergonomics, Dr. Garrison in ventilation control, Dr. Levine in chemical and management aspects; Dr. Oleinick in regulatory affairs, and Dr. Zellers in chemical aspects. The IH faculty are closely integrated with the Occupational Medicine faculty, who are also well established researchers and educators. Together, the Occupational Health (IH and OM) faculty provide great depth and breadth of experience and research activities. The IH program has continued to develop funded research during the 1990-1995 ERC-funded period. These programs have provided resources for many IH graduate students, with 14 Ph.D.

graduates in 1990-95. The OJOC and on-campus programs have also provided many Master's level research projects during 1990-95. There is a long (over 50-year) and continuing history of publications by IH faculty and students; this research has provided hundreds of papers, with over 100 during the 1990-95 period.

### **Supply and Demand for Graduates**

Very nearly all of our IH graduates go on to careers in occupational health and safety. Masters graduates find (or have, for some OJOC students) IH jobs all over the country, predominately in industry, but also in government and consulting. Doctoral graduates have gone on to prestigious positions in academia, industry, and government. The supply of open IH positions, nationally, has diminished over 1990-95, but it has been and remains sufficient for our graduates to find good jobs. We are very pleased and proud of the IH program success in providing productive IH professionals to help meet world-wide needs and challenges. We believe that the supply of future graduate students and needs for their careers will continue to be strong as the IH program moves beyond 1995.

## Occupational Health Nursing

The Occupational Health Nursing Master's Degree Program first received NIOSH support in January, 1987 and NIOSH support was approved for Ph.D. program students beginning in 1995. One Ph.D. student has been admitted for September, 1995. An on-job (OJOC) on-campus format was implemented for the OHN program beginning in September, 1993, with the first cohort completing the program in June, 1995.

### Major Accomplishments And Changes

Major accomplishments in the OHN program during the five year reporting period include the following:

- Successful implementation of an on-job, on-campus weekend program for OHNs in conjunction with the existing program enrolling students in Occupational Medicine and Industrial Hygiene. Although the program was made available to the first cohort with very short notice, seven OHN students enrolled and five completed the program. There has been considerable interest in enrollment in the next cohort beginning September, 1995, with 18 applications and 10 OHN students accepted for admission (as of August 15, 1995).
- Appointment of Dr. Mary Hogan to a tenure track position in the School of Nursing. Dr. Hogan completed her Ph.D. degree as of April, 1994, and was employed as an assistant professor in the School of Nursing beginning September 1, 1994.
- Dr. Sally Lusk was promoted to full professor, with approval by the Regents in May, 1995.
- The first OHN Ph.D. student was admitted for September, 1995. This student, Judy Morris, is nearly completed with her MS degree earned through the OJOC program. She conducted an original and independent research study for her master's thesis and as soon as she completes the preparation of that report she will be a graduate of the MS program.
- The curriculum for the OHN program has been reviewed and revised by faculty. Courses have been reorganized and revised to reflect current trends in health care and society.
- Dr. Lusk was funded to conduct two new research projects:
  1. Noise effects on cardiovascular and stress-related diseases, UAW-GM, 1993-1995.
  2. Preventing NIHL in construction workers, NIOSH, 1993-1996.

### Research Training

Although the MS degree is not a research degree in the School of Nursing, OHN master's degree students have completed theses as part of their master's program requirements. Typically these have been developed through participation in faculty research projects but nonetheless have made a significant contribution to the field. Topics addressed in these theses include: 1) workers use of hearing protection, 2) psycho-social

and ergonomic stressors for nursing home employees and the effects of worker's noise exposure on blood pressure, pulse, and anger.

As previously indicated, the first Ph.D. student will begin in September, 1995. Her Master's thesis, which is not yet completed, focuses on the problems of temporary workers, a very important topic, with the increase in use of a transitional workforce.

Additional options now available for meeting research project requirements include a research experience, and preparation and submission of a continuing education module or a manuscript for publication. One 1995 graduate met her research project requirement by participating in all phases of Dr. Lusk's research project including data collection, coding, design of interventions, implementation and testing of interventions, and writing of reports. Two students out of the current group selected the option of preparation of modules or manuscripts, and one of these has now completed her paper and submitted it to the AAOHN Journal. This manuscript describes the development and implementation of a return to work program which this student designed for her worksite.

### **Supply and Demand For Graduates**

During the five year reporting period, there have been more requests for our graduates than we have had graduates. We regularly receive telephone calls requesting prepared OHNs for positions in this region, but most of our graduates are continuing in their current positions or have already obtained positions in the field.

## Occupational Medicine

The Occupational Medicine Program in the University of Michigan's Department of Environmental and Industrial Health began in 1941. In addition to a traditional full-time residency, in 1981 a second pathway, the On Job/On Campus (OJOC) program, was added to allow physicians to take their academic training (MPH) toward board certification in a part-time format. Since 1981, the program (both full-time and OJOC pathways) has grown substantially and has maintained a stable enrollment of 20-30 physicians. Our program has produced the largest number of graduates of any Occupational Medicine program in the United States.

### Major Accomplishments and Changes

Major program accomplishments and developments during the five-year reporting period include the following:

- The program has grown and stabilized with a minimum of six residents in the full-time pathway and 15 to 20 residents in the OJOC pathway making it the largest OM residency in the United States.
- We have established a new program, the OJOC practicum pathway, which was accredited by the ACGME in 1993. To date three residents have become board eligible through completion of this pathway. With the addition of this pathway, we are the only program in the US which is able to offer a full-time residency on a non-residential basis.
- We have experienced significant faculty development. Thomas Robins, MD was promoted to Associate Professor with tenure in 1993 and has assumed the Directorship of Occupational Medicine. Alfred Franzblau, MD who was recruited as an Assistant Professor near the beginning of the grant period is under consideration for promotion. We have added eight adjunct faculty members who play key roles in the supervision of our residents in practicum placements and on our Residency Advisory Committee.
- We have added five new courses to the academic curriculum: Occupational Health Aspects of Industrial Operations (EIH 651), Advanced Topics in Occupational Diseases (EIH 691), and a three course sequence in clinical occupational medicine (EIH 711, EIH 712, EIH 713).
- We have substantially expanded our clinical activities and field site rotations for residents in both pathways while greatly increasing the financial stability of the program. We have doubled our number of patients seen by residents under the direct supervision of UM faculty with the opening of the Occupational Medicine Clinic at St. Joseph's Hospital in Ann Arbor in 1993. We have established two new major practicum rotations: one at Auto Alliance (Ford-Mazda) in Flat Rock, Michigan and the other at Dow Corning Company in Midland, Michigan. These two sites provide remuneration to the program enabling us to support a larger number of residents.
- Our faculty have enjoyed increasing national and international recognition. Dr. Garabrant was appointed to the SOH Study Section for the period 1992-96 and is currently the chair. Dr. Robins was awarded a one-year Fulbright Scholarship for his 1993-94 sabbatical activities in South Africa. Dr. Franzblau

has been asked to serve as one of two US representatives on an international commission on ergonomics.

### **Research Training**

Each of our core faculty have been extremely active and productive in research during the grant period. Research funding of OM faculty has grown to \$1.1 million dollars in annual direct costs. Major areas of research interest include occupational cancer epidemiology, musculoskeletal disorders, and occupational asthma and hypersensitivity pneumonitis. All OJOC residents complete a formal Master's research thesis. Both residents and non-physician doctoral candidates participate extensively in research activities under OM faculty supervision. After completing the residency in 1994, Cathy Simpson, MD, MPH has elected to pursue a third year of training in cancer research, under Dr. Garabrant's direction. Dr. Robins has served as the Committee Chair for seven successful doctoral candidates during this period. Dr. Garabrant has served on nine doctoral committees since his arrival at University of Michigan in 1988. Occupational medicine residents' participation in field studies with faculty have led to peer-reviewed publications on topics ranging from breast cancer, to validation of musculoskeletal surveillance, to acute respiratory effects of machining fluid aerosols. Four graduates of the residency are now serving as faculty at other universities.

### **Supply and Demand for Graduates**

The demand for our graduates in the job market during the past five years has far outstripped the supply. Our number of full-time residents is limited by the availability of funding and we turn down several highly qualified applicants each year. Graduates have been actively courted and found desirable positions in hospital-based consultative practices, corporations and academia without difficulty. Our OJOC residents enter the program already holding jobs in our field. A very substantial proportion of our OJOC graduates have been promoted or moved to higher prestige positions upon completion of the program.

## **Occupational Safety Engineering and Ergonomics**

Graduate training in Occupational Safety Engineering and Ergonomics (OSE) has been offered by The University of Michigan's Department of Industrial and Operations Engineering under NIOSH sponsorship since 1971. During this 25-year period, the IOE Department has awarded 187 Masters degrees and 55 Ph.D. degrees to students specializing in OSE. In addition, we have hosted nine post-doctoral fellows who have spent 1-2 years in our laboratories gaining experience and developing skills to pursue research and teaching careers in occupational health and safety.

### **Major Accomplishments and Changes**

Major program accomplishments and developments during the five-year reporting period include the following:

- We have graduated 40 students with Masters degrees. The vast majority of these students have accepted staff safety and health positions in the private sector. A small number of students have accepted positions with government agencies and consulting organizations.
- We have graduated 20 students with Ph.D. degrees. Most of these students have pursued academic careers, either as tenure-track faculty or as research scientists in a university setting. Several students have pursued research careers in the private sector (industrial, insurance, and consulting firms), and a few have entered governmental service as research scientists.
- We have increased our faculty size by one FTE. Dr. Yili Liu joined our faculty in 1991, bringing expertise in cognitive ergonomics, visual displays, and human-machine interaction. With the addition of Professor Liu, we now have six core faculty in OSE (Drs. Keyserling, Chaffin, Herrin, Martin, Miller and Liu). We have five additional tenure-track faculty and research staff (Drs. Armstrong, Green, Kieras, Grant, and Ulin) who participate in teaching and research activities. Finally we have three full-time engineering personnel (Messrs. Foulke, Woolley and Capps) who participate in teaching and research, and provide general technical support. Collectively we have 14 members of our faculty and staff who are actively involved in professional and research training activities in occupational safety and ergonomics.
- We modified existing courses and developed new courses for a net increase of seven courses in our curriculum. New courses were added in the following areas: manufacturing processes (IOE 425 and EIH 707), construction safety and ergonomics (CEE 533), work-related upper extremity disorders (IOE 634), injury control (PHPA 612), human-computer interaction (IOE 591), human performance laboratory (IOE 591), work physiology (IOE 491), and capital budgeting and financial engineering (IOE 452). We now offer a total of 39 courses and seminars in OSE topics.
- We established a new professional degree program, the Master of Engineering (M.Eng.) in Occupational Ergonomics. This 30-credit-hour program emphasizes the application of engineering principles and life sciences to facilitate effective integration of humans into manufacturing and service systems. The M.Eng. degree can be completed within a 12-month period and is intended for students who desire a terminal, professional degree. Admission to the M.Eng. program requires an undergraduate degree in engineering and the equivalence of two years professional work experience. A unique feature of the M.Eng program is that each student must complete a 4-credit

professional project as part of an interdisciplinary team. The M.Eng. degree program was approved as an eligible degree for NIOSH tuition and stipend support during the 1994 competitive renewal site visit.

- Fundamental concepts of ergonomics and occupational safety have been presented to all IOE undergraduate students in IOE 333 and IOE 334 as part of the core curriculum for the B.S. degree. Approximately 100-110 students complete the B.S. degree each year. Of this group approximately 60 students elect additional courses in OSE topics such as IOE 439, "Safety Management".

## **Research Training**

OSE faculty have been successful in obtaining research grants and contracts through both public and private research sponsors. Recently, sponsored research has totaled approximately \$750,000 per year. A considerable fraction of these funds are used to support doctoral students and associated research costs.

As mentioned previously, we graduated 20 Ph.D. students in OSE during the five-year reporting period. Although space does not permit us provide a detailed account of research activities, faculty advisors and doctoral dissertations can be grouped into the following general categories.

- Torso Biomechanics (Dr. Chaffin, 6 dissertations)
- Human Computer Interaction (Drs. Liu and Chaffin, 3 students)
- Upper Extremity Studies (Drs. Armstrong and Martin, 2 students)
- Warning Signs and Systems (Dr. Miller, 2 students)
- Employee participation in safety/ergonomic programs (Drs. Keyserling and Liker, 2 students)
- Protective Clothing (Dr. Keyserling, 1 student)
- Segmental Vibration (Dr. Martin, 1 student)
- Manual Materials Handling Systems (Dr. Chaffin, 1 student)
- Design of Seated Workstations (Dr. Keyserling, 1 student)
- Computer-aided Management of Occ. Safety and Health records (Dr. Herrin, 1 student)

All of our Ph.D. graduates are currently employed in research, teaching, and/or consulting positions in the academic, government, and private sectors.

We have also hosted four post-doctoral research fellows during the five-year period. Dr. Brian Buchholz completed a one-year fellowship in upper extremity biomechanics after receiving his Ph.D. in Bioengineering from U of M. He is now a faculty member in the Work Environment Dept. at The University of Massachusetts at Lowell. Dr. Mary Ann Holbein, a Ph.D. in Industrial Engineering from the University of Pittsburgh recently completed a one-year fellowship in body stability biomechanics. She is now a faculty member in the Physical Therapy Department at Slippery Rock University. Dr. Sheryl Ulin completed a two-year research fellowship. She is now full-time researcher with the U of M Center for Ergonomics, specializing in upper extremity disorders and workplace ergonomic programs. Dr. Christin Grant is presently a part-time research fellow specializing in office ergonomics.

During the past five years, OSE faculty and students have produced almost 300 research papers and presentations for publication in refereed journals, proceedings, book chapters and for presentation at national/international meetings and symposia.

## **Supply and Demand for Graduates**

During the five-year reporting period, the demand for our graduates has substantially exceeded the supply, particularly at the Masters level. The greatest area of demand is for students with expertise in ergonomics who can assume staff positions in occupational health and safety programs in medium-to-large size companies. There is also a strong demand for Masters-level ergonomists in occupational health and safety consulting organizations. Graduates of our doctoral program have also been successful in finding employment. We have, however, noticed a change in employment opportunities for our Ph.D. graduates. At the beginning of the five-year period, there were numerous employment opportunities in full-time, tenure-track faculty positions at universities. The number of these positions has decreased in recent years due to budget constraints at many universities resulting in the imposition of hiring freezes. At the same time, however, positions for Ph.D.s in safety and ergonomics have increased in the private sector providing new opportunities for our graduates.

## **Hazardous Substance Academic Training Program (HSAT)**

The HSAT program was established in 1993 by building on well-developed curricula in the Industrial Hygiene (IH) and Environmental Health Sciences (EHS) programs in the School of Public Health. The curriculum provides a comprehensive and solid grounding in the principles and applications of occupational safety and health for professionals in or entering the hazardous substance work force. HSAT graduates meet Industrial Hygiene Program requirements, and are expected to become Certified Industrial Hygienists and to provide competency and leadership in protecting people in the workplace. Receiving additional training in the environmental health and hazardous substances areas, HSAT graduates meet needs for public health professionals specializing in worker and community protection, risk assessment and management, pollution prevention, and regulatory compliance. HSAT trainees fulfill a documented need in the diverse and growing hazardous substances field.

The HSAT program priorities have been and remain: trainee recruiting and support; course and program development; and evaluation. To date, the HSAT program has supported nine trainees, five of whom have graduated and are working in the hazardous substances area. The program has emphasized master's level training, however, trainees may pursue doctoral degrees in the Department of Environmental and Industrial Health.

### **Major Accomplishments and Changes**

Major program accomplishments and developments during the reporting period include the following:

- Promotion of two key faculty: E. Zellers and S. Batterman (Program Director), both to Associate Professor with tenure.
- Recruitment of two new faculty members in the Department who are directly involved with the program: Assistant Professor of D. Hamby started September 1994 and has interests in hazardous substances (including mixed wastes), dose assessment, Superfund, health risk assessment, and environmental compliance. Associate Professor J. Nriagu started June 1994 and has interests in environmental chemistry, risk assessment, environmental equity, and community based public health. In addition, recruitment has been initiated for an additional faculty member to be shared between Industrial Hygiene and Environmental Health with interests in exposure assessment and biomonitoring.
- Representation on the ERC's Advisory Committee by individuals distinguished in the hazardous substances area, i.e., Dr. Fred Halvorsen of OH Materials Corporation in Findlay, OH, and Rodney Turpin, M.S, Chief of the Safety and Air Surveillance Section at the US EPA National Environmental Response Team.
- Recruitment, support and successful placement of nine MS students in internships and permanent positions related to the hazardous substance field. Several trainees have had among the best academic records of students in the entire School. Support and recognition for trainees has included awards, scholarships, fellowships, and research assistantships from University, government, industrial sources and foundation sources.
- Development and refinement of two new HSAT curricula at the Masters level: (1) an expanded four semester MS program in Industrial Hygiene that includes the equivalent of one semester of specialized course work in hazardous substances management, control, regulations and risk assessment (IH-HSAT option); and (2) a combined MS degree in Industrial Hygiene and Environmental Health Sciences that satisfies both program requirements (IH-EHS-HSAT option). The latter option provides additional coverage of sampling, monitoring, assessment and other environmental health topics related to hazardous substances and hazardous waste. The two options provide

flexibility in developing technical and non-technical skills that complement trainees' background and interests. Both curricula assure that graduates attain specific exit competencies in industrial hygiene and hazardous substances. While master's level training is emphasized, trainees may pursue doctoral work in Industrial Hygiene, Environmental Health Sciences, or elsewhere in the School of Public Health.

- Development and significant modifications to courses including: EIH-679, Radiation Risk Evaluation, D. Hamby; EIH-680, Environmental Management of Hazardous Substances, S. Batterman; EIH-681, Environmental Chemistry II, J. Nriagu; EIH-757, Occupational Health Aspects of Industrial Processes, R. Garrison; EIH-764, Industrial Hygiene Clinical Practicum, E. Zellers; EIH-776, Managing Health Risks, B. Chin; H-576, Evaluating, Managing, and Communicating Risk Assessments, B. Chin; EIH-869, Doctoral Seminar in Occupational and Environmental Health, E. Zellers, S. Batterman.

### **Research Training**

Although only students completing the combined HSAT-IH/EHS program are required to complete a MS thesis, several students completing the HSAT-IH option have also elected to do the same. Research topics of selected HSAT students include:

- M. Martinko, "Development and Evaluation of an Air Monitoring Exposure Assessment Program Focusing on Benzene"
- J. Greene, "Incorporating Pollution Prevention into Chemistry and Chemical Engineering Curricula: Practice and Evaluation"
- P. Davis, "An Evaluation of Environmental Reporting by the Fortune 50 Companies"
- A. Barnard, "Assessment of Beryllium Exposure at Rocky Flats"

Students are strongly encouraged to publish in professional and scholarly journals, and to present these findings at professional meetings, e.g., A. Barnard has presented his work at the national AIHA meeting and at DOE conferences; and P. Davis has submitted a manuscript to the *Journal of Environmental Management*.

### **Supply and Demand for Graduates**

The need for trained professionals in the hazardous substance field is critical in the region served by the Michigan ERC due to heavy industrialization, historically large use and production of synthetic organic chemicals and petroleum products, and many older and densely populated urban and industrial areas. The demand for our graduates appears to substantially exceed the supply, based on the rapid and easy placement of graduates, and on formal and informal needs assessment activities (including surveys). Areas of greatest demand include: risk assessment, cost containment strategies, safety and health issues related to hazardous substances, and pollution prevention. Most graduates have assumed positions in occupational health and safety programs and environmental quality in medium-to-large size companies, and governmental organizations.

## **Continuing Education and Outreach**

This brief report summarizes the Center's Continuing Education and Outreach (CE&O) activities for the just-completed five-year period from July 1, 1990 through June 30, 1995.

The Center has a centralized CE&O Program which conducts and coordinates continuing education and outreach activities for core occupational health and safety disciplines. The CE&O Program objective is to provide as many high quality programs and activities as our financial and intellectual resources will permit. We strive to provide programs which are of interest to our potential clients and will motivate enrollment.

Over the past five years, the CE&O Program has been staffed by a small, active group of individuals. This group has been stable over the period, allowing relationships to commence and develop with other regional occupational safety and health organizations. Working closely with these other organizations has allowed us to make very efficient use of our personnel resources and leverage the funds provided by NIOSH.

The Center utilized several different needs assessment instruments in each of the past five years. These instruments included course evaluations, surveys at professional conferences, meetings with local occupational health and safety professionals, faculty and staff perceptions, telephone inquiries, attendance levels at offered programs and other informal means. Two formal, mailed surveys were also conducted by the Center. This information was used to ensure that our programs would be valuable to attendees, would be presented in a desired format and would be scheduled at a time when they could be easily attended. We feel we were successful in meeting these needs as evidenced by the large number of attendees at our continuing education programs and the interest in our outreach activities.

The CE&O Program utilized input from an internal advisory committee comprised of the directors of the Michigan ERC's core programs. In addition, a group of external advisors was established in the last five year period. The external advisors represented practicing professionals in the four core disciplines from the state of Michigan and provided valuable course content and potential attendee contact information. This advisory group activity essentially served as an additional needs assessment instrument.

The remainder of this report separately presents highlights of continuing education and outreach activities.

### **Continuing Education**

Over 11,300 people attended 105 Center continuing education programs over the five-year period. Comparing this to the NIOSH minimum requirement of 2,000 attendees (400/year), it is evident that the Center greatly exceeded this benchmark. Factoring in the attendance at each program with each program's duration, the Center provided over 32,400 person-days of training to practicing occupational health and safety professionals

University of Michigan faculty and staff were heavily involved in each program offered. This very active involvement allowed the Center to offer programs distinctly different than anywhere else since the Michigan faculty are willing to share their research and practical findings directly with the attendees. The vast majority of the Center's faculty participated in at least one program per year. The strong and respected Michigan faculty allowed us to annually attract and utilize at least 60 other speakers with special skills and

knowledge to lecture in our programs. The end result was a group of high-quality programs the Center was proud to offer.

All core disciplines were addressed by courses offered. Many of the courses we offered were of interest to several of the disciplines simultaneously. This was particularly true of our ergonomics and musculoskeletal injury related programs, which also were important to many attendees categorized as 'other' professions. Typical 'other' attendees included clinical personnel (such as occupational and physical therapists), engineers, management and labor representatives. Continuing education credits were obtained to meet the core discipline attendee needs as well as the vast majority of the 'other' attendee requirements.

In general, our programs focused on specialized topics (some might be considered advanced topics) of interest to practicing occupational safety and health professionals. Many of our programs were new or radically changed with each offering. This required more course development effort than repeating more traditional courses, but kept our faculty interested in continuing education activities and made the best use of their expertise and our staff resources. Representative topics included: ergonomics (including programs devoted to job analysis, job design, medical treatment and rehabilitation of ergonomics-related injuries and illnesses, hand tool evaluation and design, low back disorders, etc.); bioaerosols; medical evaluation of workers' fitness to work; numerous epidemiology topics; nurse management of violent situations in the workplace; managing occupational eye disorders; state-of-the-art conferences on occupational musculoskeletal disorders; and many others.

Other continuing education highlights included:

- On-going relationships were established and continue between the Center and Michigan state organizations representing occupational physicians, occupational health nurses and industrial hygienists and also a chapter of the National Safety Council. These relationships provided insight into course content development and fostered goodwill between the Michigan ERC and professionals in the community.
- The Center co-sponsored programs with ten of the other thirteen NIOSH ERCs, sharing expertise between ERCs and making needed programs available beyond regional boundaries.
- Three large conferences were held to discuss the state of the art in addressing occupational musculoskeletal injuries and illnesses. These utilized internationally recognized experts as speakers and averaged over 350 attendees.
- A series of successful Industrial Hygiene Review courses were established. These have been conducted twice annually for the last five years and have been well attended.
- The Center utilized the extensive talent, expertise and experience possessed by the Michigan faculty in ergonomics to conduct numerous ergonomics-related programs. These programs are led by Michigan faculty from three of the core disciplines and attract a wide range of attendees.

### Outreach

The Center worked with the Michigan Department of Labor to provide ergonomics training and technical assistance to small Michigan companies. Training programs and services were provided to these companies at little or no charge. Over 30 companies received the benefit of these services affecting hundreds of their workers. In addition, approximately 1000 people were direct recipients of training activities.

A computer conferencing network was established and continues to provide a forum for discussion of ergonomic issues by practicing professionals across the U.S. and Canada. This network, called ErgoNet™, is maintained on a University of Michigan computer and is supported by corporate donations and user contributions. ErgoNet activity continues to increase.

The Center exhibited at both local and national safety and health conferences during each of the past five years. This involved the concerted effort of faculty and staff to promote education and training opportunities to the professional community.

Three computer software packages to evaluate workplace musculoskeletal requirements were maintained and licensed to individual users throughout the period. Over 2500 copies have been licensed to users attempting to reduce the risk of workplace musculoskeletal injuries.

The Center hosted high school and entering college students in a series of tours of Center facilities over the five-year period. This is an on-going effort to expose students to the field of occupational health and safety.

In addition to the projects noted above, the Center performed many activities conducted by individual faculty and staff members. (Detailed listings of these activities are available in the annual ERC progress reports.) Center faculty and staff members made presentations to non-occupational health and safety audiences. They assisted with developing curricula at other academic institutions and also within University of Michigan units not associated with the Michigan ERC. They also provided consultation and technical assistance to a wide range of groups including labor, industry, other academic institutions, trade associations, the legal community, insurance and government.

Notable individual outreach activities included:

- Developing and evaluating hazardous substance training material used for 100,000 non-automotive company United Auto Workers members
- Providing scholar exchange opportunities in occupational medicine, industrial hygiene and safety
- Chairing an ANSI committee to develop a voluntary ergonomics standard for industry
- Participating in local and national radio and television programs as well as the printed press to promote occupational health and safety issues
- Taking leadership and editorial roles in professional organizations and publications
- Fielding thousands of telephone inquires related to occupational health and safety
- Being a resource for other Michigan colleges and universities developing occupational health and safety programs

## Appendix A

### External Advisory Committee to the Michigan ERC

Bess Blake, MSN, RN, COHN  
Safety Manager  
Michigan Bell  
Detroit, MI

Douglas R. Earle, Director  
Bureau of Safety and Regulation  
Michigan Dept. of Labor  
Lansing, MI

Dale Gray  
Manager, Env. Health and Safety  
Ford Motor Company  
Dearborn, MI

Fred Halvorsen, Ph.D.  
Vice President, Health and Safety  
OHM Corporation  
Findlay, OH

Franklin Mirer, Ph.D.  
Director, Health and Safety Dept.  
United Auto Workers  
Detroit, MI

Gene X. Kortsha  
Director (retired) of Industrial Hygiene  
General Motors Corporation  
Utica, MI

Richard Kowalski, RN, MSA, COHN  
General Supervisor, Medical Dept.  
General Motors Corporation  
Saginaw, MI

Philip Schull, CSP  
Safety Director  
E-Systems  
Dallas, TX

Paul Adams, Ph.D., CSP  
Corporate Ergonomics Manager  
Owens- Corning Fiberglas  
Toledo, OH

John Triebwasser, M.D.  
Director of Occupational Health and  
Safety  
Ford Motor Company  
Dearborn, MI

Rod Turpin, Chief  
Safety and Air Surveillance Section  
Environmental Protection Agency  
Edison, NJ

Flint Watt, Chief  
Environmental and Industrial Health  
Michigan Dept. of Public Health  
Lansing, MI

Robert Wiencek, MD, MPH  
General Director (retired)  
Occupational Health and Safety  
General Motors Corporation  
Detroit, MI

## Appendix B

### Michigan Educational Resource Center: Academic Programs Core Faculty (1990-1995)

#### Industrial Hygiene Program

**Richard P. Garrison, Ph.D.**  
Associate Professor and Program  
Director

**Thomas J. Armstrong, Ph.D.**  
Professor

**Steven P. Levine, Ph.D.**  
Professor

**Arthur O. Oleinick, Ph.D., M.D.**  
Associate Professor

**Edward T. Zellers, Ph.D.**  
Associate Professor

#### Occupational Health Nursing Program

**Sally L. Lusk, Ph.D.**  
Professor and Program Director

**Mary Hogan, Ph.D.**  
Assistant Professor

**Carol Loveland-Cherry, Ph.D.**  
Professor

**Deborah Oakley, Ph.D.**  
Professor

**Barbara Guthrie, Ph.D.**  
Assistant Professor

#### Occupational Medicine Program

**Thomas G. Robins, M.D.**  
Associate Professor and Program  
Director

**David H. Garabrant, M.D.**  
Associate Professor (ERC Director,  
1991-95)

**Alfred Franzblau, M.D.**  
Assistant Professor

#### Part-time OM Faculty

**D. Hincamp, M.D.**  
Visiting Assistant Professor

**J. Albers, M.D.**  
Professor

**S. Berent, Ph.D.**  
Professor

**R. Werner, M.D.**  
Assistant Professor

**J. Saunders, M.D.**  
Adjunct Associate Professor

**J. Andonian, M.D.**  
Adjunct Associate Professor

**R. Cook, M.D.**  
Adjunct Associate Professor

**F. Mirer, Ph.D.**  
Adjunct Associate Professor

**M. Santoro, M.D.**  
Adjunct Assistant Professor

**R. Egedahl, M.D.**  
Adjunct Assistant Professor

**C. Ways, M.D.**  
Adjunct Lecturer

**Occupational Safety  
Engineering and  
Ergonomics Program**

**W. Monroe Keyserling, Ph.D.**  
Associate Professor and Program  
Director (ERC Director 1995-)

**Don B. Chaffin, Ph.D**  
Professor

**Gary D. Herrin, Ph.D.**  
Professor

**James M. Miller, Ph.D.**  
Associate Professor

**Jay Elkerton, Ph.D.\***  
Assistant Professor

**Yili Liu, Ph.D.**  
Assistant Professor

**Bernard J. Martin, Ph.D.**  
Assistant Professor

**James A. Foulke, B.S.**  
Lecturer

**Charles Woolley, M.S.E.**  
Lecturer

\*Resigned from faculty during reporting  
period

**Hazardous Substances  
Academic Training**

**Stuart Batterman, Ph.D.**  
Associate Professor and Program  
Director

**Jerome Nriagu, Ph.D.**  
Associate Professor

**David Hamby, Ph.D.**  
Assistant Professor