DEPARTMENT OF HEALTH & HUMAN SERVICES

Memorandum

Date February 9, 2004

From Principal Engineer, OEP, NIOSH

Subject Final Progress Report for entry into NIOSHTIC2/NTIS for NIOSH Training Grant No. T01 CCT 417979

To Vern P. Anderson, Chief, IRB, EID (C-18)

The enclosed report has been received from the Program Director to document work performed during the specified grant project period. The following information applies to the designated Training Project Grant (TPG):

Title: Occupational Safety and Health Training Grant

Project Director: Gary A. Mirka, Ph.D.
Department of Industrial Engineering
North Carolina State University
Raleigh, NC 27695

Grant No.: T01 CCT 417979

Project Period: 7/1/2000 - 6/30/2003

Please place the report in DIDS and I also recommend it for entry into NIOSHTIC2 and submission to NTIS.

Thanks for your assistance.

John T. Talty

John T. Talty, P.E., DEE

Enclosure

fpr.ncsu

OCCUPATIONAL SAFETY AND HEALTH TRAINING GRANT

July 1, 2000 - June 30, 2003

CDC/NIOSH Training Grant No. T01/CCT417979-03

Program Directors: Carolyn M. Sommerich, PhD and Gary A. Mirka, PhD

North Carolina State University
Department of Industrial Engineering
Raleigh, NC 27695

FINAL PROGRESS REPORT

September 30, 2003

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1 ABSTRACT

This final progress report describes all relevant activities of the NIOSH-funded Training Project Grant in the Department of Industrial Engineering at North Carolina State University during the period of July 1, 2000 through June 30, 2003. Within the Department of Industrial Engineering at North Carolina State University we offer a focused program area of safety and ergonomics. Training grant funds provided by the National Institute for Occupational Safety and Health were used to support students in this safety and ergonomics program option consistent with the goals described in the original application for the training grant. Over the course of this grant, the leadership for the grant changed hands from Dr. Carolyn Sommerich to Dr. Gary Mirka but with no substantive changes in the focus or curriculum for the trainees. Three students have completed the full safety and ergonomics program curriculum, have graduated and have begun careers in occupational safety and health. As a result of the success of this training project grant our safety and ergonomics program has become a component of the North Carolina Occupational Safety and Health Education and Research Center at the University of North Carolina at Chapel Hill. Therefore, we did not seek a renewal of this training project grant and this represents the final report for the grant.

2 SIGNIFICANT FINDINGS

During this project period for this Training Project Grant, three students completed the required coursework as outlined in the Training Project Grant proposal. This coursework included the Applied Practicum in Occupational Safety, a course that had the students work in a local company for the period of one semester. This course afforded them the opportunity to work with the company's safety personnel to address areas of concern in this facility. This was facilitated by a collaboration that we developed with Wendy Laing from the North Carolina State University Industrial Extension Service. This practicum was found, by both the students and the faculty, to be an extremely worthwhile component to the overall education of the trainees. In addition to the coursework and practicum, each of the students conducted an independent research project for their Master's thesis.

In terms of the effects of this Training Project Grant on the safety and ergonomics program area within the Department of Industrial Engineering, the impact of this funding source was substantial. Specifically, at the time that the original proposal was developed, the safety and ergonomics program area was quite heavily slanted towards physical and cognitive ergonomics. As students were recruited to the Training Project Grant, the required safety courses began to be offered regularly and this reinvigorated interest in this program area, both for on-campus and distance education offerings. Over the course of the Training Project Grant, the group of faculty working through the North Carolina Occupational Safety and Health Education and Research Center at The University of North Carolina at Chapel Hill became more aware of our efforts and subsequently asked us to join their center as a program area. We are in the first year of support for this program area and already have four students following the required safety and ergonomics curriculum.

3 REPORT

3.1 OVERVIEW

Traineeships provided through the Training Project Grant Program in Occupational Safety and Ergonomics at North Carolina State University proved valuable, not only in terms of the recruitment and training of the graduate students enrolled in the program, but also in the general reinvigoration of the safety component of our program. The Training Project Grant provided educational opportunities to engineering students interested in pursuing industrial, consulting, or academic careers in occupational safety and ergonomics.

The goal of this program was, and continues to be, to augment the scope, enrollment, and quality of the safety and ergonomics concentration area in the Department of Industrial Engineering. As such the traineeships had a significant impact, both on the students it directly supported, as well as the other students in the program through enhanced support of research and curriculum development. Within the Department of Industrial Engineering, from full-time and adjunct faculty, students are offered courses that cover the spectrum of topics in ergonomics and safety, including occupational biomechanics, occupational safety engineering, systems safety, human factors in systems design, ergonomic performance assessment, environmental factors and human performance, user-centered design, and concentrated readings and research experiences.

3.2 PROGRAM LEADERSHIP AND FACULTY

Over the course of this Training Project Grant the leadership transitioned from Dr. Carolyn Sommerich to Dr. Gary Mirka. This was necessary as Dr. Sommerich relocated from North Carolina State University to The Ohio State University. This transition was a smooth one that took place in the final year of the Training Project Grant. There were no new students recruited to the Training Project Grant in this final year and Dr. Mirka simply guided the existing students through the applied practicum course and advised them through their master's thesis research. Dr. Sommerich did maintain contact with these students throughout this final year and served on several of the thesis committees.

In addition to Drs. Sommerich and Mirka, Dr. David Kaber and Dr. Nelson Couch provided much of the needed leadership in the re-emphasis of safety in the curriculum. Dr. Couch offered IE 741 Occupational Safety and IE 794A Systems Safety multiple times during the project period. Dr. Kaber taught both on-campus and distance education sections of IE 741 Occupational Safety during the project period and, in fact, received internal funding from the College of Engineering for the development of a CD-based version of this course.

Table 1 lists the faculty who participated in this Training Project Grant and their roles. Those individuals who are listed as "Core" faculty either played a direct role in the development and delivery of core coursework or participated in the research activities of the trainees. Those listed as "Adjunct" indicates that they participated in the Training Project Grant through the delivery of courses not required but related to the Training Project Grant objectives or were active in their support of the Training Project Grant

Table 1. Faculty associated with the Training Project Grant program.

Faculty	Core/ Supporting/ Adjunct	Competencies
Carolyn M. Sommerich, PhD -NCSU IE Department -OSU IW&SE Department	Core (Director)	Ergonomics, biomechanics, epidemiology
Gary A. Mirka, PhD -NCSU IE Department	Core	Ergonomics, biomechanics, physiology
David Kaber, PhD -NCSU IE Department	Core	Occupational safety, human factors
Nelson Couch, PhD, CSP, CIH -NCSU IE Department	Core	Occupational safety, systems safety
Hester Lipscomb, PhD -Duke University -NCSU IE Adjunct Faculty	Core	Epidemiology, Occupational Health
Samuel D. Moon, MD, MPH -Duke University -NCSU IE Adjunct Faculty	Adjunct	Occupational medicine, psychosocial work factors
Richard Pearson, PhD -NCSU IE Department	Adjunct	Systems safety, environmental stressors, product liability
Sharolyn Converse, PhD -NCSU Psychology Department -NCSU IE Adjunct Faculty	Adjunct	Industrial and organizational psychology, human error
Michael S. Wogalter, PhD -NCSU Psychology Department	Adjunct	Human factors, warnings, HCI
Katherine W. Klein, PhD -NCSU Psychology Department	Adjunct	Methodology, decision making in the presence of external stressors

3.3 PROGRAM DESCRIPTION

Traineeships in Occupational Safety and Ergonomics were offered to graduate students (MIE (non-thesis) and MS (thesis)) in the Department of Industrial Engineering at NCSU, to provide educational opportunities to engineering students interested in pursuing industrial, consulting, or academic careers in occupational safety and ergonomics, or related areas. Here, faculty and student research continues to address several NORA Priority Research Areas, including Disease and Injury (Low Back Disorders and Musculoskeletal Disorders of the Upper Extremities); Work Environment and Workforce (Emerging Technologies, Organization of Work, and Special Populations at Risk); and Research Tools and Approaches (Exposure Assessment Methods, Intervention Effectiveness Research, and Risk Assessment Methods).

Safety and ergonomics is one of four areas of concentration within the Department of Industrial Engineering. This topic area has received significant support from the Department of Industrial Engineering, the College of Engineering, and North Carolina State University during the past decades, which has resulted in the hiring of three new ergonomics faculty members, an increase of seven new courses available to graduate students (and six more revised courses), over 2500 sq. ft of lab space, and over $150,000 worth of new research equipment.

The goal of the Training Project Grant was to augment the scope, enrollment, and quality of the department's safety and ergonomics concentration area. As such the traineeships had a significant impact, both on the students it directly supports, as well as the other students in the program through enhanced support of research and curriculum development. Within the department students are offered courses, from full-time and adjunct faculty, that cover the spectrum of topics in ergonomics and safety, including occupational biomechanics, occupational safety engineering, systems safety, human factors in systems design, ergonomic performance assessment, environmental factors and human performance, user-centered design, and concentrated readings and research experiences. Relevant courses are also offered through the Department of Psychology and other College of Engineering departments, as well as through other colleges and universities in the area, through existing inter-institutional agreements. Trainees were required to participate in an applied practicum in safety in their final semester of course work. Student research experience occurred through experimental practicum courses, independent thesis research and work on other NIOSH-funded research projects.

3.4 TRAINING CANDIDATES

The trainees in our program are candidates for the Master of Science or the Master of Industrial Engineering degrees within the safety and ergonomics program in the Department of Industrial Engineering. They are admitted competitively based on grade point average, letters of recommendation, and standardized test scores through the normal process used by the department. Once admitted the candidates are reviewed with regard to their interests in safety and ergonomics and the trainee appointments are then awarded. In addition to those directly supported by the Training Project Grant, others following the Training Project Grant curriculum found support in the form of graduate research assistantships and graduate teaching assistantships. Recruitment of appropriate training candidates was accomplished through the

web page of the Department of Industrial Engineering as well as more active recruiting through postings on pertinent internet list-servers. The average number of applicants to the safety and ergonomics program area within the department is about 20 per year. Of these, ten are admitted and two to six find funding and enroll. To date, all students that have been offered the NIOSH traineeship have accepted, and two-thirds have been seen through to the completion of the program. Two students not directly supported by the Training Project Grant have also followed this curriculum through to completion.

3.5 TRAINING FACILITIES AND RESOURCES

Space: The Ergonomics Laboratory is composed of four separate laboratory facilities: a heavy industrial ergonomics space (Riddick Room 337), a space to investigate light assembly operations (Riddick Labs room 338), an office ergonomics space (Riddick Room 341A) and a computer room (Riddick Room 341B). The dimensions of Riddick 337 are 30' x 26' x 12' which allows for simulating heavy industrial activities such as construction work activities and simulated work on conveyor systems. The office ergonomic space is 21' x 17' x 10' and is adequate for conducting basic office workstation design research. The computing facilities room is 21' x 10' x 10' and houses computers peripherals and the lab library.

Equipment: The Ergonomics Laboratory is equipped with two EMG systems (a 10-channel and a 16 channel), two Bertec force platforms, two cable-based Lumbar Motion Monitors, two telemetry-based Lumbar Motion Monitors, two hand/wrist goniometer systems all of which can be used in either laboratory or field studies. Each of these devices has custom software for the collection and analysis of the data.

The lab is equipped with a hydraulic Kin/Com isokinetic dynamometer that has been modified to interface with a custom-build reference frame for the study of trunk motion. In one configuration it is useful for the study of symmetric and asymmetric lifting motions (in this state it is called the asymmetric reference frame (ARF)) and it can be transfigured to study twisting exertions of the torso (in this configuration it is called the twisting reference frame (TRF)).

The lab also contains a Kin/Com 125E dynamometer for the study of other joints of the body (shoulder, elbow, knee etc.) Each of these dynamometers is a computer controlled apparatus that allows us to precisely control the kinetics and kinematics of motion through the use of custom software that is capable of isometric, isokinetic and constant acceleration motion. This allows us to do detailed EMG analysis as an individual is performing a simulated occupational task. Field data is also collected using handgrip dynamometers

The lab is equipped with two 32-channel A/D converters for collection of transducer data. One of these is portable for collection of field data while the other is dedicated to the laboratory for the collection of EMG and transducer data. The lab is also equipped with four VHS-C camcorders for collection of video data in the field.

The video data collected in the field can be processed in a variety of ways. For those applications that require an analysis of temporal characteristics of the video data, the lab has a computer-controlled video analysis system (OCS Tools system) that can be used to provided frequency and duration information when observing work from the field. There are eight desktop PCs for data collection, analysis, modeling and manuscript preparation that are connected through ISDN ports to the university mainframe for access to university-held software, email and the World Wide Web. There are also two laptop computers for portable data collection, analysis, modeling and manuscript preparation.

Software: The operating systems that are used in the laboratory include Windows XP, and Windows 2000. We generally use the MS Office suite for spreadsheet, word processing and presentation development. Most of the data analysis software was developed in house by the faculty and graduate students in Borland C++ or QBasic. The SAS statistical software program is on each of the PCs and all of the PCs are connected through a local area network.

Additional facilities: Several other NCSU laboratories are also involved in the work done by the ergonomics faculty. In the IE department they would include The Rapid Prototyping Laboratory and The Systems Laboratory. The Construction Automation and Robotics Laboratory housed in the department of Civil Engineering has worked with the ergonomics research team in the development of ergonomic interventions in the construction industry.

3.6 CURRICULUM

The curriculum of this program has been designed to satisfy the departmental requirements, as well as meet the needs of engineers who wish to assume responsibilities in occupational safety and ergonomics. The department offers three graduate degrees (MIE, MS, and PhD), but for the purposes of this traineeship program, only master's degrees (MIE and MS) were considered. In keeping with department requirements, trainees identified an advisor and developed a Plan of Graduate Work after one semester of course work (9-12 hours). This plan of work requires that the students take courses to gain a breadth in the discipline of industrial engineering as well as take courses in a minor area outside the department. For the students involved in the Training Project Grant program this minor was listed as "inter-disciplinary" and focused on a series of courses in safety.

Safety Minor: To satisfy the safety minor, students selected four courses from the courses (or equivalents) listed below. Courses in italic typeface were required for the trainees.

IE 741: Occupational Safety Engineering (3, F, alternating years)
IE 794A: Systems Safety (3, F, alternating years)
IE 796: Applied Practicum in Occupational Safety & Ergonomics
ENVR 141: Air and Industrial Hygiene (3, F), UNC-CH
ENVR 144: Industrial Toxicology (2, S), UNC-CH
ENVR 147: Occupational Safety (2, F), UNC-CH
ENVR 149: Health Hazards of Industrial Operation (3, S), UNC-CH
MAE 510: Effects of Noise and Vibration (3, F)

MAE 514: Industrial Noise Control (3, S)
EPID 125: Injury as a Public Health Problem (3, F), UNC-CH
EPID 160: Principles of Epidemiology (3, F&S), UNC-CH
EPID 168: Fundamentals of Epidemiology (4, F), UNC-CH
EPID 268: Theory and Quantitative Methods in Epidemiology (4, F), UNC-CH
EPID 276: Occupational Epidemiology (3, S), UNC-CH

Required Applied Practicum in Occupational Safety & Ergonomics: During the final semester of course work all trainees engaged in an applied practicum in a local company. This applied practicum was created for the express purpose of giving trainees an introductory work experience specific to occupational safety and ergonomics. The trainees worked with a safety specialist in the company and prepared a technical report summarizing the work experience and prepared and presented a summary at the work site.

In addition to the safety minor and the applied practicum course, students following this curriculum also were required to enroll in IE 544 - Occupational Biomechanics and IE 740 - Human Factors and Systems Design - two courses that were more ergonomics-focused.

3.7 TRAINEES

During this project period three students were supported in using Training Project Grant funds. One student dropped out after one year of training due to health reasons. Two students were recruited, funded, and completed the program. One student followed the complete Training Project Grant program but was not funded using training grant funds, but instead was funded through a research assistantship. Listed below are the three students that completed the program.

NAME	Entered Program	Completed Program	Degree Received	Employer
Elizabeth Covalla	8/2001	5/2003	MSIE	Zenith Insurance Co.
Karen Noack	8/2001	5/2003	MSIE	Kohler Co.
Sunil Sudhakaran	8/2001	5/2003	MSIE	Ergonomics Center of North Carolina

3.8 CONCLUSIONS

The regional need for safety and ergonomics training remains high. Comments from employers have consistently recommended the combination of safety and ergonomics as a valuable skill set for graduating students. The Training Project Grant just concluded has been effective at developing these skills in the trainees and has also reinvigorated the safety component of our ergonomics and safety area within the Department of Industrial Engineering at North Carolina

State University. As our group continues to meet the needs of industry by producing skilled graduate engineers with a focus on safety and ergonomics we plan to continue to make use of these lessons learned as we begin our training efforts through the North Carolina Occupational Safety and Health Education and Research Center at the University of North Carolina at Chapel Hill.

4 PUBLICATIONS RESULTING FROM TRAINING GRANT

Master's Theses

1 Sudhakaran, Sunil, (2003) "Effect of Personality Type on Performance of an Overhead Task". Thesis Committee: Mirka, G (NCSU), Couch, N (NCSU), Lipscomb, H (Duke U)

2 Noack, Karen, (2003) "College Student Computer Use and Ergonomics", Thesis Committee: Mirka, G (NCSU), Sommerich, C (NCSU/OSU), Couch, N (NCSU)

3 Covalla, Elizabeth, (2003) " Visual Posture Observation Error and Training", Thesis Committee: Mirka, G (NCSU), Sommerich, C (NCSU/OSU), Couch, N (NCSU)