

Minutes of Second Annual Meeting
on
"Human Subjects for Biomechanical Research."

The meeting was convened by Mr. Arthur E. Hirsch of NHTSA at 9 a.m. on Friday, December 6, 1974, at the University of Michigan Highway Safety Research Institute. Mr. Hirsch indicated that the purposes of the one-day meeting were to bring together, for informal discussion, the researchers who are interested in conducting biomechanical research with human cadavers, to receive reports from the ad-hoc committees which were established in 1973, and to hear informal presentations concerning new testing techniques with cadavers. After outlining the day's agenda, Mr. Hirsch called for committee reports.

Ad-hoc Committee on Future Meetings. Dr. John Melvin, HSRI, reported that 13 responses had been received to his questionnaire about interest in establishing a regular meeting of this group as the third day of the Stapp Conference. Eleven respondents desired an informal workshop (7 wanted 1/2 day, 4 preferred full day) and said they would participate. Opinion was evenly divided on the need for a formal association and formal papers (6 yes, 7 no). Apparently the group finds the informal atmosphere preferable and wants to continue the workshop environment.

Ad-hoc Committee on Laboratory Facilities. Mr. Arthur Hirsch, NHTSA, noted that he also received 13 responses to his questionnaire concerning laboratory facilities for biomechanical research. Eight of the 13 indicate that they have access to cadavers for testing; five have crash sleds. Mr. Hirsch indicated he would enclose a summary of available material with these minutes, but cannot present a comprehensive review of facilities at this time due to the limited number of responses. He will keep the questionnaires on file, so they may be updated or completed as desired.

Ad-hoc Committee on a Statement of Ethics. Dr. R. G. Snyder, HSRI, presented the proposed "Ethical Position on the Use of Human Bodies in Biomechanical Research." This statement (a copy is included with the minutes) was composed by Dr. E. Harris, and is intended to be referenced in papers which report tests conducted with cadavers. It has been submitted to the National Academy of

Sciences for an endorsement which is expected in a few months. A modified version was also submitted to the American Association of Physical Anthropologists, and endorsement is expected in February 1975. After some discussion about the type of statement needed and the timing of its submittal to NAS, Mr. Hirsch indicated that comments on the statement should be sent to him by mid-December. If the consensus of the group favors the statement as presented, the endorsement from NAS will be pursued.

Ad-hoc Committee on Guidelines for the Comparison of Human and Human Analogue Biomechanical Data. Dr. Daniel J. Thomas, NAMRL, presented the report of the five-member committee. The committee met twice, in June and November, for the purpose of developing guidelines (not standards) which could be stated simply and which, if adopted, could enhance comparability of biomechanical data among researchers. The committee did not attempt to generate new material, but rather collated the existing material.

The committee report, which is included with the minutes, discusses five guidelines which are considered to be the minimum requirement for comparability of data bases. Briefly, the guidelines are:

1. Use a right-handed coordinate system;
2. Establish and document a laboratory-fixed coordinate system;
3. Use an anatomically-based subject coordinate system (preferably with applicability across species)
4. Use known relationships between anatomical and instrumentation coordinate systems; and
5. Specify the initial conditions for all four coordinate systems (laboratory, fixture, anatomical and instrumentation).

Dr. Thomas encouraged researchers to begin presenting anatomical coordinate systems for consideration and to include dummies as part of the anatomical system problem.

The subject of the committee continuation was discussed. Dr. Thomas expressed an interest in continuing the committee's work and solicited additional members and comments for the committee.

Dr. Claude Tarriere, Renault-Peugeot, suggested three other areas in which he felt guidelines are needed: transducer characteristics (especially bandpass),

a protocol for characterizing the subject anthropometrically, and a similarity of format for presentation of data.

The subject of one committee vs sub-groups and task forces was discussed. Dr. Thomas argued that the degree of communication required for the "ad-hocracy" type of operation is better accomplished by one operating committee. The group agreed, and the Ad-hoc Committee on Guidelines will be retained, with Dr. Thomas as Chairman.

The Committee reports being complete, the meeting was opened to a series of informal presentations concerning various biomechanics testing problems, programs and techniques.

The first two papers were presented by Dr. Albert King, Wayne State, and Dr. Nabih Alem, HSRI, and addressed the problems associated with measuring angular accelerations using 6 linear accelerometers. The numerical methods used to calculate angular acceleration quickly accumulate errors and the equations "blow up". Dr. King proposed the use of 9 accelerometers in a one triaxial, 3 biaxial configuration. This method allows an algebraic solution (using rather difficult techniques). A laboratory check-out has indicated that the approach is feasible. Details of the nine-accelerometer technique are discussed in Dr. King's report which is included with the minutes.

Pressurization of the cadaver to more closely approximate the living human was the topic of the next two papers. Mr. J.R. Cromack, Southwest Research Institute, discussed a method SRI has developed to pressurize the circulatory system. The technique involves introduction of 30-40 μ polyethylene beads, in a suspension of water and methylalcohol, into the arterial system. The beads are intended to plug arterioles and capillaries to prevent fluid loss while enough normal saline is introduced just prior to the test to achieve diastolic pressure. Two cadavers have been thus tested to date, and the technique has been effective. Subsequent discussion indicated that some laboratories have a problem with fluid loss when pressurizing without attempting to plug the capillary bed, and some do not. The group supported the need for

further investigation in the area.

Dr. Tarriere then discussed pressurization of brain and lungs. He pressurizes the brain just prior to test with a solution which includes India Ink. Post-test examination is enhanced, since the presence of India Ink carbon particles in brain tissue can be indicative of blood vessel rupture. Dr. Tarriere also injects air into the lungs to pressurize the thoracic cavity. Since the amount of air in the lungs is arbitrary, he injects 2 l through a tracheal catheter just prior to testing, allows the thoracic cage to return to equilibrium and inserts a "blow-out" plug in the catheter.

Dr. Weissner, Volkswagen, then showed a film of tests conducted to investigate pain limits in actual auto crashes. Production-model Volkswagen Golfs, equipped with production three-point harnesses, were used in the tests. Ninety-degree vehicle-to-vehicle intersection collisions were staged. Three volunteers drove the striking vehicles, and collision velocities were 25 kph (12 kph BEV) and 35 kph (17 kph, 10 mph BEV). The deceleration profile was a square wave of 10-12g. In all cases, the subjects maintained control of the car and in no test did any subject experience any pain.

The remainder of the papers dealt with testing techniques. Howard Pritz Battelle Columbus, reported a method by which cadavers can simulate pedestrians in auto/pedestrian collisions. An aluminum tubing "exoskeleton" supports the cadaver with 90% of body weight on one leg. Only the initial response to lateral impact is studied in this program and the exoskeleton does not influence that response.

Dr. William Powell, West Virginia University, then described a method their group has developed to apply strain gages to cadaver femurs for an investigation of femoral injury due to knee impact. Two problems encountered were skin excursion, which tended to tear the leads from the gages, and 60 Hz noise, which developed when the tissue was closed over the gage. Both problems were solved by encasing the gage and leads in molded rubber sheeting. Gages are successfully bonded to human bone by sanding the bone and drying with ether, then applying the gage with five times the normal amount of adhesive. Dr. Powell noted that gage linearity

has not been affected by these procedures.

The last paper was presented by Dr. Tarriere. He described a series of tests which compare thoracic deflections obtained from a 6-inch disc impactor and from seat belts, using volunteer subjects and static and dynamic tests with cadavers. Less injury was obtained when preloaded belts and pressurized lungs were employed. Also, for a given deflection, the human volunteers accepted 1.4 times as much force as the cadavers. Also, seat belt loads were found to be more acceptable than disc loads. Discussion revealed that researchers consistently obtain injuries with the flaccid chest that are known to not occur in real life. Pressurizing the lungs for thoracic impact tests may make the cadaver a better surrogate.

The paper presentations were summarized by noting that they pointed out the primary objective of this group-trying to determine when the cadaver is a good model of the living human being and when it is not.

The final item of business was a discussion of new topics to be considered by the group. Dr. Tarriere suggested the group consider a method of standard presentation of injury descriptions. He feels a more detailed scale is needed than that provided by the AIS system. Dr. Tarriere will chair a new ad-hoc sub-committee to address this topic. The sub-committee will work as two half-committees - in Europe and the U.S. The sub-committee topic will include description of cadaver characteristics pre-and post-test. Dr. Melvin and Dr. Snyder, UC San Diego, will work with Dr. Tarriere. Dr. John States will also be included, since he is on a committee of the AMA which is attempting to elaborate on the AIS. Dr. Tarriere indicated he would send out a preliminary report for consideration prior to next year's meeting.

The next meeting of this group will take place after the 19th Stapp Conference on November 19, 1975.

The meeting was adjourned by Mr. Hirsch at 3:10 p.m.

David R. Foust, HSRI
Recorder