Discussion—
Panel on "Stereocompilation"

Chairman Thompson: Some differences of opinion have been expressed in the papers we have heard, and that is what we would like to bring out in the discussion which follows. We will open our discussion by letting the members of the panel have at each other. I think we can begin with Mr. Gruner who has indicated that he has a comment that he would like to bring up now.

Mr. Gruner: I wouldn't want to present myself as the main debater of questions, but I will have to leave very soon and so I trust I may be permitted to lead off. Basically I think the picture that has unfolded before us indicates that the development trends in Europe and America follow in more or less parallel courses. I believe that we could also state that wherever electronics enters into the field of conventional design very probably America is leading, and that pleases us, of course, particularly.

A field of photogrammetric application is moving into the foreground which was not mentioned and that is, namely, the field of map revision. This is particularly apparent in countries that have gone through extensive destruction during World War II and are rapidly building up and had to practically start from scratch. There is hardly any map sheet that would not need revision and therefore the problem arose of how to use existing conventional photogrammetric equipment to perform map revision quickly and economically. Some of the developments using automation and electronic components are particularly pointed at this need.

I would like to mention one other thing that is interesting from the designers' viewpoint. Dr. Bertram mentioned twice the Stereotrigomat which is one of the first stable-base or first-order plotters designed in Jena; one of its design elements is interesting and this could be compared to what we have in our automobiles as power brakes and power steering. The Stereotrigomat is of course a mechanical solution in which levers and straight edges move whenever an x, y, or z-increment is introduced by one means or the other. You know that if you have linkages where the intersecting members intersect at very obtuse angles, a small increment in one of the coordinate directions requires a large movement of one of the members which needs power. If you have to apply the power without assistance, then of course you may have deformations in the linkage and therefore loss of accuracy. A very interesting development is brought into this machine which I call *power assist*. You have a *power assist* in moving the mechanical elements whenever the stress of these elements increases beyond the tolerable level so that it might fit.

May I also refer to Mr. Alster's paper? I believe we have for a long while not heard an authority speak of the actual grass-roots operations in an outfit that has to live from its income and make money, and would have to live up to specifications and to time limits. Therefore I believe such a clear demonstration as we have seen here is extremely interesting. However, I missed one thing and I wish to ask Mr. Alster the question: In describing what the stereocompilers do when they first plot the planimetry and partially edit it, and then start with the hypsometry (as he called it), no mention was made of two things. Hydrography was not mentioned and probably it is being done together with the hypsometry—with the drawing of contours. However, every operator knows that any error in the hypsometry shows up most glaringly where a little creek doesn't coincide just exactly with the turnback of the contour. Then, in the practical side of completing the map sheet the question arises: What is the practical value today of either working on one sheet and compiling all the features, planimetric, hypsometric, and so on, on one sheet, or having rather a color separation right on the mapping table which would of course require reference marks so that several sheets would always fall in proper position over each other? Could you answer this Mr. Alster?

Mr. Alster: I will try. Mr. Gruner, on the hydrography, unless it is flat country and we don't have many contours to compile, we don't attempt to draw the center lines of the streams until after the contours are compiled and then that determines whether or not we should show the center lines of the streams. So actually the hydrography is tied in with the contours and it is done simultaneously. One would be done before the other only when the nature of the topography dictates.

So as you say, it is something that is considered purely on the nature of the topography itself. Many times when we compile the planimetry we will draw all of the streams, center lines, and so forth, but as I say, it is an optional thing with the compiler.

On the second part of the question, our own firm does not do much color separation. We are basically a surveying and mapping firm. We do a lot of field surveys and our primary product is a topographic map. We do a fine-line draft and the scales are anywhere from an inch to 40 feet with 1-foot contours to 400 feet to the inch with 10-foot contours. The latter is the rare part of our work because most of our work is 100 feet per inch with 2-foot contours. We rarely get into a color-separation requirement at those particular scales, so we do it in order to accomplish the end product in a most efficient manner. This is the basic reason we do not have overlays for the various phases of the compilation. That is a peculiarity of our own firm. Other people may have other requirements but our line is principally topographic mapping at that large scale.

Chairman Thompson: I would like to offer the microphone to the other members of our panel. Charlie Theurer, do you have any comment you would like to make?

Mr. Theurer: One of the things that was interesting to me—I used the word *ergonomics* and I had never heard of this word before a few weeks ago—has to do with the interface between the operator and the instrument. Mr. Alster mentioned an operator who would draw the contours and perhaps another specialist who would draw planimetry and so forth. We have found that people working in this business now are given a diversity of work so that they would maintain an interest and so that they would also understand all the features of the map, rather than try to segment it into different operations. Did I misunderstand you when you said that you had specialists who draw planimetry and other men draw contours? Was it a misunderstanding?

Mr. Alster: Yes, I think it was.

Mr. Theurer: I am sorry. But actually we have found that people like to go in the field occasionally and have part of the year in the field to see the conditions as they exist. They then come into the office and spend a percentage of their day only, rather than spend the entire day, on any type instrument, whether it be in a darkroom or a lighted room. They become involved with the necessary computations that are required, and so forth, which makes for happier operators, and people you are able to keep. I am sorry I misunderstood.

Mr. Alster: I think it was a misunderstanding. We don't have people who are trained only to compile planimetry. In fact, there is a little difference in opinion amongst our own personnel on the training of people. There is a great scarcity of trained compilers; we can't find them. So in considering training people, the question comes up: Shall we train people to compile planimetry because it is more difficult for a trainee to learn to handle the plotting of the contours than the plotting of planimetry? We believe that in a very short time we can train one who has stereoscopic perception to draw planimetry. If he just keeps that point of light on the ground and if he has a sense of accuracy, then in a relatively short time he can be producing. But producing what? That is where the difference of opinion comes. Is he a real stereocompiler? Of course not. He is just half a compiler. We have never had anyone compiling who was only able to compile planimetry. We have never resorted to this limited stereocompiler. Our people are well trained and have the ability to do all the phases of the compilation, and it is just a matter of which is done first. I think that some operators may prefer to start right off compiling the contours. None of our people do it that way, but this is just an optional thing. If someone told me that one of my competitor firms has compilers who compile contours first and then follow with planimetric detail, I wouldn't be surprised.

Mr. Welden: I would like to make several observations. First of all I heard Mr. Gruner mention that the analog instruments in a sense are here for a long time, and of course the analog is primarily my business, versus the automated. I felt pretty good for a little bit and then I heard Dr. Bertram say: "Watch out or you are going to be out of business shortly." I would like to direct a question, I think, to Mr. Hopkins, who might shed some light on this. In the stereocompilation phase do you people, or in your experience have you, engrave directly from the manually operated instruments?

Mr. Hopkins: We have to a limited extent. A scribing needle mounted in the pantograph permits us to scribe detail of various kinds. Our practice in doing this, though, has been almost entirely in the direct scribing of contours from the stereomodel. This can be processed in a number of ways. It can be printed onto another manuscript and then fair-scribed later. The product directly from the

plotter is generally too rough to be utilized directly without some further atention.

Mr. Welden: Also, I'd like to ask you another question because you happen to come from the U.S. Geological Survey. In your experience with the StereoImage Alternator (SIA), have you noticed any difference in eye acuity, say the depth of perception ability of a compiler, one who may have been a borderline case with the anaglyphic system? With the SIA system would this have a tendency to improve, or was there no difference at all?

Mr. Hopkins: I don't know that we have any direct evidence of increase in acuity or depth perception as a result of the SIA; however, there is considerable gain in ability to see the detail in the model. You haven't lost the light in the system which has been cut out by the filtering system. Another point, the introduction of the SIA into our operation has coincided very nearly with the introduction of a Visual Care Program in which we are giving clinical examinations and prescription filter spectacles to people using anaglyphic instruments, and prescription clear glasses to people using SIA. I don't think we can really separate this difference.

Dr. Bertram: I have a couple of comments. I am going to step out of my role of automation here and get into an area that I know very little about and that is conventional plotting. I gather that practically all the compilation work in the U.S. is done with a double-projection type plotter. As an engineer who has been around so-called human engineers quite a bit I look at that instrument and think: "What a bore!" I am wondering whether Americans have taken it to heart because it is inexpensive and management therefore likes this or whether they really think that they get more out of their compilers with that instrument. Wouldn't it pay to put a little bit more into the instrument?

Mr. Gruner: I think we are apt to lose sight of the significance of the readability of a map. A good map is really a piece of art. Yes, it has to have an inherent accuracy, for instance, in the delineation of contours. When the human operator, let us say first the conventional land surveyor, produced it, he produced it by measuring a few selected points and interpolating the rest between the points by his ingenuity. The stereo operator does it point by point and therefore produces, as has been recognized for 40 years, a much higher fidelity of the topographic relief, and also a much higher completeness of the presentation. But even that is not enough to make a map a really good map. The cartographer, particularly the European cartographer, prided himself, and still does, in finishing a map and making it a piece of art which really tells you more than just the penciled or colored lines indicate. Even with the best stereo operator the characteristics of the topography, of the underlying tectonic structure, do not show up unless the skilled topographer, or the geographer, or the geologist, adds what needs to be added in order to make this map the really valuable tool that is needed for so many purposes. I remind you that the best maps, that have the greatest usefulness, are being turned out by the Swiss people. You have all seen these beautiful maps, with relief shading and so on, which really are pieces of art. They are effective and really useful to the fullest amount. Any automation can never produce such a product. It will take the human brain, the expert topographer, to transform it into a useful piece of map. There is no doubt about it, when we speak of peace-time mapping to standard specifications, the expert human element in mapmaking cannot be eliminated. This may be totally different for military purposes where speed is the main factor, not economy, and where any map is better than no map. But this does not apply to peacetime mapping, and therefore we should not lose sight of the requirement for producing maps which are really worthy of their meaning, of being pieces of cartography, pieces of art.

Chairman Thompson: Mr. Hopkins, would you like to add to that?

Mr. Hopkins: Not specifically to that, but I would like to add a partial answer to Mr. Gruner's earlier question and then ask him a question. With regard to color separation at the compilation stage, the Geological Survey does practice this to a degree. The usual practice is to separate components of compilation into three basic manuscripts: one with the black or cultural data, one with the brown or contour data, and one with green which is the woodland information. Registration between these sheets is accomplished by three punched holes and snug-fitting studs. These sheets may be stacked up directly on compilation surfaces and kept in registration completely. My question relates to something you said in your talk in which you described some electronic units which would require the attention of the human. In effect, I believe you said every man would be a supervisor. This interests me because it might go a long way toward solving some of our human problems.

Mr. Gruner: What I said, in some other phrasing, was that, unfortunately, Mother Nature doesn't yield too much to automation, by which I meant that there are of course a lot of obstacles to a fully automated map. We have tests that have been run so far and map sheets that have been produced under ideal conditions, but as I said in my paper, "Down to Earth," there is no way of defoliation of forest territory in order to make either the electronically guided correlation or the floating mark of the analog plotter really touch the ground and depict the ground configuration in a geometrically true manner. The stereo operator will have to be a constant supervisor in the normal case of aerial photography which is usually over territories where the greatest need for maps is, the cultivated, built-up areas, where automated procedures must naturally fail. We also find that our human operator fails in many instances. It is very well known that a map drawn by the two eyes of the operator is not correct in instances where foliage covers the ground and that is particularly true in water courses where you always have the densest foliage because of the moisture in the ground. This is where field revision comes in, in order to produce a map which a contractor will accept in terms of the accuracy stipulations which are written into the contract. And so it will remain; with the skilled operator, we can probably achieve a certain degree of correction when experience tells him that the height of the growth is a certain amount. He can hold his floating mark under the roof of the foliage in order to establish something which is reasonably accurate with reference to those portions which are bare where the floating mark can be easily placed on the terrain surface.

Chairman Thompson: At this time we would like to entertain some questions from the floor. If anyone has a question, please proceed to the mike. Just walk right up to it and state your name and organization and we will try to answer. Mr. Tewinkel.

Mr. G. C. Tewinkel (Coast & Geodetic Survey): I just came from the session in the other hall on remote sensing, and also in my association with the journal I keep editing these articles on radar, infrared, color, and remote sensing. Mr. Gruner, it seems to me you are awfully pessimistic, considering the tremendous advances that have been made in the last few years in these things, to say that it never will be done. I think that is awfully pessimistic and I am afraid, if I might venture to say so, that you are being just like the old fellows 25 years ago when they said the Stereoplanigraph wouldn't work. Don't you think maybe you and I are getting a little bit old and are being maybe a little bit unprogressive?

Mr. Gruner: Well, I would have expected you not to put it that strongly. Of course, I have said several times that I am a museum piece, but still I have tried to keep in step with progress and I thought this would have been expressed in the paper that I have read to you. If I had been as bad as you thought, I am sure that paper would read quite differently.

Mr. Tewinkel: I did detect a vast difference between the paper you just read and "Down to Earth." Have you changed your mind in that year and a half?

Mr. Gruner: No, I have not changed my mind. I have been openminded, I have seen the progress that has been made, I have seen moderation in these over-exaggerated claims that we had read in papers in 1966. I do not believe these claims have been voided since I gave the paper; my paper probably wouldn't have that effect. I had very interesting reactions and unexpected reactions. Yes, of course, as I expected, and it was the purpose of the paper, that I would really stir up a storm. I did it on purpose, not because of my old-fashionedness, oh, no! Amazing also was the reaction from the other side of the ocean, and that was consent and applause as I never had expected. We all live in certain spheres of thinking, and yes, as you grow older you stay behind a little in your thinking. But if you apply logic and a little moderation I believe there are a good many things that certainly are over-exaggerated as far as claims are concerned.

I do not say, when I express doubt, that this or that cannot be achieved. I think it would be false to discourage our scientists, in our industries in particular, to pursue certain courses. That would be false because that particular industry needs plenty of encouragement. As you know research and development costs an enormous amount of money and the returns on the investments are rather slow to come; it takes years and years and years. I think you may have misunderstood me when I make statements which may make you doubt whether such things could be possible or not. No, we should try every avenue of development, but rather restrain ourselves in making claims which cannot be justified at this time. Developments are slow in our research laboratories and in some of these advanced instrumentations. As Dr. Bertram

told us, they are going to come and will have a certain application, but the time when Mr. Alster could use them is far, far away. Therefore I dare to repeat what I said in the Lisbon Congress four years ago when some similar claims were made and the prediction was made that our analog instruments are soon going out of the window. I said that may happen in the far future, but the last ones to go will be the direct projection plotters.

Frank Baxter (U. S. Geological Survey): I would like to direct a question to Mr. Hopkins concerning the visual aid program. What types and degree of visual deficiencies have been noted among the compilers in this visual aid program?

Mr. Hopkins: It just so happens I have some statistics on that subject. Really, we have two sets of statistics. Based on 100 clinical examinations of compilers in the Atlantic Region of the Geological Survey we found this: 4 percent of the compilers had near-perfect vision, emmetropia, in other words, no refractive correction needed; 20 percent of the compilers tested suffered myopia (near-sightedness); 60 per cent hyperopia (far-sightedness); 29 percent presbyopia (loss of accommodation due to diminishing elasticity in the eyeball and the lens itself); 77 percent suffered astigmatism; and 77 percent anisometropia (in which each eye enlarges the image or receives the image at a different scale). To extend this a little bit further, a total of 242 compilers have had clinical examinations in the Visual Aid Program in both the Atlantic Region and the Rocky Mountain Region. These statistics relate to age: 25 percent of those tested were less than 36 years old, 47 percent were between 36 and 45, and 28 percent were over 45. Of course, the advancing age is one of the problems that contributes to loss of the really sharp acuity in stereovision which we require in stereocompilers.

Mr. A. C. Stiefel (U. S. Geological Survey, retired): I would just like to add a few comments to Mr. Gruner's with regard to the artistry of topographic maps. I well remember not many years ago when we remapped the Yosemite National Park and the Grand Canyon and we very carefully compared our new stereocompiled maps with those old maps made by such greats as Francois Matthes and Richard Evans. Many of us felt that the artistry of the maps produced by those topographers with their old method of planetable topography had something that the new maps had lost. I feel very much that we should keep in mind the human element both in producing the maps and in reading the maps. After all, we can do a lot of things mechanically but if we get too far away from people we are probably going to be making maps for robots or something like that instead of people. So I hope that we will always keep in mind that a map is an artistic product and will leave some of the artistry in our maps.

Mr. J. W. Halbrook (U. S. Army Engineer Topographic Laboratories): I would like to change the subject slightly. I wonder if there are some panelists who have been engaged, or know of the work that is going on currently in map revision. I am speaking of map revision now as opposed to recompilation. I wonder whether this is still just a stepchild or whether there are some more sophisticated means of plotting than in years past.

Mr. Theurer: A very interesting experiment is going on which I saw demonstrated at the IBM Center in Wheaton, Md. A computer is used, and I don't know exactly which computer it is. The map is displayed on a TV tube; it looks like a 20- or 24-inch TV tube. This application is for updating the magenta overprint on aeronautical charts and it is just one of the overlays of the chart. The radio aids to navigation, the air ways, and this type of information are constantly changing, and this demonstration shows how an operator with an electric pencil is able to move data around on the TV tube. At the same time these data are put on to tape in the computer so that when the display comes back it has had the corrections applied to it. This shows a lot of promise, but I think the line work is still a little bit on the ragged side. They can produce a print from this TV tube, but it is not very artistic. This is the state of the art right at the present time, but it shows great promise.

Mr. Hopkins: I think you have an answer to the sophisticated approach to map revision. Map revision is a tremendous problem insofar as standard quadrangle mapping is concerned. A tremendous backlog of maps need revision. I don't think these are going to wait for the development of sophisticated systems. I guess you could say the Geological Survey is pioneering in a simplified approach to map revision. It is an interim map-revision program in which the revision information is added from aerial photographs by direct monoscopic transfer where possible, or by stereoplotting where it is not possible. This information is all that is added to the map; there is no field check on the revised information. The revised data are printed in a magenta overprint and the whole process is

aimed at getting it done very quickly and as inexpensively as possible to produce the backlog of badly needed revision.

Mr. Welden: Mr. Chairman, I might just add a remark on that. I think the area of map revision is probably one of the areas that has most been overlooked in the past. I really believe the orthophoto is going to have a great impact on map revision with respect to showing planimetric features, vegetation, and other items of this nature.

Mr. Fred Hayes (Army Map Service): I would like to ask Mr. Alster, or one of the representatives of the non-AMS agencies, if in any way you apply quality control to your compilations as they are underway?

Mr. Alster: In a small organization we believe that we know each and every one of our people. I think we know their limitations and their abilities, and nowadays the few people whom we have in our private organization are quite experienced and we don't exercise a check on their work. We know from their record of performance that they have the ability to lay it down on a compilation manuscript so it will meet the accuracy requirements. Whenever we get new personnel and we are not sure of their ability, the exercise of quality control that we use is to have one of the experienced men check behind the inexperienced man until we are absolutely sure that the less-experienced man, so to speak, has the ability to meet the requirements. We don't let him alone until we are sure of it. Now this is how we exercise quality control. We just don't trust them until they prove that they can be trusted. This is a responsibility that we have of course to the clients, but other than that we have cursory checks on the work. We just oversee it. We have editing that is part of a drafting process, and if something is out of line we have a close coordination between the draftsmen and the compilers. Other than that we are too small to have what would be known as a quality-control unit such as would be peculiar to a larger organization.

Mr. Tewinkel: Dr. Bertram brought up a question a little while ago which had to do with projection-type instruments and direct-viewing instruments and the question was not answered to my satisfaction. I would like to ask three of the panel to give an answer to this: Mr. Hopkins, Mr. Welden, and Mr. Theurer.

Chairman Thompson: The question as I recall it was: Why do the government agencies use instruments such as Kelsh, ER-55, and such? Is it because they are cheaper? Or what are the reasons? Is that the question?

Mr. Tewinkel: That is correct. I continue to see more B-8 plotters as I go around the country. What is the explanation? I would like their answers to it.

Mr. Welden: Let me take a crack at this first and I will pass it on to Mr. Theurer. I think if you will look around in organizations you will find that a certain set of instruments exist there and the answer in part is due to the manufacturers and their representatives. Who got there first with the most? The reason I say this is that if you say you are operating with the Kelsh instrument you may not want to put a Balplex into where you are going to try to interchange plate sizes and scales in your mode of operation. It is easier to program for one type of instrument. That could be one answer. The other one, if you look around in some of the areas around here, could be because of personnel. Some of the more astute gentlemen within the organization have come up with a type of instrument such as in the Geological Survey with the ER-55. This became their instrument and they stayed primarily with it. You will find in the large organizations (this is true in the Geological Survey as well as in the Army Map Service) a mixture of instruments. But in the smaller organizations I think you are going to have to program for one given type of instrument, and price could have an effect on that.

Mr. Theurer: We have been using color photography for a good number of years in our work and the B-8 lent itself very well to using either color, infrared, or panchromatic photography. Another very good reason, although this wasn't the primary reason, is the ease of operation of the B-8; the operator is in a comfortable position. I'm referring to the B-8 type of instrument, not the B-8 specifically, but the type of instrument that can be operated in an ordinary lighted room where it is much more comfortable for the operator. I don't know what you people use for *C*-factors on the various instruments, but we have gone as high as 1800 for the B-8 plotter because of the direct-viewing system as opposed to the anaglyph system for which we used to use a *C*-factor down around 1200.

Mr. Hopkins: As far as the Geological Survey is concerned, it got its start in photogrammetry during the mid '30's when a large amount of mapping was needed in the TVA area and rapid investment in photogrammetric equipment was desirable at that time. Considering the numbers of instruments or people to use them and the money available,

the double-projection plotter fitted the investment pattern of the Survey better than the stereoplanigraph did at that time. It was more readily available. Once this decision is reached, of course, you rather set the pattern for future expansion in the photogrammetric operation; however, the Geological Survey is not anywhere near 100 percent in double-projection instrument field. We have stereoplanigraphs, A-7's and A-8's in operation, we are installing B-8's and PG-2's—instruments of the type that lend themselves to color photography, super-wide-angle photography and so forth. However, if we were to scrap our double-projection plotters and buy plotters of the B-8 type, which cost roughly twice as much per plotter, you can see the tremendous amount of investment that would be required in buying some 500 new instruments for the Geological Survey.

Chairman Thompson: In line with that, the chair would like to take the privilege of asking a question, and I would like to address this to Dr. Bertram. Sid, would you care to give us a forecast on when the automated systems might produce maps that conform with national map-accuracy standards?

Dr. Bertram: I am not quite sure what you mean, first of all, because the UNAMACE now is quite capable of obtaining the basic map data to whatever standards you want to work to. I think it is as accurate as any instrument in the world today. There is a question, though, as to what you are going to get from the automatic instrument. While Mr. Gruner was here I meant to say something about the teamwork that has to go on in the compilation process when you get to automation. We do not have a completely automatic system today. The UNAMACE, in particular, was built to have a human partner. The operator has to get the job started. He has to outline to the machine the areas where it may need particular attention. A number of things go on which basically the instrument is able to measure very rapidly and very accurately. In the areas of the field where there is a reasonable amount of detail, if there is enough for a man there is enough for the UNAMACE. In the areas of the field that are not too rugged, as I mentioned in my paper, if you have housing tracts and large-scale mapping to do, I don't care what kind of instrument you have, whether it is automatic or not, the man is going to have to take over in those areas. Now I visualize some time in the future when the basic type of equipment that we have in the UNAMACE may be used as a manual plotter, simply because you are going to get a lot more out of the man when you use a UNAMACE than you will if he is huddling over the projection-type plotter. This was the point to my question to the panel about the double-projection plotter, which I think is a very clumsy instrument. I am not sure that the alternative is one of the European types, such as the B-8, but where you have as much of an investment in people as you have at the Geological Survey, at the Army Map Service, and the others, it seems to me that someone ought to be taking a good look at what you ought to give these people in order to get the maximum benefit from them. The initial instrument cost is only a very, very tiny part of what it costs to get the final map. The instruments cost maybe $10,000, but I'll bet you spend a good deal more than $10,000 on the men that are going to run them.

Chairman Thompson: All right, then your answer to the question in which I asked for a forecast on when the automated systems would meet map standards is "Now."

Dr. Bertram: That is right.

Chairman Thompson: That is a direct answer. Well, we have been sitting here for a long time and covered considerable ground. I thank the audience for being so patient, and I thank the panel for having participated.

Articles for Next Month

Abraham Anson, Developments in aerial color photography.
W. G. G. Blakney, Accuracy standards for topographic mapping.
Edward Efron, Image processing by digital systems.
Kalevi Eranti, Stereoscope for strips.
Edward M. Mikhail, Analytic mirror photos.
H. L. Oswal and S. *Balasubramanian*, An exact solution of absolute orientation.
Gary W. Schallock, Metric tests of color photography.
Daniel Vitiello, *Merle Biggin*, and *Gerald Middleton*, Automatic contouring at AMS.
Paul R. Wolf and *Donald Graff*, Lunar control from Ranger photos.
J. A. M. Wolters, Accuracy of analytics by computer simulation.