Mahmoud A. Ayoub

Mahmoud A. Ayoub is a professor of industrial engineering at North Carolina State University. Dr. Ayoub teaches and conducts research in ergonomics and occupational safety, areas in which he has published widely. He is a fellow of the Institute of Industrial Engineers (IIE), as well as a member of many professional societies, such as Alpha Pi Mu and Phi Kappa Phi honor societies. Dr. Ayoub is listed in numerous Who's Whos, including *Who's Who in the World*. He is also a member of the North Carolina State University Academy of Outstanding Teachers.

EDUCATION

B.S. Civil Engineering, Cairo University, 1964

M.S. Industrial Engineering, Texas Tech University, 1969
Thesis: *Quantification of Human Motion by Stereogrammetric Techniques*

Ph.D. Industrial Engineering, Texas Tech University, 1971
Dissertation: *A Biomechanical Model for the Upper Extremity Using Optimization Techniques*

PROFESSIONAL EXPERIENCE

North Carolina State University

Professor (1980–Present)
Director, Ergonomics Research Group (1986-1992)
Founding Director, North Carolina Ergonomics Resource Center (1994–1996)
Associate Professor (1975–1980)
Assistant Professor (1971–1975)

University of North Carolina at Chapel Hill

Adjunct Professor (1980–1983)
Adjunct Associate Professor (1975–1980)

Texas Tech University

Visiting Assistant Professor (Summer, 1971)

TEACHING

Dr. Ayoub blends theory with practice, integrating the various facets of industrial engineering knowledge and skills with design for human comfort and well-being. He extends his laboratory beyond the confines of the North Carolina State University campus to encompass North Carolina industries and business concerns.

In 1985, his students voted him *Outstanding Industrial Engineering Faculty*, and in 1987, they selected him a *North Carolina State University Outstanding Teacher*.

Courses

Dr. Ayoub has taught a diverse number of courses in ergonomics, biomechanics, work physiology, safety, engineering economic analysis, and industrial engineering.

Course Evaluations

Selected Comments from Students in ***IE 452: Ergonomics***

> "I thoroughly enjoyed this class! . . . this experience has opened up my awareness to issues in industry today . . . I do feel that I have learned something!"
> "He [Dr. Ayoub] is truly the greatest! He is funny and very personable. I never felt intimidated nor stupid. He helped me learn through thinking. . . .
>
> I am very fortunate to have worked with him this semester and hopefully will have a chance to do so again. . . . very knowledgeable about course matter. Very informative lectures. Left nothing to be misunderstood. Very clear with announcements."
>
> "[I liked best the] instructor's enthusiasm [and] visual aids. . . . I enjoyed the class a lot. The instructor makes the course interesting. I've had classes in the past that should have been enthusiastic but ended up being dull due to a boring instructor."
>
> "He [Dr. Ayoub] kept it interesting, he really cared, [he's] knowledgeable about subject matter from experience." "[I liked best the instructor's] attitude & personality towards teaching"
>
> "Instructor has a ton of real-life experience." "[I liked best the] enthusiasm of the teacher, his love of people and his understanding." "Professor seemed to enjoy the class." "[I liked best about the course] the instructor--[he's] amusing & interesting." "He's [Dr. Ayoub's] funny, keeps class exciting, a genius!" "[Dr. Ayoub's] enthusiastic, knowledgeable, willing to help."
>
> "[I liked best the instructor's] willingness to help & concern for his students." "He [Dr. Ayoub] makes it fun with demonstration. Very willing to help." "Instructor showed great knowledge & excitement towards subject material. He possesses a good attitude & a friendly, but professional atmosphere." "[I liked best] everything, I love ergo."
>
> "[I liked best] Ayoub's jokes. Cool teacher—the funniest." "Very cool teacher." "[I liked best that] I learned about something I never even heard of."

Selected Comments from Students in ***IE 311: Engineering Economics***

> Dr. Ayoub [is] very knowledgeable & enthusiastic." "Dr. Ayoub was wonderful." "He [Dr. Ayoub] was enthusiastic, always in a

good mood. He explained well and was fair." "[Dr. Ayoub is a] nice guy. Learned something useful."

"[Dr. Ayoub is] very helpful, good at making students learn. [His] style of teaching [is] unique. He is a tough instructor but knows what he is talking about." "He [Dr. Ayoub] explained [material] well."

"Dr. Ayoub was a good teacher for this class . . .his strength is definitely in ergonomics."

"Instructor has a likeable demeanor, worked helpful examples in class, and was courteous to students." "Prof. went over material many times; good attitude toward teaching; explained clearly."

"[Dr. Ayoub was] always happy to answer questions, [was] well organized, [and] explained everything well." "Teacher was energetic and I enjoyed his attitude; overall was a good experience." "The instructor was very helpful & understanding & fair." "[Dr. Ayoub was] willing to help students a lot; made himself available, courteous to students."

"The instructor made the course very interesting. Probably the most willing to help of any instructor I ever had!"

"To put it plainly, Ayoub is THE MAN!! He is very comical and makes learning very pleasurable." [I liked best about the instructor that he is] knowledgeable and enthusiastic; [I liked best about the course that it was] challenging." "[Dr. Ayoub used] many examples [and was] always available."

"Instructor made it a joy to come to class."

Selected Comments from Former Students:

"Dr. Ayoub has played an important role in my professional development and career guidance. His personal enthusiasm for ergonomics led me to pursue a career in that field. . . . I firmly believe that it has been his method of educating, sincere efforts to further the field of ergonomics, and his belief in the field that encouraged me to follow this career path. As an instructor, Dr. Ayoub is second to none. His lectures were geared toward practical application of theory. The lectures were backed up with labs that encouraged the student to think about how the topic discussed could be applied to the work-a-day world. Within his lectures one could always sense his concern for the people who worked in conditions which were not ergonomically acceptable, and his passion for correcting those situations."

"Professor Mahmoud Ayoub is without question the most outstanding teacher I have ever had during my university years at Purdue, the University of Missouri, and North Carolina State. Dr. Ayoub is outstanding firstly because he is an incredibly effective teacher. In Ergonomics class, he captures the attention of students with humorous anecdotes of real-life situations that relate theory to the concrete. His classroom presentations and labs are further enriched with slides, professionally designed graphics, case

studies, outlines, supplementary information, videos, and references. When he cannot receive funding for needed equipment, he does not hesitate to supply the items out of his own pocket. . . . His example inspires students to think, question, and find answers, and to treat others with respect along the way."

"(Just remember.....I learned from the best....YOU !)"

"I am genuinely proud and honored to be able to say that I studied with you."

Course Development
In 1999/2000, Dr. Ayoub redesigned Ergonomics (IE452), utilizing multimedia presentations, case studies, digital imaging, video clips, and demos; invested more than $30,000 in the process. Course conversion will be completed in 2001.

Students
Dr. Ayoub has supervised thirty-two students who have earned M.S. and Ph.D. degrees. Many of his students have established themselves as industry leaders, educators, and distinguished researchers.

RESEARCH
In his research, Dr. Ayoub blends engineering, medicine, operations research, and computer science in an integrated approach to study the multifaceted problems typical of ergonomics and societal systems. He has been quite successful in attracting external funding in support of his research programs and has received the top research awards from his major professional societies. His research encompasses three major problem areas: (1) ergonomics of cumulative trauma disorders, (2) safety and risk management, and (3) job design/job restructuring. For each of his research projects, he involved several graduate students and faculty members from within and outside the College of Engineering (NCSU) and the UNC School of Medicine, as well as physicians and industrial engineers from industry. Results and findings of his research programs have been presented to the scientific community through the open literature and via technical reports and monographs that are distributed to many active research groups and centers in the United States and abroad.

"I am both pleased and honored to attest to the outstanding research conducted by Mahmoud A. Ayoub, Ph.D. Dr. Ayoub is a nationally recognized and respected researcher, particularly within the exciting area of ergonomics. His national leadership role in applying ergonomics to the workplace is recognized by countless clinicians and researchers. His research and publications are timely, state-of-the-art, and have improved the medical management of numerous patients."

Journal of Pain Management
Pain Therapy Centers
Greenville, South Carolina

"…I am so impressed with your chapter on CTD. It is the best piece I've read in the area-comprehensive, informative, well documented, practical-a gem!"

Medical School
University of New England

"I saw quite a lot of the modeling situation when I was in the States this summer and of all the modelers, Ayoub was by far the most realistic."

University of Birmingham
England

"The more I see of the work coming out of your University, the more I respect it, and recognize that some of your approaches may have practical use by the safety movement as a whole."

Labor Safety Council of Ontario
Canada

"The articles promised by you at our most enjoyable and informative visit to your office have arrived in good order. The articles contain valuable and pertinent information and shall play a significant part in research and writing currently taking place."

School of Medicine
The University of North Carolina at Chapel Hill

"I have found your contributions to Alexander & Pulat's text, Industrial Ergonomics very valuable. I refer to them quite often."

Industrial Rehabilitation Associates
Massachusetts

"On account of your experience and understanding of the state of ergonomics in USA, we would like to discuss the above mentioned project with you. We would be grateful if we could arrange an appointment at your institution."

Institut Fur Produktionstechnik Und Automatisierung
Stuttgart, Germany

His total ergonomics program for dealing with cumulative trauma disorders at Hanes (Sara Lee) is an exemplary effort that encompassed original research, ergonomics awareness training, and workplace improvements. His work with Hanes has produced impressive results and convinced the industrial world of the values of sound ergonomics. The Hanes program has been copied and implemented by many companies and industrial concerns throughout the United States.

"Thanks for taking the time to address members of Hanes' Advisory Council. You were obviously well equipped to deal with the topic, and the Advisory Council was impressed with the information as well as your presentation style."

Hanes Group

> "Your leadership in implementing our Ergonomics Program is sincerely appreciated, and the momentum you have generated will be of tremendous benefit to our employees."
> Hanes Group

> "We have still had no Carpal Tunnel cases at Airmold, this year."
> W. R. Grace

Dr. Ayoub was instrumental in the creation of the North Carolina Ergonomics Resource Center in 1994. The Center is funded by the state of North Carolina.

Funding

Dr. Ayoub's research activities have been funded by government agencies and industrial concerns:

National Science Foundation, Naval Air Logistics Command, Naval Air Rework Facilities, National Institute for Occupational Safety and Health (NIOSH), National Bureau of Standards

North Carolina Department of Labor, North Carolina Department of Transportation, North Carolina Department of Correction

Reynolds Metals Company, Aluminum Company of America, Northern Telecom, Westinghouse, DuPont (North Carolina, South Carolina, Virginia, Delaware), Sara Lee, Eaton, Rayovac, Allied Fibers, Circuit City Stores, Harriet and Henderson, PCC Airfoil, General Electric, Kentucky Derby Hosiery, Anvil Knitwear (South Carolina)

Publications

Dr. Ayoub's list of publications includes more than eighty papers and technical reports.

Papers published in *Human Factors*, *Ergonomics*, *Applied Ergonomics*, *Industrial Engineering*, *IIE Transactions*, *Occupational Medicine*, *Safety Research*, *Professional Safety*, *Occupational Accidents*, *Pain Management*, *and Ergonomics Reviews*

Six chapters in handbooks on Occupational Safety, Medicine, and Management

Books: *ErgoDigest*, *ErgoExecutive*, *ErgoSupervisor*, *ErgoRight (Software Manual)*
Books (In press):

1. *Ergonomic Diagnosis*
2. *Ergonomic Prescription*
3. *Ergonomic Solution*

A/V Programs: Feelin' Good on the Job (a twenty-five-minute ergonomic training video); Ergonomic Risk Factors (25 minutes)

Specific Research Achievements

1. Preemployment Screening for Physically Demanding Jobs

Dr. Ayoub designed, developed, and implemented an integrated and comprehensive screening program for Reynolds Metals Company.

Sponsor: Reynolds Metals Company, Richmond, Virginia

Role: Principal investigator and research group leader

Time: 1978–1983

Application
Program has been implemented at all plants of the Alumina and Reduction Divisions of Reynolds Metal Company.

Scope
This program comprises a mix of basic research and industrial application. Adapting existing job analysis techniques, the program determines demands and physiological responses of employees and translates the results into practical tests that are administered by medical personnel, enabling physicians and engineers to establish a match between job demands and employees' work capacity. It gave Reynolds an objective method for meeting the regulatory requirements while assuring profitable levels of human performance.

> In response to several complaints in the states of Texas and Washington, EEOC opened an investigation of the Reynolds program, its design, its selection criteria, and its testing protocol. EEOC concluded that Reynolds developed and implemented a valid program that was in compliance with the established guidelines.
>
> Reynolds Metals Company is still successfully using Dr. Ayoub's program, developed some fifteen years ago.

Extension
A program encompassing a combination of (workplace, tool, and job) redesign and screening was implemented for ALCOA's Badin Works, North Carolina.

Time: 1985–1989

Publications
Several papers and reports have been published. The principal publications have appeared in *Industrial Engineering* and as a series in the *Journal of Occupational Medicine.*

Ayoub, M. A. 1976. Optimum design of containers. In *Safety in Manual Materials Handling, ed.* C. B. Drury, DREW (NIOSH) Publication No. 78–185, 139–146.

Ayoub, M. A. 1979. Control of manual materials handling hazards through employee training, selection and placement. North Carolina State University, IE Technical Report.

Ayoub, M. A. 1980. The design and implementation of a preemployment screening program for physically demanding jobs. North Carolina State University, IE Technical Report.

Ayoub, M. A. 1980. Effectiveness of the safest lifting method in controlling occupational back injuries. North Carolina State University, IE Technical Report.

Ayoub, M. A. 1980. The ergonomic approach for the design of preemployment screening and selection programs. *IIE Proceedings, Spring Annual Conference*, 494–498.

Ayoub, M. A. 1980. The manual lifting problem: The illusive solution. American Society of Mechanical Engineers, paper 80-C2/SAF-2.

Ayoub, M. A. 1982. Control of manual lifting hazards, Part I: Training in safety handling. *Journal of Occupational Medicine* 24(7): 573–577.

Ayoub, M. A. 1982. Control of manual lifting hazards, Part II: Job redesign. *Journal of Occupational Medicine* 24(9): 668–676.

Ayoub, M. A. 1982. Control of manual lifting hazards, Part III: Preemployment screening. *Journal of Occupational Medicine* 24(10):751–781.

Ayoub, M. A. 1982. The manual lifting problem: The illusive solution. *Journal of Occupational Accidents* 4:1–23.

Ayoub, M. A. 1982. Preemployment screening programs that match job demands with worker abilities. *Industrial Engineering* 14(3):41–49.

Ayoub, M. A. 1983. Ergonomic design of a preemployment screening program. In *Applied ergonomics: Selected cases and practical issues*, ed. T. Kvalseth, 152–185. Butterworths.

Ayoub, M. A. 1985. Screening and job placement. In *Industrial Ergonomics: A Practitioner's Guide,* ed. D. Alexander and M. Pulat, 250–261. IIE Press.
"I have found your contributions to Alexander & Pulat's text, Industrial Ergonomics, very valuable. I refer to them quite often." Industrial Rehabilitation Associates, Massachusetts

Ayoub, M. A. 1987. Badin ergonomics study: Executive summary. Aluminum Company of America (ALCOA).

Ayoub, M. A., and A. N. Elshafei. 1974. Manual materials handling (lifting): Optimization models for allocation of resources and assessment of human work capacity. North Carolina State University Operations Research Report 94.

Ayoub, M. A., and K. Glenn. 1986. Potroom tool redesign: Analysis and evaluation, Research Report. Aluminum Company of America (ALCOA).

Ayoub, M. A., and J. Green. 1986. A model for potroom job evaluation and restructuring, Research Report. Aluminum Company of America (ALCOA).

Ayoub, M. A., and D. M. Scheltinga. 1990. Job Design: II. Optimum design. In *The Automated Factory Handbook,* ed. D. I. Cleland and B. Bidanda, 472–495. TAB Books.

Ayoub, M. A., and C. L. Smith. 1990. Job design: I. Approaches. In *The Automated Factory Handbook,* ed. D. I. Cleland and B. Bidanda, 459–471. TAB Books.

Ayoub, M. A., M. C. Battigelli, F. S. Schlosser, and P. Swenton-Wall. 1980. Design, testing and implementation of a preemployment screening program for the reduction plants of Reynolds Metals Company, Final Report.

Ayoub, M. A., J. Green, K. Glenn, and M. Tadlock. 1986. Badin ergonomics study: The database. Aluminum Company of America (ALCOA).

Gruver, W. A., M. A. Ayoub, and M. B. Muth. 1979. A model for optimal evaluation of manual lifting tasks. *Journal of Safety Research* 11(2):61–71.

Muth, M. B., M. A. Ayoub, and W. A. Gruver. 1976. A nonlinear programming model for the design and evaluation of lifting tasks. In *Safety in Manual Materials Handling, ed.* C. B. Drury, DREW (NIOSH) Publication No. 78–185, 96–109.

Pearson, R. G., and M. A. Ayoub. 1973. Review of *Methodology in Human Assessment,* ed. by Hashimoto, Kogi, and Grandjean. *Human Factors Bulletin*.

2. Cumulative Trauma Disorders (CTDs)

Dr. Ayoub designed and supervised the implementation of a total and comprehensive ergonomics program at all Hanes plants and facilities in North Carolina, South Carolina, Georgia, and New Mexico.

Sponsor: Sara Lee, Winston-Salem, North Carolina

Role: Principal researcher and consultant

Time: 1981–1986

Scope

Developed a six-point program that includes (1) education, (2) methods improvement, (3) workplace modification, (4) identification of employees at risk, (5) disorder tracking, and (6) rehabilitation. Educational programs involve training of employees, supervisors, and plant industrial engineers to recognize CTDs, understand their causes, and develop effective control measures. Most of the training was delivered through video presentations specifically prepared for this program. All workplaces in more than twenty plants were modified in accordance with specific ergonomic recommendations developed by the ergonomics teams. More than 14,000 employees received ergonomics training. The program was, and continues to be, a major success. At Hanes, the number of new cases reported in 1982 was 80% below the number of cases reported in 1981, and the number of lost days involved with the 1982 cases was 90% lower than those in 1981. Hanes spent in excess of $3,000,000 on ergonomics improvement and health maintenance projects across all its facilities. Many companies

have adapted and implemented CTD control programs patterned after the Hanes approach.

Extension
The architecture and philosophy of the Hanes program were used for developing and implementing CTD ergonomics programs for W. R. Grace, GlaxoWellcome, ROCCO, Mead, and Baxter Health Care, among others.

"We have still had no Carpal Tunnel cases at Airmold, this year." W. R. Grace

A program as comprehensive as that of Hanes was developed for Northern Telecom (NT). Several graduate students worked on various aspects of NT workplaces, tools, and jobs for the purpose of controlling, if not eliminating, the problem of cumulative trauma disorders (CTDs).

> "As anticipated, Thursday afternoon's presentation on "CTD" . . . was cited by many as one of the most valuable sessions. You and Dr. Hadler put on an informative show."
>
> Northern Telecom

> "We at Northern Telecom, and especially those of us in the health and safety field, are proud of our association with you and NCSU and wish you continued success in all your endeavors."

> " . . . Should like very much to have the opportunity to visit your laboratory while I am in the States and talk to you. As both our departments are concerned with research into biomechanics and industrial ergonomics, I should like to learn more of your research."
>
> University of Nottingham
> England

Time: 1986–1990

Additional Implementations: Westinghouse, DuPont, and Anvil (South Carolina)

Major Development: The establishment of the **North Carolina Ergonomics Resource Center** in 1994.

> "I would like to extend our warmest thanks to you and your fine staff for making our visit to Ergonomics Resource Center so valuable-and so pleasant. We had a great time. The center is truly impressive- from the level of technology arrayed there to the quality of your publications. Everything was first rate. It was clear to all of us that all of you have invested tremendous time and talent in the center. It shows."
>
> School of Medicine, University of Maryland

Current Research: ErgoRight ®

ErgoRight, on-line virtual ergonomic consultant, is a computer-based system for developing ergonomic solutions addressing various facets of a job and its workplace.

ErgoRight® is used when the sheer magnitude of a problem involves many variables, increasing the potential for missing the true meaning of what the job

and its workplace portray. Such is the case with the many facets of CTDs and their causes.

ErgoRight makes it easy to:

1. Estimate the CTD risk for one or more jobs using ErgoRisk™. ErgoRight® offers methods to check the consistency as well as the relevancy of the risk estimates.

2. Determine the workplace and job attributes likely to contribute to the development of CTDs using ErgoCause™.

3. Develop an optimum job structure that will minimize the potential for developing CTDs using ErgoTation™.

4. Accommodate persons with specific limitations and characteristics by identifying suitable jobs that would fit their capabilities using ErgoRank™.

5. Define work teams by effecting a match between job stresses and individuals' fitness for work using ErgoMatch™.

6. Manage and monitor the ergonomics of jobs and their workplaces using ErgoDiary™.

7. Define and maintain characteristics of the workforce and maintain OSHA recordable injuries and illnesses using Biography and ErgoLog™.

8. Profile people's fitness for work, their job concerns, and any reported symptoms of CTDs using ErgoFitness™ and ErgoSnapshot™.

9. Develop custom-tailored checklists to conduct special surveys and be able to analyze and profile the responses using ErgoSurvey™.

10. Track and document all costs associated with ergonomics and correlate such costs with OSHA-recordable cumulative traumas and related cases using ErgoCost™ and ErgoLog™.

11. Learn about ergonomics and ergonomic solutions through examples and applications using *RightErgo?* and *Pain at Work*. Surf the Internet directly from ErgoRight® and access suppliers and vendors of ergonomic products and services.

12. ErgoRight gives the option to use its tools and procedures individually or collectively to perform various ergonomic analyses and evaluation. Some tools such as ErgoDiary and Biography are likely to be used frequently to track people and their jobs; some other tools such as ErgoRisk and ErgoCause will be utilized only when the job is changed, modified, or investigated.

Publications

Several design manuals were prepared for various sponsors and clients.

Several presentations were made to various industrial groups and at research meetings, including the IEA meeting in Japan and a symposium at the National Institute of Health, Finland.

Ayoub, M. A. 1975. Occupational biomechanics and human motion analysis, Proceedings of the International Workshop on Voluntary Human Motion, University of Florida, 221–255.

Ayoub, M. A. 1981. Ergonomics evaluation of selected sewing jobs, Hanes knitwear.

Ayoub, M. A. 1982. Tendonitis control program for the apparel industry. IEA`82, The 8th Congress of the International Ergonomics Association, 162–163.

Ayoub, M. A. 1983. Three proposals for workplace/method improvements at Galax: Analysis and evaluation. Hanes (Sara Lee).

Ayoub, M. A. 1985. Physical work. In *Industrial Ergonomics: A Practitioner's Guide*, ed. D. Alexander and M. Pulat, 10–27. IIE Press.

Ayoub, M. A. 1987. Cumulative trauma disorders: A prospective study of six plants. Sara Lee Corporation.

Ayoub, M. A. 1989. Ergonomic deficiencies: I. Pain at work. Ergonomics Research Group, North Carolina State University.

Ayoub, M. A. 1989. Ergonomic deficiencies: II. Probable causes. Ergonomics Research Group, North Carolina State University.

Ayoub, M. A. 1989. Ergonomic deficiencies: III. The root cause. Ergonomics Research Group, North Carolina State University.

Ayoub, M. A. 1989. Ergonomic deficiencies: IV. Corrective measures. Ergonomics Research Group, North Carolina State University.

Ayoub, M. A. 1990. Ergonomic deficiencies: I. Pain at work. *Journal of Occupational Medicine* 32(1):52–57.

Ayoub, M. A. 1990. Ergonomic deficiencies: II. Probable causes. *Journal of Occupational Medicine* 32(2): 131–136.

Ayoub, M. A. 1990. Ergonomic deficiencies: III. The root cause and corrective measures. *Journal of Occupational Medicine* 32(5): 455–460.

"I read with interest your three papers on Ergonomic Deficiencies in the Journal of Occupational Medicine. I found the articles to be concise, readable and very practical."
California Work Diagnostic & Rehabilitation Center

Ayoub, M. A. 1992. Ergonomic improvements: I. Workplace evaluation. Ergonomics Research Group, North Carolina State University.

Ayoub, M. A. 1992. Ergonomic improvements: II. Workplace redesign. Ergonomics Research Group, North Carolina State University.

Ayoub, M. A. 1992. Ergonomic improvements: III. Machine evaluation. Ergonomics Research Group, North Carolina State University.

Ayoub, M. A. 1992. Ergonomic improvements: IV. Machine redesign. Ergonomics Research Group, North Carolina State University.

Ayoub, M. A. 1994. Ergonomics. In *Chronic pain management handbook,* ed. C.D. Tollison, Williams, and Wilkins.

Ayoub, M. A. 1995. ErgoPERFECT. *ErgoTalk*. North Carolina Ergonomics Resource Center.

Ayoub, M. A. 1996. CTDs: Facts, fictions, and fibs. *ErgoTalk.* North Carolina Ergonomics Resource Center.

Ayoub, M. A. 1996. Right-Ergo? *ErgoTalk*, North Carolina Ergonomics Resource Center.

Ayoub, M. A., and M. M. Ayoub. 1970. Stereophotogrammetry in human motion analysis. Proceedings of the American Society of Photogrammetry, 256–285.

Ayoub, M. A., and K. M. Rau. 1986. Expert systems for the diagnosis and control of cumulative trauma disorders. Ergonomics Research Group, North Carolina State University.

Ayoub, M. A., and N. E. Wittels. 1988. Cumulative trauma disorders: I. Overview. Ergonomics Research Group, North Carolina State University.

Ayoub, M. A., and N. E. Wittels. 1988. Cumulative trauma disorders: II. Ergonomic factor. Ergonomics Research Group, North Carolina State University.

Ayoub, M. A., and N. E. Wittels. 1988. Cumulative trauma disorders: III. People and management factors. Ergonomics Research Group, North Carolina State University.

Ayoub, M. A., and N. E. Wittels. 1989. Cumulative trauma disorders. *International Review of Ergonomics* 2:217–272.

Ayoub, M. A., M. M. Ayoub, and J. D. Ramsey. 1971. A stereometric system for measuring human motion. *Human Factors* 12:523–536 (also AD-703873).

Ayoub, M. A., M. M. Ayoub, and A. Walvaker. 1974. A biomechanics model for the upper extremity using optimization techniques. *Human Factors* 16:585–594.

Ayoub, M. A., H. Main, and N. Wittles. 1987. Creedmoor ergonomics: Survey and evaluation. Northern Telecom.

Ayoub, M. A., H. Main, and N. Wittles. 1987. Creedmoor ergonomics: Workplace and tool redesign. Northern Telecom.

Ayoub, M. A., H. Main, and N. Wittles. 1987. Creedmoor ergonomics: Preemployment screening. Northern Telecom.

Burnett, J., and M. A. Ayoub. 1989. Cumulative trauma disorders: I. The problem. *Pain Management* 2(4):196–209.

Burnett, J., and M. A. Ayoub. 1989. Cumulative trauma disorders: II. Assessment of risk. *Pain Management* 2(5): 256–264.

Joines, S., and M. A. Ayoub. 1995. Design for assembly: An ergonomic approach. *Industrial Engineering* 27(1): 42–46.

Khalil, T. M., and M. A. Ayoub. 1976. Applied ergonomics. *Industrial Engineering* 8(4): 26–33.

Product Design/Development
Designed/redesigned several hand tools for sponsors and clients. All designs followed the same research paradigm: (a) ergonomic analysis, (b) design proposals, (c) prototyping, (e) testing and evaluation (both in the laboratory and in the workplace). Four of these tools are commercially available on the open market:

- Skin Stapler, Edward Weck
- Wire Skinner, Northern Telecom
- Wire Stripper, Westinghouse (Westinghouse recommended the design for a patent)
- Screwdriver, Cooper Tools

> "We feel fortunate to have such a distinguished scientist among our family of consultants and look forward to a long-term collaborative effort.
>
> Edward Weck & Company, Inc."

3. Safety and Health

Dr. Ayoub has carried out extensive research in the use of the modeling approach to gain insight into the causative mechanisms of accident and health problems. He has designed and implemented several safety management information systems and accident causation models.

Sponsors: NIOSH, United States Navy, North Carolina Department of Labor, North Carolina Department of Transportation

Role: Principal investigator

Time: 1976–1984

Application
Dr. Ayoub and his associates at North Carolina State University developed a program of instruction that encompasses ten comprehensive courses for the Naval Aviation Logistics Center (NALC). The primary goals of the training program were to (1) utilize quantitative methods (operations research, systems theory, engineering sciences, etc.) for the objective assessment, evaluation, and control of NALC workplace hazards and (2) select among competing alternatives in design, staffing, and other aspects of NALC occupational safety and health programs. The institute, under the direction of Dr. Ayoub, was responsible for training industrial, electrical, and mechanical engineers selected from six naval air rework facilities. More than three hundred engineers took one or more courses over a three-year period.

> "I can only state that I wish we had been one tenth as successful in stimulating research interest and advancing the state-of-the-art in aiding technology at other research facilities, as we were with the efforts directed by Dr. Ayoub."
>
> Navy Personnel Research and Development Center

Department of the Navy

" . . .Like to discuss with you and members of your staff research and education in the field of industrial and occupational safety as well as simulation of the accident process in man-machine systems."

Office of the Labor Counselor
Swedish Embassy
Washington, DC

Publications

Ayoub, M. A. 1973. Occupational safety: The challenge of the seventies. *Southern Engineer*.

Ayoub, M. A. 1974. Biomechanics in occupational safety and health. In *Effectiveness of alternative methods to reduce occupational illness and accidents.* Final Report, NSF C-829, prepared by Westinghouse Behavioral Safety Center, Columbia, Maryland.

Ayoub, M. A. 1975. The problem of occupational safety. *Industrial Engineering* 7 (4):16–23.

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Smillie, R. J., and M. A. Ayoub. 1980. Job performance aids: Evaluation of design alternatives via network simulation. *Ergonomics* 23(4):319–359.

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PRESENTATIONS AND SEMINARS

Dr Ayoub's efforts to train and educate industrial engineers in ergonomics have transcended classroom boundaries and reached the heart of the workplace. He has offered hundreds of ergonomics awareness workshops to thousands of employees, supervisors, managers, and engineers throughout the United States and abroad. He continues to lecture on ergonomics at national and international meetings and seminars offered by diverse professional organizations and groups:

University

University of Florida, University of Miami, Duke University, University of North Carolina at Chapel Hill, University of North Carolina at Greensboro, Georgia Tech, Texas Tech University, University of Petroleum and Minerals (Saudi Arabia), University of Washington

Government

United States Nuclear Regulatory Commission, United States Navy

Medicine

American Medical Association, American Academy of Occupational Medicine, Western Ohio Occupational Medical Association, New York College of Osteopathic Medicine, American Occupational Medical Association, Carolinas Occupational Medical Association, Mason Clinic (Seattle)

> ". . . extend to you many thanks and appreciation for the quality of your discussion. Needless to say, the membership enjoyed your talk and came away from the meeting with new and worthwhile ideas to augment our tasks in the field."
>
> Western Ohio Occupational Medicine Association
> Cincinnati, Ohio

> "We certainly appreciate the time that you took to meet with us and enlighten our staff regarding ergonomics. I know it was a strenuous schedule! Nevertheless our staff was extremely impressed, got new understanding of the complexity of these issues, and expressed a unanimous desire to work with you again in the future."
>
> The Mason Clinic
> Seattle, Washington

> "Your information was very valuable for our health and safety professionals. I believe that you effectively communicated the fact that pain and other impairments will occur when the body is asked to extend beyond its intended range of motion."
>
> Health and Safety
> Northern Telecom
> Nashville, TN

> "I want to express my appreciation for your efforts, not only at the AMA Disability Conference at which you did so magnificently, but also for your extra added effort in coming to Dayton."
>
> AT&T
> Network Systems
> Columbus Ohio

Safety/Health

American Industrial Hygiene Association, The Carolinas Section of American Industrial Hygiene Association, American Society of Safety Engineers, National Safety Congress, North Carolina Colleges and University Safety Association, Association of State OSHA Directors, National Association of Governmental Labor Officials (NAGLO), Virginia Safety Association, Western North Carolina Safety School, North Carolina Meat Processors Association, North Carolina Poultry Processors Association, Crawford and Company, Occupational Safety and Health State Plan Association (OSHSPA), North Carolina Association of Self-Insurers

Textiles

American Apparel Manufacturers Association, American Textiles Institute, American Knitwear Association, Georgia Textile Manufacturers Association, Georgia Industrial Commission, Middle Georgia Manufacturers Association, Courtaulds (England), Carpet and Rug Institute, International Apparel

Research Conference, Hosiery Technology Center, National Hosiery Association

> "Your presentation to our Human Resources group was absolutely outstanding! Don't think I have ever had the number of positive feedbacks on any speaker as I had on you. Our people were impressed and appreciative of your efforts. Your interjection of humor really kept the program interesting."
>
> The Carpet and Rug Institute, Dalton, Georgia

> "As I told you in person, you did an outstanding job, and it was quite evident that your knowledge of the subject, your experience with industrial employees, and your superb presentation maintained the attention of our members, and resulted in a very successful and helpful program."
>
> Georgia Textile Manufacturers Association, Atlanta, Georgia

> "As I told you earlier you came extremely recommended by many professionals in the field of safety. I can hardly wait to meet you in person for I have been told that your combination of knowledge and humor makes an outstanding lecture."
>
> Firestone Tire Co
> Wilson, NC

State Government

North Carolina Division of Health Services, North Carolina Department of Labor, North Carolina Department of Administration, 12th Annual Industrial Relations Seminar

Engineering

American Furniture Manufacturers Association, Institute of Industrial Engineers, Duke Power, H B Maynard and Company, Most Users' Conference, Textiles Industrial Engineers

Other

North Carolina Academy of Trial Lawyers, Chamber of Commerce (Winston-Salem, North Carolina), Chamber of Commerce (Greensboro, North Carolina), Circuit City Stores, National Association Of Railroad Trial Counsel (NARTC), Institute of Business Law

> "I've been told that you gave an excellent presentation on lifting and included information that would certainly be helpful in preventing future on-the-job lifting injuries. Thanks for such an excellent presentation."
>
> General Telephone Company (GTE)

> "Several of my staff heard your delightful presentation at the Workers Compensation Board Function here . . . "
>
> Institute of Graduate Health Sciences,
> Atlanta, Georgia

ERGONOMIC TRAINING

Dr. Ayoub has conducted more than two hundred ergonomics awareness sessions for management and employees of companies:

Hanes Knitwear, Hanes Hosiery, L'eggs, Hanes Printables, BIBB, Burlington Industries, Reynolds, ALCOA, Bali, Mead, W. R. Grace, Northern Telecom, Federal Express, Frito-Lay, Burroughs Wellcome, DuPont, ROCCO, Glaxo, Air Products, Kentucky Derby Hosiery, Anvil Knitwear (South Carolina).

Short Courses

Dr. Ayoub's work with industry is not limited to applied research and problem solving. Rather, he has made a concerted effort to offer ergonomics training to engineers, managers, and employees throughout industry—in the United States and abroad. His training programs have reached thousands of practitioners from many corporations and government agencies:

United States Navy, National Bureau of Standards, American Industrial Hygiene Association, St Augustin's College (Raleigh, NC), American Association of Railroads, Gulf Oil, Institute of Occupational Health (Helsinki, Finland), University of Puerto Rico (Mayagues, Puerto Rico), Western Electric, Hanes Group, BIBB, Texas Tech University, General Foods, Northern Telecom, Mead, DuPont, North Carolina Department Of Labor (OSHA), IBM (Charlotte, North Carolina), Univerity of North Carolina at Greensboro.

> "On behalf of all of us from the Center for Consumer Product Technology at NBS, I would like to thank you for spending the other day with us. Your seminar/tutorial on biomechanical modeling and the discussion which followed have really stimulated our thought process."
>
> National Bureau of Standards
> Washington, DC

> "Your presentations at our Departmental Ergonomics Meeting were very helpful. Your knowledge and ability to communicate well stimulated my interest in developing training materials for our engineering people-designers and management."
>
> E. I. DU PONT DE NEMOURS & COMPANY

PROFESSIONAL ACTIVITIES

Organizational and Committee Memberships

State of North Carolina

Member, Task Force for Development of the State of North Carolina Plan on Accidental and Violent Death and Disability, 1977–1978

North Carolina State University

Presided over and participated in numerous committees on the university and departmental levels:

College of Engineering

Search Committee, Research Committee, ASEE Committee, Scholarship Committee, Open House Committee, Safety Committee, Space Committee

Industrial Engineering Department

Human Performance Task Force; Planning Committee; Public Affairs Committee; Admissions Committee; Industrial Engineering Department Head Search Committee; Personnel Committee; Recognition and Public Affairs Committee; Screening Committee; Advisor, Alpha Pi Mu; Contributor and Editor, *IE Graduate Research Bulletin*; Contributor to on-campus summer program for black and female high school students (1975–1976)

Institute of Industrial Engineers (IIE)
Dr Ayoub served as the Work Measurement and Ergonomics Department editor for the *IIE Transactions*. In 1976, he served as a guest editor for a very successful series on ergonomics and safety published in *Industrial Engineering* for thirteen consecutive issues. In addition, he served on the editorial board of the *International Journal of Occupational Accidents*.

Dr. Ayoub was director of the Ergonomics Division of IIE. He has served the Raleigh Chapter of IIE in different capacities, including program chairman, newsletter editor, and member of the board of directors. He remains very active in IIE through his work with both the Work Measurement and Ergonomics Divisions. He is a frequent speaker at meetings and seminars sponsored by many IIE Chapters in North Carolina.

IIE, director of the Ergonomics Division (1982–1984)
Editorial board, *Journal of Occupational Accidents* (1980–1990)
Guest editor, *Journal of Industrial Engineering* (1975–1976)
Department editor for Work Measurement and Ergonomics, *IIE Transactions* (1984–1988)

Human Factors and Ergonomics Society
Member, ANSI Safety Committee, Textiles
Chair, The Jack A. Kraft Award Committee (1991–1998)
President's Committee on Employment of Handicapped

Reviewer Service

American Institute of Industrial Engineers, National Institute of Occupational Safety and Health, National Science Foundation, Wiley Intersciences, *Journal of Biomechanics*, *Journal of Occupational Medicine*, *Journal of American Industrial Hygiene Association*, *Operations Research*, *Ergonomics*, Indian Institute of Technology, Pennsylvania State University, University of Southern California, Auburn University, Texas A & M University.

Visitor Host

Over the years, several scientists came to North Carolina State University to work and study with Dr. Ayoub. The list includes visitors from Japan, Rumania, Canada, Egypt, Germany, Sweden, and Finland.

Consultant

Dr. Ayoub is frequently sought out as an authority, both as a speaker and as a consultant. His consulting work is almost totally limited to applied research and implementation of his research findings in many private and public organizations:

Government
Manpower Planning and Development (NIOSH), Office of Regulatory Analysis (OSHA), Naval Air Logistics Center (US Navy), North Carolina Department of Labor (OSHA), United States Department of Justice, National Science Foundation

Dr. Ayoub assisted the North Carolina OSHA, from 1989 to 1998, in planning and performing ergonomic assessments of diverse workplaces and business concerns (poultry, meat packing, food processing, distribution centers, textiles, apparel, pharmaceuticals, auto assembly, plastics, health care, insurance, and data entry).

Industry
Westinghouse, DuPont, GE, Gulf Oil, IBM, ITT, TexasGulf, Reynolds Metals, Duke Power, Buehler Products, Murray Ohio, Sangamo-Weston, Research Triangle Institute, American Association of Railroads, Ekol Containers, Sav-a-Stop, Fairchild, ROCCO, Air Products, Southern New England Telephone Co., Burlington Hosiery, Hanes Knitwear, Hanes Group, BIBB, L'eggs, Bali, Hanes-DSD, Sara Lee, Danco (General Mills), Butler Polymet, General Foods, Canadell (Canada), Metal Forge, W. R. Grace, Mead, Courtaulds (England), William Carter Co., Burroughs Wellcome, Edward Weck, Baxter Healthcare, Ciba-Geigy, Glaxo

> " . . . thanking you for your excellent presentation on cumulative trauma disorders of the upper extremity at Burlington Industries. It was very informative and I think accomplished the purpose of generating interest in defining the scope and managing this very important problem."
>
> Medical Services
> Burlington Industries, Inc.

Legal
Weaver, Noland, Anderson (Attorneys at Law, Raleigh, NC); City Attorney (Raleigh, NC); Ogletree, Deakins, Nash, Smoak and Stewart (Attorneys at Law, Greenville, SC); Cofer & Beauchamp (Attorneys at Law, Atlanta, GA); Lavin, Coleman, Finarelli & Gray (Attorneys at Law, Philadelphia, PA); Lord, Bissell & Brook (Chicago, IL); Hall & Evans (Attorneys at Law, Denver, CO); Spence, Ricke & Thurmer (St. Paul, MN); Rooks, Pitts, and Poust (Attorneys at Law, Chicago, IL); DeBank, McDaniel, Heidgred, Holbrook & Anderson (Attorneys At Law, Raleigh, NC); Cowan and Owen (Attorneys & Counselors at Law, Richmond, VA); Teague, Campbell, Conely and Dennis (Attorneys At Law, Raleigh, NC); Gilberg & Kurent (Attorneys at Law, Washington, DC); Knudsen, Berkheimer, Richardson & Endacott (Attorneys at Law, Lincoln, NE; Denver, Colorado); Woods, Rogers & Hazlegrove (Attorneys at Law, Roanoke, VA); Hunton & Williams (Attorneys at Law, Richmond, VA); Office of the Solicitor (US Department of Labor, Kansas City, Missouri)

> "Any attempt to properly thank you for all your effort, time and patience in this matter would certainly fall short of the mark. As you well know, your assistance in this case was absolutely invaluable, and it was a real pleasure working with you."
>
> *Teague, Campell, Conely & Dennis*
> *Raleigh, NC*

"You have been of invaluable assistance on this case. The quality of your work on the case assisted us greatly in obtaining a satisfactory settlement."

Office of the Solicitor, Kansas City

Case Reports (Ergonomic Analysis), Court Documents

1. Shorr v. GM, et al., Raleigh, NC, 1982
2. James Braidman v. Ashland Oil Co., Chicago, IL, 1986
3. Ward v. R. D. Werner Co., Durham, NC, 1988
4. Martin v. Guardite, Inc., Richmond, VA, 1989
5. Haririnia v. Amtrak, Washington, D.C., 1991
6. Soros v. Burlington Northern, Alliance, NB, 1992
7. Bunnell v. Burlington Northern, Alliance, NB, 1993
8. Johnson v. Norfolk and Western, Roanoke, VA, 1994
9. Rush v. Burlington Northern, Denver, CO, 1994
10. Lahm v. Burlington Northern, Omaha, NB, 1995
11. Adkin, et al. v DuPont, Wilmington, DE, 1996
12. Monsoor v. Burlington Northern, Denver, CO, 1997
13. Tillman v. Burlington Northern, St. Louis, MS, 1998
14. Jones v. Amtrak, Washington, D. C., 1998
15. Secretary of Labor v. Hudson Foods (Civil No. SW-97-07-H), 1999

HONORS

Memberships

Fellow, Institute of Industrial Engineers
Academy of Industrial Engineers (Texas Tech University)
Alpha Pi Mu, Phi Kappa Phi

Listed in *Who's Who in Engineering*, *Who's Who in Technology Today*, *Who's Who in the South*, *American Men and Women of Science*, *Who's Who in America*, *Who's Who in the World.*

Teaching

Outstanding Faculty Award, Industrial Engineering, North Carolina State University, 1985
North Carolina State University Outstanding Teacher, 1987

Research

Dr. David Baker Distinguished Research Award, Institute of Industrial Engineers, 1987
Jack Kraft Award for Innovative Research in Human Factors, Human Factors and Ergonomics Society, 1988
Phil Carroll Award for Outstanding Achievement in Work Measurement, Institute of Industrial Engineers, 1980

Service

Through his students, Dr. Ayoub has contributed significantly to industrial engineering—its knowledge and data and its applications to diverse occupations and businesses. North Carolina State University (NCSU)

alumni who benefited from his teaching and research have become the bridge and solid contact between NCSU and industry.

> "As a past director of Safety Research for the National Institute for Occupational Safety and Health, and most recently as Director of the North Carolina Department of Labor's Occupational Safety and Health program, I have had the opportunity to become aware of Dr. Ayoub's research efforts and to have hired some of his students. He is recognized as a national leader in ergonomics, and I believe his major contributions will be that his students will continue to improve work conditions for employees throughout the world."
>
> North Carolina Department of Labor, Raleigh, NC

The establishment of the award-winning North Carolina Ergonomics Resource Center in 1994 is a testament to the quality and effectiveness of his ergonomics prescription for industry.

In 1996, the North Carolina Ergonomics Resource Center was named by the Ford Foundation and Harvard University as one of the top twenty-five innovative government programs in the United States.

MEDIA COVERAGE

Dr. Ayoub is frequently interviewed by the media concerning issues related to ergonomics and cumulative trauma disorders. Stories and reports have appeared in all major newspapers in North Carolina, as well as some coverage in regional and national media.