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NEWSLETTER





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LABORATORY FEATURE

BIOMECHANICS IN THE STATE OF INDIANA, U.S.A. AN HISTORICAL PERSPECTIVE

There are four major universities in the State of Indiana that have biomechanical laboratories. They each are unique and are doing quality research. The request of William E. Morrison, President of ISBS, was to produce an article about Biomechanics at Indiana, revealing a bit of the history and its present activities. Each university will be highlighted briefly and separately.

BALL STATE UNIVERSITY

The Ball State University Biomechanics Laboratory was first established in autumn of 1978, as a Kinesiology instructional laboratory. The Director of the Laboratory and only active faculty research member was Gale Gehlsen. Original equipment included a Locam camera, a Vanguard Analyzer, goniometers, tensiometer, and various home made instruments developed for instructional purposes. First of many publications appeared in 1980 (Angular displacement, strength and flexibility as contributing factors in shin splints. *Research Quarterly*, 51, 1980). Since that time the laboratory has been responsible for over 50 presentations and publications. Although the Laboratory had received several internal grants the first external grants were received from NIH, AARP, NCAA, and Consumer Product Safety Commission.

The Biomechanics Master Degree program was started in 1984. The majority of our graduates have gone on to Doctoral Programs at other Universities.

In 1988, Rafael Bahamonde (Ph.D. from Indiana University) joined the Laboratory Staff. Jennifer Edwards (M.S. Ball State University) joined the Laboratory Staff in 1992. In addition, the Laboratory has had four visiting Professors (one per year) from Korea in the past seven years.

INDIANA STATE UNIVERSITY

The biomechanics laboratory at Indiana State University was established in 1977 under Dr. Stanley Brassie. At that time biomechanics laboratories were in existence at Purdue University, Ball State University and Indiana University under the direction of Dr. Carol Widule (PU), Dr. Gale Gehlsen (BSU), and Dr. John Cooper (IU). Master's and doctoral degrees were granted in the specialization of biomechanics at Purdue and Indiana since the 1970's with Indiana University's program being the largest program enrolling yearly over 20 graduate students to study in the area of sports biomechanics. A Masters degree program in human performance was established in 1970 at Ball State University and in 1983 a Master's degree program in Exercise Science was developed by Dr. Alfred Finch at Indiana State University. Through the evolution of the degree programs in Indiana a unique spirit of cooperation developed with the sharing of equipment technical expertise, graduate student information exchanges in the form of the biannual meetings of the Indiana Inter-Agency Research Council and the yearly meeting of the Midwest Graduate Biomechanics Student Symposium. The later group includes involvement of faculty and students from as far as Ohio, Indiana, Michigan, Wisconsin, Illinois, and Iowa.

The biomechanics laboratory at Indiana State University in 1980, had basic cinematographic analysis capabilities situated on a basement laboratory with a couple of biomechanical studies being conducted yearly. Then in 1983 a digitizer and a research electromyograph was added to the laboratory. A fire in 1984 completely destroyed the laboratory and new 3000 sq. ft. biomechanics laboratory was designed and constructed including a force platform, high speed film analysis equipment, electromyographic equipment, a filming staging area with rubberized floor and a darkroom.

Since the establishment of the present laboratory, studies conducted have examined gait alterations after fatigue, effects of ankle appliances on electrical activity of lower leg, center of pressure alterations while wearing an ankle appliance. Kinetic and kinematic analysis of gait in knee replacement patients (cooperative effort with Ball State University), effects of Trager body treatment on low back muscle relaxation, neural and hypertrophic alterations due to strength training, and relationship of running kinematics to leg strength imbalances.

In 1992, two Ariel Performance Analysis Systems (APAS) were added to the laboratory and currently video analysis, electromyographic and kinetic analysis is being conducted on a prototype that provides variable active traction to patients. Further research is being conducted on industrial ergonomic projects and beta testing on the accuracy of the Ariel Video System.

INDIANA UNIVERSITY

Indiana University's trust into the biomechanical field began in 1966 when John M. Cooper was hired to develop a biomechanical laboratory and to create a doctoral program in human performance. Earlier, Arthur Later-Hammel had a laboratory where some biomechanical research was done, but his investigations were primarily in the motor learning area.

Prior to the early 1960's there were courses in biomechanics as well as some research done and publication, such as books. However,, there were no masters or doctorate programs in this area. The early laboratories had only a few tools and very little equipment.

At the University of Southern California, where Cooper had been previous to coming to Indiana University, some equipment had been acquired. This was done by scouting pawn shops, army and navy surplus stores, accepting discarded equipment from industry, borrowing from laboratories in the city (some were out-right gifts) and other departments in the University and being alert to all possibilities at other universities on a loan or acquisition. Through the years many pieces were built by the instructor and/or his students. Gradually, a fully equipped laboratory with good equipment was the end result.

Many pieces of equipment were given personally, so Cooper was told by the USC officials to take what he desired to Indiana University which he did to a limited degree. After about three years a space for the laboratory was provided along with a limited budget. Earlier, one room was used as a laboratory.

A laboratory often is a reflection of the personality, philosophy and interest of the director. The one at Indiana was no exception. Each student was given the opportunity to investigate a problem that was of interest to him or her. Seldom was research of a cooperative nature done, that is, students working together on a dissertation, yet, most students helped one another.

This concept may create some problems where equipment and subjects aren't available in certain areas. However, every conceivable area from curling to gymnastics was investigated. The director's main interest was in sports; however, students has an interest in movement of children (abled and disabled) and some in senior citizens.

Some means of keeping the current equipment functional and the building of new tools, must be established. This was done by having a small budget to pay the electronics department for their services.

At the present time a laboratory assistant is hired on a permanent basis. Completely renovated laboratory facilities have been accomplished. These included placing other research facilities, such as, motor control, adjacent to the biomechanics laboratory.

There are now fifty or more doctoral graduates from Indiana University teaching and directing laboratory activities in the United States and Canada.

The present director of the laboratory is doing research in 3D photography and in the development of a special computer program. After image data is once acquired, various variables, such as angles and velocities, can be manipulated by the use of a specialized computer program without subjects being present to repeat the action (film data of high jumping was used). Furthermore, the calculations of the resultant joint forces and torques at the shoulder and elbow joints in baseball pitching have been published. These are representative of the quality research being done in the Biomechanics Laboratory.

PURDUE UNIVERSITY

Biomechanics started at Purdue in the spring semester of 1965 when Ruth B. Glassow came as a visiting professor in the Department of Physical Education for Women to assist in developing the new undergraduate and graduate programs in the study of Human Movement. In one brief semester, Ruth established important links with a number of departments and services available on the Purdue campus. Carol Widule succeeded Ruth in the fall of 1965 and found it easy to expand upon the links that Ruth had established.

Those working in the area of kinesiology and biomechanics today take the computer for granted. Prior to 1965, however, all biomechanical computing was done on mechanical calculators. When M. Beck did her dissertation at the University of Wisconsin in 1966 on *The Path of the Center of Gravity During Running in Boys Grades One to Six*, it took her approximately 3 hours to calculate the center of gravity of the body for one frame. Needless to say, the number of frames in the analysis was limited and the calculation of higher order derivatives was not even a consideration.

In 1965, Richard Garrett was on the faculty in the department of mechanical engineering at Purdue and Gladys Garrett had just begun her doctoral study. The collaborative efforts of R. Garrett, G. Garrett and C. Widule, were among the first (along with S. Plagenhoef, *Research Quarterly*, 1966, 1968) in the country to report use of the computer in *Kinesiological Research*. The paper *Computer-Aided Research in Kinesiology* was presented in 1967 at the AAHPER National Convention, in Las Vegas. The paper *Human Movement via Computer Graphics* was presented in 1969 at the AAHPER National Convention in Boston. (copies of both papers appended). Since that time, the computer has been an integral part of all numerical and graphical analyses in kinesiological/biomechanical research around the world. We have moved from mainframe computers with capacities less than our modern day microcomputers, to super computers. The first graduate degree in the area of biomechanics was awarded at Purdue in 1968. Since that time, 40 biomechanical related master's and doctoral degrees have been awarded.

The subject of the research at Purdue has centered around three areas: theoretical modeling, sport biomechanics, and gait patterns of children. We were pioneers in calling attention to the need for error reduction in cinematographic data (Widule & Gossard, Presentations at the 1970 AAHPER National Convention, Seattle and 1971 Third International Seminar on Biomechanics, Rome, Italy, and publication by Widule & Gossard, *Research Quarterly*, 1971). Our research related to modeling was following in 1980 by Patrick and Widule in a presentation at The Biomechanics Symposium at Indiana University on *Digital Filtering of Cinematographic Data*. Since the early 1980's the use of some form of smoothing algorithm has become standard practice in cinematographical biomechanical research. In the sport biomechanics area we have focused primarily on rowing, triple jumping (females), and weight lifting.

The gait pattern of both "normal" and handicapped children has been studied by C. Widule and students as long as biomechanics has been at Purdue. The most significant finding of all those research efforts, I believe, was reported in the 1976 Transactions of the 22nd Annual Orthopaedic Research Society (Widule, DeRosa, and Lindseth, *Procedures for Kinematic Analysis of Gait of Multiple Handicapped Children*). In this study a procedure was reported for determining the efficiency of a gait pattern based on a ratio of the total kinetic energy of a gait cycle to the minimum kinetic energy for the cycle. The ratio was found to be a valid measure of assessing gait differences between normal and handicapped children. With the recent acquisition of an AMTI force plate, our gait research has been extended significantly. Of particular interest is the completion of a master's degree thesis on the *Relationship of Ground Reaction Forces and Lower Extremity Geometry to Post-Surgical Chronic Knee Pain* (Cossette, 1993).

Over the last 28 years of biomechanical teaching and research at Purdue, Carol Widule has been struck by how the computer has been the single most important factor influencing our understanding of the human body as a mechanism for movement. Graduate students as well as undergraduate students have found the computer an essential part of their curricular experiences.

While the computer has served us primarily in the past as a number cruncher, we are now using computers (primarily microcomputers), to play music, show picture--both still and moving, simulate laboratory experiences, show 3-dimensional objects, provide interactive problem solving experiences, and allow us to talk with one another around the world. With this sort of technology at our fingertips, the future holds more emphasis for communication of biomechanical information. Additionally, textbooks will undergo a transformation where we will rely more on CD-ROMs, Photo CDs, and laser disks. Students who are currently learning human anatomy using the computer and video disk are performing as well, and sometimes better than students taught by traditional methods. The new technology is ideally suited for the study of biomechanics, where the content is frequently dynamic.

FELLOWS AND LIFE MEMBERS

Last call for nominees for Fellows and Life Members:

The Awards Committee is making a last call for nominations for Fellows and Life Members. The Awards Committee, chaired by Vice-President, Awards, is composed of the Vice-President of Conferences and Meetings, the Secretary-General, and two other Directors appointed by the Chairperson. After the Awards Committee makes its decision, the names of successful candidates selected for Fellows and Life Members shall be forwarded to the President and the Executive Council in order that announcements may be made at the Annual General Meeting at the University of Massachusetts.

Fellow: A class of membership "reserved for individuals who have made outstanding contributions in biomechanics related to sports over a period of years. Elected by the Executive Council, a Fellow is exempt from payment of annual dues and registration fees for symposia, conferences and seminars of the Society while having all the privileges of membership." (ISBS Constitution)

Life Member: "A special membership category reserved for members who have made outstanding contributions to the Society. Elected by the Executive Council, a life member has all the privileges of membership but does not pay annual dues." (ISBS Constitution)

Names of nominees for Fellow or Life Member, along with credentials and reason for nominating should be sent to:

Dr. Barbara A. Gowitzke
Chair, Awards Committee, I. S. B. S.
123 Woodview Crescent
Ancaster, Ontario, L9G 1E8
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