

XIII Congress of the
International Society for Photogrammetry
Helsinki, 1976
Commission V
Invited Paper

R. E. HERRON, PH. D.
Baylor College of Medicine
Houston, TX 77025, USA

Biostereometrics '74—A Report

A review of the presented papers.

THE INTERNATIONAL SOCIETY of Photogrammetry Commission V Symposium: "Biostereometrics '74" held in Washington, D.C., September 10-13, 1974, was hosted by the American Society of Photogrammetry in conjunction with the XIV International Congress of Surveyors. The Proceedings published by the ASP contain complete manuscripts of all papers presented at the symposium, except for a few which missed the printer's deadline.* In this report I will summarize the presentations, mention some of the highlights, and make a few personal comments.

For the benefit of readers who are unfamiliar with the term "biostereometrics," perhaps a definition would be helpful. Biostereometrics is *the spatial and spatio-temporal analysis of biological form and function based on principles of analytic geometry*. The primary tools of biostereometrics are stereophotography, holography, interferometry and other three-dimensional form sensing techniques which yield signals, imagery, or other data which can be readily handled by modern stereoplotters, comparators, computers, and related data processing and display devices.

The major components of the symposium were seven technical sessions, an informal forum, and a speaker's luncheon.

Session I on "Biostereometric Systems" opened with a series of welcomes from ISP President, Dr. S.G. Gamble, Commission V President, Dr. H.M. Karara, and the Program Chairman, Dr. R.E. Herron.

In the first paper, Dr. Karara, University of

Illinois, reviewed recent developments in the design of photogrammetric systems for use in biostereometrics. He stressed the need for close cooperation between photogrammetric engineers and biomedical specialists in order to ensure future expansion of the field.

L.F.H. Beard of Addenbrooke's Hospital, Cambridge, England, in a paper co-authored by P.F. Dale, K.B. Atkinson, H.J. Law, and A.R. Elkington, described the design and use of a hand-held stereometric camera which promises to make stereometric analysis more widely accessible for hospital and other clinical use.

Professor J.R. Cuzzi, Baylor College of Medicine, Houston, USA, outlined an automatic system for stereometric analysis based on the possibility of controlling the object, the photographic conditions and the necessary elements of orientation.

Dr. W. Faig, University of New Brunswick, Canada, described an analytical plotter system and derivation of the pertinent equations for precision mapping of a close-range object.

W.J. Iams of Memorial University of Newfoundland, St. Johns, Canada, in a paper co-authored by Dr. John W. Evans, described how a photogrammetric system has been used to monitor interactions of organisms and rock substrate over a three-year period along the Barbados coastline.

Col. M. Kurtz, U.S. Army, read a paper authored by Dr. E.M. Mikhail, Purdue University, USA, concerning the growing potentials of hologrammetry in biostereometrics. Examples involving the use of holograms and holographic stereomodels were described and compared.

G. Voss, Jenoptik, Jena G.m.b.H., German

* Copies are available from ASP Headquarters, 105 North Virginia Avenue, Falls Church, Virginia 22046, USA. The price for ASP members is \$7.50 and for non-members \$12.50.

Democratic Republic, reviewed recent developments in the Jena Instrument System for biostereometrics. Emphasis was placed on the cameras, e.g., the UMK 10/1318, and suggestions for new applications were given.

Session II, presided over by Prof. A. K. Torlegård, Royal Institute of Technology, Stockholm, Sweden, included two further papers on biostereometric systems and six papers on cranio-facial morphology.

Dr. J. Höhle, Wild Heerbrugg Instruments, N.Y., described how the Wild P31, P32 and C40 cameras and widely available aerial mapping instruments can be used for biostereometric purposes.

J.E. Hugg, Baylor College of Medicine, Houston, USA, outlined a procedure for simultaneous recording of front and rear stereopairs of a standing human subject and the associated use of conventional plotting techniques.

I. Newton, University of Newcastle upon Tyne, England, described an investigation of several different techniques of posing the head for studies of facial change. The accuracies of the various systems were reviewed and compared.

Dr. E.J. Lovesey, Royal Air Force, Farnborough, England, described the development of a projected grid (light-slit) system of photogrammetry for use in anthropometric studies such as the measurement of facial form.

A.M. Wright, Hospital for Sick Children, Toronto, Canada, in a paper co-authored by H.U. Lichtenberg and R. Moore, described various uses of stereometric data (including the production of physical models) for planning surgical reconstruction of congenital facial deformities.

K.B. Atkinson, University College, London, in a paper co-authored by I. Newton and B.D.G. Morgan, examined the relationships between prosthesis content and volume determination in a case of breast reconstructive surgery.

I.J. Dowman, University College London, in a paper co-authored by A.R. Elkington, reported on a feasibility study involving the use of photogrammetry to measure glaucoma development in the human retina.

Prof. K. Torlegård, Royal Institute of Technology, Stockholm, in a paper co-authored by C.E.T. Krakau, compared the use of a light-slit method with stereophotogrammetry for measuring volume of a normal optic disc.

Session III, with Dr. V.R. Kratky, National Research Council, Ottawa, Canada, presid-

ing, comprised seven further papers on cranio-facial morphology.

Dr. Bernard Schwartz, Tufts University School of Medicine, Boston, USA, in a paper co-authored by Dr. R.E. Herron and Prof. J.R. Cuzzi, described some of the advantages of using stereometric parameters other than contour maps for quantifying the geometry of the eye and its component structures.

Dr. V.R. Kratky presented a review paper on problems associated with the choice of instrumentation and analytic methods for ophthalmologic applications of photogrammetry.

Dr. G.L. Portney, University of California, Davis, USA, described the use of photogrammetry for measuring three-dimensional changes in the optic nerve head cup in normal and glaucomatous eyes.

Dr. B.E. Cohan, University of Michigan, Ann Arbor, USA, described preliminary results achieved with a system of instrumentation for stereometric analysis in ophthalmology.

Dr. W.W. Bowley, University of Connecticut, Stowe, USA, in a paper co-authored by Drs. C. Burstone, H. A. Koenig and R. Siatkowski, described the use of a laser holographic system and a finite element technique for predicting tooth displacement based on a ten-times-sized model.

Dr. J.E. Bergström, Royal Institute of Technology, Stockholm, in a paper co-authored by Carl-Olaf Jonason, reported on the accuracy of a stereophotogrammetric method involving a stereomicroscope for quantifying gingival topography *in vivo*.

Dr. R.J. Forstrom, University of Minnesota, Minneapolis, USA, in a paper co-authored by F.F. Ahlgren, F.D. Dorman, R.J. Isaacson, T.M. Speidel, and A. Erdman, described a stereo movie system for stereometric measurement of human jaw motion.

Session IV was devoted to spatio-temporal (four-dimensional) studies in biostereometrics. Dr. H. M. Karara, University of Illinois, USA, presided.

V.D. Brandow, University of Illinois, read the paper of Dr. M.I. Bullock, University of Queensland, St. Lucia, Australia, on the use of stereophotogrammetry in a comparative study of three-dimensional spinal and leg movements in foot pedal operations.

Dr. F.G. Lippert, University of Washington, Seattle, USA, in a paper co-authored by Drs. M. Hussain and S.A. Veress, evaluated two photogrammetric approaches, one semi-analytical, the other analytical, for three or four-dimensional measurement of musculo-

skeletal motions. Both medical and engineering aspects were considered.

Prof. J.R. Cuzzi, Baylor College of Medicine, Houston, presented a paper, co-authored by D.V. Goulet and R.E. Herron, describing how a set of stereometric body form and function parameters can be derived from a digital three-dimensional description of human body geometry.

Dr. R. Stowe, Argonne National Laboratories, Chicago, USA, in a paper co-authored by N.A. Frigerio and J.W. Howe, described the use of a stereometric x-ray system for measuring *in vivo* skeletal motions.

B.G. Trenholm, Shriners Hospital for Crippled Children, Winnipeg, Canada, in a paper co-authored by Dr. D.A. Winter and G.D. Reimer, presented the results of using a TV-computer approach to the solution of two spatio-temporal problems in clinical medicine, one relating to left ventricular geometry and the other to human gait kinematics.

Dr. R.E. Herron, Baylor College of Medicine, Houston, in a paper co-authored by Dr. Y.I. Abdel-Aziz, described the development of a simple stereometric sensor, the "contour-graph," for clinical measurement of stump-socket geometry for improving the fit of artificial limbs.

On September 12, the President of ISP's Commission V, Dr. H.M. Karara, and the Chairman of ASP's Close-Range Photogrammetry Committee, Mr. R.F. McGivern, hosted a luncheon at the International Club of Washington in honor of the symposium speakers. The luncheon was co-sponsored by the following companies: H. Dell Foster Company, Galileo Corporation of America, The Kelsh Instrument Division of Danko Arlington, Inc., Kern Instruments, Inc., and Zena Company. The generous contributions of these companies are gratefully acknowledged. We are also indebted to Mr. S. Jack Friedman, Executive Vice President, O.M.I. Corporation of America, who was instrumental in having the club's excellent staff and facilities put at our disposal for this memorable occasion.

Session V, with Professor Hans Greuel, University of Düsseldorf, Federal Republic of Germany, presiding, was devoted to stereometric x-rays. Prof. Greuel, in the opening paper, reviewed some of the theoretical and practical problems associated with stereometric x-ray analysis of the relationship between the child's skull and the mother's pelvic dimensions shortly before delivery. The localization of tumors was also discussed.

Dr. B. Altschuler, Brooks AFB, San Antonio, Texas, in a paper co-authored by R.M. Perry and Dr. M.D. Altschuler, reported on an improved mathematical technique (multiangular laminagraphy) for deriving axial sections, serial cross-sections, serial sagittal sections, and serial frontal sections of anatomical structures.

Prof. T. Oshima, Tokyo University, Japan, presented an overview of recent developments in biostereometrics in Japan, including a wide range of clinical, biological, and industrial applications.

E. Seeger, Stuttgart University, Federal Republic of Germany, in a paper co-authored by M. Arnu, described the Zeiss ST R 1-3 stereocomparator for stereometric x-ray analysis. The historical background of stereometric x-ray analysis was also briefly reviewed.

C-O Jonason, Royal Institute of Technology, Stockholm, in a paper co-authored by K.O. Frykholm and A. Frykholm described the application of a stereometric method for three-dimensional measurement of tooth impressions in criminological investigations.

Prof. J. Kobelin, Miami-Dade Community College, USA, outlined a course for the training of photogrammetric technicians in biostereometrics, architecture, transportation, and other fields.

An informal forum was held on the evening of September 12, with Dr. R.E. Herron presiding (Figure 1). This very informal happening consisted of brief presentations by those with equipment, films, and slide-tape shows to display, promote, or otherwise take advantage of a willingly captive audience. Spokesmen and exhibitors included those named in the composite photograph which accompanies this report and others who escaped the attentions of roving photographer John Hugg. As well as having an opportunity to sample brain-washing in all its international variety, the forum participants generally "let their hair down" and had a forthright, informative, and stimulating exchange, which lasted until the hotel staff demanded that the room be cleared so that they could set up the chairs for next morning's session.

Session VI, with K.B. Atkinson, University College London, presiding, was devoted to studies of body geometry/form.

J. Defier, National Geographical Institute, St. Mandé, France, in a paper co-authored by F. Borel, described an analog photogrammetric method for determining human body surface geometry as an aid to radiation dose planning.

K.B. Atkinson, University College, Lon-



FIG. 1. Participants in the informal session. Clockwise above: Oda explains his equipment to an attendee; Beard, Newton, and Watkins; Beard, Duncan, and Jonason during questions; Lippert and Jonason; Dowman and Karara; Dowman, Herron, and Newton. Clockwise below: Takasaki points out details of his work; Cuzzi, Hohle, and Lichtenberg; Kurtz, Altschuler, Takasaki, and Anderson; Cuzzi and Whittle; Bryson, Mair and Wright; Herron.

don, read a paper submitted by A. Boyde, University College London, and H.F. Ross and W.R. Bucknall, Cartographic Engineering Ltd., Salisbury, England. Two new stereometric plotting instruments designed especially for use with scanning electron microscopic records were described.

Dr. S. Ghosh, The Ohio State University, Columbus, USA, outlined a new procedure for analytical calibration of the scanning electron microscope and reported the results of a sample test at three different magnifications.

Professor P.H. Burke, University of Sheffield, England, described the use of a modified dual—"Multiplex" stereometric camera in a study of normal and abnormal facial morphology and growth of children.

Dr. J.P. Duncan, University of British Columbia, in a paper co-authored by J. Foort and S.G. Mair, outlined a new approach to the physical modeling of human body parts based on an automatic process called "Polyhedral Machining." A silhouette technique, using optical or video recording, was also described.

Prof. Homorodi, Geodetic Institute, Budapest, Hungary, read a paper submitted by Drs. M. Domokos and B. Kismartoni, Technical University, Budapest, Hungary. The paper dealt with the use of a simple stereometric method of recording facial morphology, particularly ear form, in a health survey of mentally handicapped children.

Dr. V. Kratky, National Research Council, Ottawa, Canada, read a paper authored by Dr. G.W.D. Armstrong, Dr. T.J. Blachut, and M.C. van Wijk. The paper described an application of analytical photogrammetry to evaluate the performance of a transverse loading system in surgical correction of scoliosis.

Session VII, with Dr. R.E. Herron, Baylor College of Medicine presiding, included seven further papers on body geometry/form.

Prof. J. Anderson, Kings College, London, in a paper co-authored by A. Short, M. Mutch, and R.D. Grover, described the development and use of a new approach to stereometric measurement of body form based on a pulse-modulated ultra-sonic camera which houses the transmitter, receiver, and associated circuitry.

Dr. M.J. Whittle, NASA, Houston, in a paper co-authored by Dr. R.E. Herron, J.R. Cuzzi, and J.E. Hugg, described recent uses of the Baylor Biostereometric System to monitor the effects of extended space flight on the body form of Skylab astronauts.

Dr. H. Takasaki, Shizuoka University, Japan, described his work in moiré inter-

ferometry as related to biostereometric studies. Theoretical and practical aspects of the method were reviewed.

Dr. J. der Hovanesian, Oakland University, Rochester, Michigan, in a paper co-authored by M. Tafraian described the use of moiré interferometry in corneal, podiatric, biomechanical and other human morphological studies.

R.V. Free, Birmingham, Alabama, outlined further uses of a moiré interferometric method in biostereometrics, with special reference to studies of external spinal geometry.

Dr. R.E. Herron, Baylor College of Medicine, Houston, presented an epilogue which focused on helping the beginner to understand the proceedings of the Biostereometrics '74 Symposium and thanking the speakers, exhibitors, and attendees.

Dr. H.M. Karara, in a brief closing session, thanked everyone for their fine support. The first International Symposium on Biostereometrics was then adjourned.

It is difficult to summarize in a few lines the overall impact of a meeting which ranged so widely as this one. The expressed goal of the symposium was to stimulate improved communications among those already interested in biostereometrics such as researchers, clinicians, designers, instrument manufacturers, and others. In addition, it was hoped that newcomers to biostereometrics would find the presentations and proceedings useful as an introduction to the "state-of-the-art."

Many participants formally and informally expressed satisfaction that the symposium had indeed provided a valuable and altogether too rare opportunity to make friends and discuss mutual interests with far-flung colleagues. Hopefully, many of these contacts will be sustained through the medium of correspondence and exchange of reprints until the next symposium comes around.

The scope and variety of the presentations must have been somewhat overwhelming for newcomers and even for some of the more experienced participants. Yet, the fact that the symposium did not represent a very coherent whole is not surprising, considering that we are dealing with a new field (although the roots of stereometric analysis go back at least five centuries). New sciences develop when theory and technology intersect and, in this instance, new understandings about the mathematical analysis of organic form are "intersecting" with advances in photoptics, electronics, and other modern technologies. The fusion of hardware, software, and theoretical insights from what have traditionally been rather disparate disci-

plines will take time, but the future course seems almost assured (perhaps inevitable).

More specifically, the symposium demonstrated that:

(1) The mathematical strategy of biostereometrics is sound, but the methods must be further refined to make solutions more efficient and cost-effective.

(2) There is no universal "best" method of stereometric sensing. The range of potential applications is so broad and the measurement conditions are so varied that we can expect to see many different techniques and instrumentation systems play important roles in the future.

(3) More objective evaluation of the various approaches to stereometric sensing is needed.

(4) Research which is aimed at better understanding and definition of a problem must be clearly distinguished from the development of clinical tools (aimed at improving hardware or software design). It is generally inappropriate to evaluate one type of study by the standards one would apply to the other.

(5) Communications between exponents of biostereometrics, photogrammetric engineers, physical scientists and manufacturers must be greatly improved. There is still too much "re-inventing of the wheel." Instrument manufacturers could benefit from using a wider knowledge base than in-house and local experts can provide.

(6) Most of us yield too often to an unfortunate ethno-centricity in attributing the sources of relevant literature and ideas, which belies the potential of modern information retrieval systems such as are available in libraries around the world. American writers tend to quote other Americans, the British other British, the Canadians other Canadians, the French other French, the Germans other Germans, Swedes other Swedes, and so on. In the biomedical sciences there should be no national knowledge boundaries.

This writer will continue to do everything possible to remove such boundaries (inadver-

tent or otherwise). By the time of the Helsinki meeting, I hope to complete a supplement to the bibliography on biostereometrics compiled for the 1972 ISP meeting in Ottawa. Anyone interested can obtain a copy of the supplement after the Helsinki meeting by writing to the Biostereometrics Laboratory, Baylor College of Medicine, 1333 Moursund Avenue, Houston, Texas 77025, USA. Contributions of reprints and other pertinent information would be greatly appreciated.

Before concluding this report, I want to express my personal thanks to Dr. H.M. Karara, for his indefatigable and always timely contributions as symposium coordinator; Dr. K. Wong, U.S. Correspondent for ISP Commission V, for yeoman service on the program committee; to V.D. Brandow and J.B. Ihenacho, both from the University of Illinois, for supervising the registration procedures and helping the participants in myriad ways with consistent good humor, and to Jaime R. Cuzzi, John E. Hugg, Sherry Gilleland, Marjorie Gordon, and other staff members of the Biostereometrics Laboratory, Baylor College of Medicine, for assistance too wide-ranging to recount in detail here.

I have not been able to do justice to all the planners, speakers, exhibitors, program assistants, and other participants whose contributions made the symposium what it was. One experienced observer commented that "It was as perfect a symposium as I have ever experienced." This remark reflects the unusual spirit of cooperation and enthusiasm which prevailed among those involved at all stages of the undertaking. It also might help to explain why the program chairman and the planning committee regard their association with this stimulating event as a rare privilege.

Journal Staff

Editor in Chief, *Dr. James B. Case*
 Newsletter Editor, *M. Charlene Gill*
 Advertising Manager, *Wm. E. Harman, Jr.*
 Managing Editor, *Clare C. Case*

Associate Editor, Remote Sensing & Interpretation Division, *Dr. Roger M. Hoffer*

Associate Editor, Photography Division, *Abraham Anson*

Associate Editor, Photogrammetric Surveys, *H. M. Karara*

Cover Editor, *James R. Shepard*

Engineering Reports Editor *Gordon R. Heath*

Chairman of Article Review Board, *Lawrence W. Fritz*

Editorial Consultant, *G. C. Tewinkel*
