*Photographic Interpretation in the Earth Sciences**

Photo Interpretation Committee Subcommittee V Annual Report March 20, 1963

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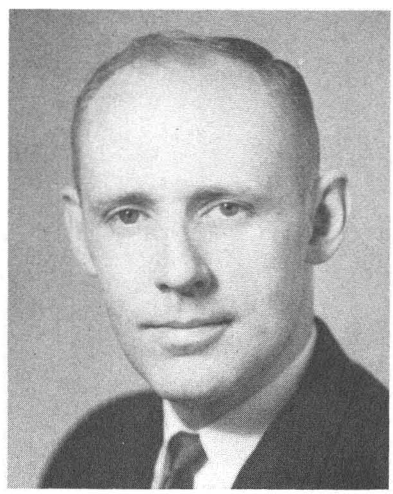
Chairman, Subcommittee V

THE field of interest of Subcommittee V, Uses of Photo Interpretation for Scientific Purposes (Earth Sciences), is so large that it necessarily overlaps the fields of interest of each of the other subcommittees. Applications of photo interpretation in earth science fields must be based upon relationships between the image and the energy flow which produces it, must consider the recording system used to obtain the images, must involve methods and equipment for extracting information, must include an understanding of engineering and military uses of photo-images, and should not ignore extra-terrestrial uses of photo-images. Training and personnel selection, and proper recognition of outstanding work, are also matters of concern to earth scientists using photo interpretation.



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To facilitate the work of Subcommittee V, seven fields of interest within the earth science area have been recognized and seven working groups created, one for each field of interest. While this arrangement facilitates the work of the subcommittee, it does not imply that these seven fields of interest are independent. Just as the area of interest of the total subcommittee overlaps that of each of the other subcommittees, so the working groups overlap with each other (Table 1). The forester for instance must consider soils, geology, etc., and the geologist should appreciate vegetation, landuse, and all other subject-matter areas integrated into the photo-image.

During 1962 Subcommittee V attempted to do three things:

1. Review the status of photo interpretation.
2. Keep abreast of research under way.
3. Consider areas where additional research is needed.

None of these tasks has been completed, nor is it likely that they ever will be. Findings to date are summarized in the sections that follow.

* Presented at March 24–30, 1963 ASP-ACSM Convention, Hotel Shoreham, Washington, D.C.

TABLE 1

ORGANIZATION OF SUBCOMMITTEE V
PHOTO-INTERPRETATION COMMITTEE

1962

CHAIRMAN: *C. E. Olson, Jr.*
VICE-CHAIRMAN: *K. H. Stone*

WORKING GROUPS

1. AGRICULTURE AND SOIL *Kenneth Dotson* *Nicholas Holowaychuk* *R. T. Odell* *Harold Rib*	2. ARCHEOLOGY *R. S. Baby*
3. FORESTRY AND PLANT ECOLOGY *C. W. Barney* *R. W. Becking* *John Carow* *Philip Gimbarzevsky* *R. C. Heller* *M. P. Meyer* *K. E. Moessner* *R. B. Pope* *B. T. Stanton* *R. C. Wilson*	4. GEOGRAPHY *W. H. Bailey* *A. W. Booth* *R. W. Finley* *J. P. Latham* *A. P. Muntz* *K. H. Stone* *C. E. Taylor* *A. B. Viola* *Sherman Wengerd*
5. GEOLOGY *D. H. Elliott* *Charles Kolb* *David Landen* *Donald Orr* *W. V. Trollinger* *H. R. Wanless*	6. WATERSHED MANAGEMENT *J. R. Meiman* 7. WILDLIFE AND RANGE MANAGEMENT *Harold Steinhoff*

STATUS OF PHOTO INTERPRETATION

The dramatic success of photo interpretation during the Cuban crisis of October 1962 underscored current capabilities. While high-speed, low-altitude photography is seldom necessary, and only infrequently economically justifiable in earth science fields, the fact that excellent photography can be obtained under adverse conditions of weather and relative image motion holds considerable promise for earth scientists. This and the increasing capabilities of radar, infrared, and other remote sensing systems, constitute some of the most significant advances during the last three years. Unfortunately, military security restrictions prevent widespread implementation of these sensing systems in civilian practice. Where implementation has been possible, some notable successes have been achieved, but security requirements have sharply restricted the publication of results. If additional information cannot be released from security restrictions, it may be both desirable and essential to obtain security clearances for increasing numbers of earth scientists.

During late 1961 and early 1962, there was considerable discussion regarding possible obsolescence of aerial photography (Abrams, 1961; Goddard, 1962; Fischer and Ray, 1962). Current applications of photo interpretation suggest that it is not the photograph, but our concept of it, which may be obsolete.

Use of spectral reflectance data in interpretation and planning of aerial photography (Fischer, 1960; Walker, 1961; Langley, 1962; Olson, 1962), and use of microdensitometric data for quantitative interpretation of tone differences (Fischer, 1962a and b), are adding new dimensions to the interpreter's look at his photography. Use of telemetered photographs from satellites, such as TIROS, have brought photo interpretation into meteorology and weather forecasting (Coates, 1961; Tepper, 1961), and have given earth scientists new views of the planet they work on, as well as closer looks at objects beyond the earth's atmosphere.

With the advent of orbiting satellites, the possibility of surveying man's domain from a vantage point which passes within line-of-sight of all points on the earth in something like half-a-day, has become a sudden and once unexpected reality. However, the glamor associated with satellite photography and electronic data processing equipment often causes us to overlook steady improvements in photo interpretation and its application to everyday problems of earth scientists. In the final analysis the utility of any tool is determined by its usefulness in accomplishing the tasks of its users. It would seem that the number of archaeologists, foresters, geographers, geologists, and engineers using photo interpretation as an everyday tool far exceeds the number of persons interpreting photography for space exploration and military purposes. Therefore, brief mention of some of the advances in a few of these areas seems pertinent.

The MANUAL OF PHOTOGRAPHIC INTERPRETATION, published by the American Society of Photogrammetry in 1961, includes a thorough review of the status of photo interpretation through 1959 and part of 1960. Accordingly, Subcommittee V has concentrated its attention on advances made during the last three years. However, some review of earlier accomplishments will be found in this report.

Forestry

Inventory.—Aerial photography has been an important tool in forest inventory (Wilson et al., 1961; Wilson, 1962) for at least 20 years, and its use is still increasing (Francis, 1962). One Canadian company reports that it uses aerial photography at scales ranging from 1/40,000 to 1/2,400 in its regular inventory work. Photography at a scale of 1/40,000 is used for mapping broad landtypes (surficial deposits) and rapid evaluation of potential productivity of forested or burned-over areas. Photography at scales of 1/31,680 and 1/15,840 is used for mapping and determining area of clear-cut acreages. Photography at the 1/15,840 scale is also used in classification of forested areas. Large-scale photographs (1/2,400) are used in determining pulpwood volumes in millyards or in water storage (P. Gimbarzevsky).*

Methods and Specifications.—The amount of aerial photography flown specifically for forestry purposes is increasing and general specifications for forest photography have been evolved (Avery and Meyer, 1962). Special purpose photography at scales larger than 1/15,000 have proved to be quite useful. In the Pacific Northwest panchromatic photography at a scale of 1/12,000 is considered to be a standard type and scale for inventory and timber management planning surveys (R. B. Pope). In tests of accuracy in mapping stand condition-class, results with 1/12,000 scale photography were as satisfactory as results with 1/5,000 and 1/8,000 scale photography (Bernstein, 1962a). Interpretation of understory vegetation from 1/12,000 scale photography has progressed to operational status (Bernstein, 1962b).

In many parts of Canada, the cost of field measurement of inventory sample plots has led to increased use of large-scale vertical and oblique photography. Detection and species identification for not less than 95 per cent of all trees in a sample plot and measurement of stem diameter to the nearest inch are desired. The smallest scale of photography permitting experienced interpreters to meet these specifications seems to be 1/750. Split-vertical, or oblique, photographs with approximately 15 degrees of tilt taken in fall or winter when broadleaved trees are leafless are preferred (private communication from J. Peaker). Interpretation of tree species from this type of photography has been discussed by Sayn-Wittgenstein (1960, 1961).

Fire Detection and Suppression.—Initial tests of airborne infrared sensors in *forest fire detection and suppression* have been performed at the Intermountain Forest and Range Experiment Station (Hirsch, 1962). On the basis of these tests, it appears that existing infrared sensors are suitable for mapping the perimeter of large fires and for locating spot fires outside of the main perimeter. However, masking effects of forest stands seriously limited detection capability, and errors in fire location were great enough to present problems in determination of access routes for suppression crews.

Geology

Another report describing application of infrared imagery to earth science problems was recently published in PHOTOGRAMMETRIC ENGINEERING (Lattman, 1963). Lattman reported that tonal differences between a sandstone and a shale near State College, Pennsylvania, permitted easy delineation of the sandstone-shale contact. Several springs along the sides of a synclinal valley were also dis-

* Undated citations of this form are to unpublished communications from individuals working with photo interpretation. Most individuals named in these citations are members of Subcommittee V of the ASP PI Committee.

cernible on the infrared imagery, although they were not interpretable from conventional aerial photography.

Photo interpretation is an important tool in *geology*. During the last few years, several volumes have been published documenting the capabilities and status of "photo geology" (Lueder, 1959; Ray, 1960; Miller, 1961; von Bandat, 1962).

Archaeology

Photo interpretation is attracting more and more attention as an *archaeological research* tool. Results of British workers were summarized at the International Symposium on Photointerpretation held at Delft, Netherlands, in the fall of 1962 (Bowen, 1962; Feacham, 1962; St. Joseph, 1962). Features of archaeological interest are often observed by photo interpreters in the course of their work on other problems. Many of these potential discoveries are lost because the photo interpreter does not realize what he is seeing. Recently, one interpreter's curiosity led to additional study and the discovery of what may prove to be ancient Indian fish traps in the Potomac River (Strandberg, 1962a).

Agriculture

Applications of photo interpretation in *agriculture* are also increasing (Dill, 1959; Colwell, 1960a; Koechley, 1960). However, specific advances in this area have been few in number during the last three years or have escaped the attention of this committee. One report of progress concerned detection of *potato blight* from infrared aerial photographs (Brenchly and Dadd, 1962).

Hydrology

Hydrologists have also turned to aerial photographs in finding solutions to some of their problems (Howe, 1960; McBeth, 1961). In the mountain watersheds of the western United States, snowmelt provides large volumes of water that must be controlled if dependable water supplies are to be provided to many large and small communities. Areal extent and seasonal change in snowfields in these watersheds is valuable information, and watershed managers are turning to aerial photographs as an aid in evaluating and assessing the snowfields under their jurisdiction (D. R. Meiman).

The Antarctic

Photo interpretation is used in the *Antarctic* to inventory "map-worthy areas"; in detecting and mapping crevasses, although no positive method of detection has yet been found; and in preparing shaded relief representations of terrain features (Landen, 1962). Leighty (1962) has also reported on the use of aerial photographs for route location on ice caps. Excellent descriptions and illustrations of types of Arctic ice were also published during the last three years (Thorén, 1960).

Control Points

It is axiomatic in photogrammetric mapping that a control point is no stronger than its photo identification. Tests of panels for marking *control point locations* continue, and these must be based upon photo interpretation evaluation of the photo-images showing the control point panels (Landen, 1962). Either the photogrammetrist is becoming a P.I., or he has always been one but has been reluctant to admit it.

Land Management

Two recent disastrous floods have provided additional proof of the applicability of photo interpretation to *land management*. High tides and heavy rains caused by the Isewan typhoon of September 1959 produced extensive floods in central Japan. Aerial photographs taken after the floods had receded revealed a clear relationship between landform and the areas that had been flooded. The results of the interpretation of these photographs proved of considerable value in reconstruction and town planning. Land classifications have been applied in the alluvial plain ringing the Bay of Tokyo to facilitate *planning and flood damage control* in this area of high flood incidence (Nakano, Ohya, and Kanakubo, 1962).

Following the recent flood at Hamburg, Germany, three pairs of stereograms made from aerial photographs taken before and during the flood were used to detect flood damage to dikes. It appeared that location, nature, and size of all damage more than one-half meter in length, width, and depth could be detected on photography at a scale of 1/6,500 (Schroeder-Lanz, 1962).

Geographic Research

Photo interpretation continues to be an important research tool of the geographer. The broad scope of *geographic research* requires study of relationships between different elements of the area being studied. Interrelationships between rocks, soils, vegetation, and climate have long been recognized and studied by physical geographers, while cultural geographers emphasize the works of man. These relationships are important in photo interpretation. Complete recognition of the value of such cross-correlations is hindered by unnecessary channelization of photo interpretation into specific fields, such as forest P.I. or photo geology. This is often intensified by the tendency of foresters, geologists, and engineers to ignore work done by geographers. However, the broad field of the geographer emphasizes relationships between elements such as soils, vegetation, and man (Steiner, 1962; Tomlinson and Brown, 1962; Stone, 1963), and geographic researchers are providing important information concerning the more specific disciplines.

Reports of geographic research tend to emphasize content analysis of aerial photography rather than photo interpretation techniques or procedures (Monkhouse, 1959; Schneider, 1962; Stone, 1962; Walton, 1962). Geographers often provide bibliographic collations that are especially valuable in specific earth science fields. The summary of photo interpretation of vegetation prepared by V. P. Finley (1960) and reports on world air photo coverage (Stone, 1961) are examples.

Use of Color

Application of *color photographs* in earth science fields are increasing. However, widespread use of color photography (Fischer, 1962; Colwell, 1962a; Doverspike and Heller, 1962; Haack, 1962) continues to be hindered by the relatively high cost of such coverage. Fischer (1962) reported on the use of aerial color transparencies as an intermediate product in preparing black and white prints utilizing energy in narrow spectral bands. Prints were made from aerial color transparencies using panchromatic film and a filter selected on the basis of spectrophotometric and colorimetric measurements. Greater tonal contrasts between rock units were achieved in this way than with standard panchromatic photography.

Doverspike and Heller (1962) reported on trials of *aerial color transparencies* taken with a Hulcher 70 mm. camera for identification of *tree species*. Scales of 1/3,960, 1/1,584, and 1/1,188 were used. Species identification proved to be significantly better from the color transparencies than from panchromatic photography at the same scale. Greatest accuracy was achieved with the largest scale when 81 per cent of the trees were correctly identified. However, little improvement in accuracy was noticed between the 1/1,584 and 1/1,188 scales.

Wide acceptance of color photography for *special survey* purposes has been hampered by lack of suitable field interpretation methods. Foresters at the Pacific Northwest Forest and Range Experiment Station have developed a split light-table for field use that facilitates stereoscopic study and detailed interpretation of color transparencies in the woods (Wear, 1960).

New "Periodical"

This summary of the status of photo interpretation during the last three years would be incomplete without some mention of the new *Editions Technip, Photo Interpretation*, published in Paris, France, three times a year.* This "periodical" includes excellent photo examples and descriptive interpretations in a wide variety of earth science fields. While detail lost through half-tone reproduction of photographs is always regrettable, the publishers of *Photo Interpretation* are doing an excellent job of illustrating current capabilities.

Equipment

A long list of new equipment for photo interpretation could be compiled. However, consideration of such devices falls more properly within the areas of Subcommittees II and III and will not be considered here.

RESEARCH UNDER WAY

Much research in photo interpretation is involved in determination of basic matter-energy-image relationships (Olson, 1962) for terrain features and in development of better techniques of information extraction from photo-images. Work on light reflectance, microdensitometric interpretation of tone differences below human visual thresholds, automations of photo interpretation, photographic edge-isolation techniques, and additive color photography (the so-called "Land" process) are examples. Results of such research will be of immense value to photo-interpreters in the earth science fields but fall within the areas of interest of Subcommittees I, II, and III. Only brief mention of this research will be found below.

Research on uses of photo interpretation in the earth sciences is diverse and most often is categorized as applied research. This should not be surprising, since this research is stimulated by a current need for a certain type of information. Studies of photo interpretation

* Societe des Editions Technip, 7 rue Nelaton, Paris 15 eme in care of Madame Atepee.

in raisin-lay surveys (Colwell, 1962b), in estimating lake depths in small mountain lakes (Moessner, 1963), in detecting forest fires from infrared images (Hirsch, 1962), in identification of tree species (Doverspike and Heller, 1962), in using a microdensitometer to identify landuse classes for forest inventory purposes (Doverspike and Flynn, 1963?), in detecting locations of underground explosions (Orr, Young, and Welch, 1962), and in meteorologic interpretation of satellite photography (Tepper, 1962) are cases in point.

Research Projects

Some current research projects are mentioned below. The diversity of these research projects may well be an indication of the status of photo interpretation today.

Geographic Distribution.—Quantitative analyses of *geographic distributions* are being implemented by utilizing electronic scanners, computers, and other devices for statistical or graphical measurement or display of the patterns discernible in aerial photography or other imagery (Coppock and Johnson, 1962; Latham, 1963). These studies are being interrelated with developments in automatic photo interpretation (Rosenfeld, 1962; Mumbower and Richards, 1962) and perceptron research (Leland, 1962).

Remote Sensing.—The Institute of Science and Technology of the University of Michigan, with the support of the U. S. Office of Naval Research, is engaged in a study of remote sensing of environment. In this study consideration is being given to all forms of remote sensing devices, both airborne and ground, and their applications to earth science fields. A major aim of the project is to narrow the gap between engineers producing sensing devices and potential earth science users of these sensors.

Remote Object Recognition.—The U. S. Geological Survey is investigating several methods of discrimination and recognition of objects from a remote position. Among these are studies of energy reflection characteristics of rock surfaces; of relationships between polarization and surface configuration; of methods of measuring and analyzing patterns in aerial imagery; and of absorption, reflection and emission characteristics of natural objects as related to varying increments of the electro-magnetic spectrum. As part of the work on these projects, infrared imagery is being obtained of the Shenandoah Valley, Virginia, and of an active volcano in Hawaii. Radar imagery is also being evaluated as a geologic mapping tool.

Reflectance and Absorption.—In addition to those being made by the U. S. Geological Survey, reflectance and absorption measurements are being made at other locations. The Stanford Research Institute is working on selective absorption by rocks of wavelengths out to 30 microns. The Forestry Department of the University of Illinois is working on light reflectance measurements of vegetation, painted surfaces, and other terrain elements using a trailer-mounted spectrophotometer with digitized readout capable of reflectance measurements for wavelengths between 0.25 and 2.5 microns.

Spectrophotometric research in the visible and near-infrared spectra is also under way at the U. S. Department of Agriculture Experiment Station at Beltsville, Maryland. Work at Beltsville has been confined to reflectance from 24 species of agricultural crops and weeds and has been performed with the cooperation of the U. S. Army Engineer Research and Development Laboratory, Ft. Belvoir, Virginia. The U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi, is investigating reflectance properties of soils in the visible light and radar regions.

Research on application of computer techniques and reflectance data to film/filter selection is continuing (Langley, 1962). Development of a nine-lens camera by Itek Laboratories, Palo Alto, California, provides an increased capability for simultaneous testing of different film/filter combinations (Woo, 1962).

Water Pollution.—Film/filter tests for detection of sources and diffusion of water pollutants are also under way. Initial studies of heated coolant water discharges below thermo-electric power plants indicate that effluent entry points, and trails of heated coolant water downstream, can be detected on panchromatic/minus blue photography even when invisible to an observer in the photographic aircraft (Strandberg, 1962b).

Insect and Fungus Disease.—Research on detection and analysis of insect and fungus diseases in agricultural and forest crops is under way at the University of California and the University of Minnesota, at the U. S. Forest Service Research Laboratories in the Pacific Northwest and Intermountain Regions, and at the U. S. Department of Agriculture's Experiment Station at Beltsville, Maryland.

Forest Classification.—Investigations of photo-stratification schemes used in timber volume inventories and management surveys are under way at the Intermountain Forest and Range Experiment Station, Ogden, Utah. Preliminary results indicate that photo classification schemes based on cubic volume give better results than stand-size, density, or species classes patterned after ground survey classification schemes (K. E. Moessner). New cubic-foot and board-foot aerial volume tables are also being prepared at the Intermountain Station.

Work under way at the University of Minnesota also includes tests of timber stand classification tables and their application to operational forest inventories. This study and a second on effects of sun azimuth on interpretation of aerial photographs of forest vegetation are scheduled for completion in 1963 or early 1964.

Meteorology.—Meteorologic research continues to use aerial photography. The Arctic meteorology photo probe program (Evans, Baumann, and Andryshak, 1962) has helped pave the way for further progress. High-resolution pictures of a vigorous low-pressure disturbance obtained from altitudes up to 140 miles have provided meteorologists a basis for studying cloud brightness and also established the value of using similar pictures, taken of an area seen by a weather satellite, for supplementing photographic data. Infrared film and a Wratten 88-A filter produced the best pictures. Camera settings were 1/500 second and f/8.0.

Analogous Areas.—Several studies of comparative photo interpretation of areas located in different parts of the world (the so-called "analagous areas" concept) are in progress. A report on one such study (Viola, probably 1963) was presented at the 1963 Annual Meeting of the American Society of Photogrammetry. The U. S. Army Corps of Engineers are currently engaged in at least two comparative studies using photo interpretation. A study under way in the Research and Development Laboratories, Ft. Belvoir, Virginia, is scheduled for completion by mid-1963. A second study, this on comparative interpretation of photography of tropical areas, is being conducted by the Waterways Experiment Station, Vicksburg, Mississippi.

Land Use and Population Distribution.—Studies of economically depressed areas have shown that photo interpretation can be a valuable tool in planning necessary changes in landuse and population distribution. One such study performed for two areas in the Swiss Alps has been described by Steiner and Haefner (1962). They found that present landuse and altitudinal zoning were clearly interpretable from aerial photographs. Reconstruction of the economic genesis and recent changes in landuse were also possible. Development trends could thus be inferred and projected and projected trends used as a basis for determining any necessary corrective action that would improve economic conditions in the region.

Research Needs

Commission VII of the International Society of Photogrammetry, meeting at Delft, Netherlands, in September 1962, adopted several general resolutions. One reads as follows:

"It is recommended that detailed study of the following problem areas be encouraged, because these areas appear to offer opportunities for significant advances in the application of aerial photography and photo interpretation:

"a. Photo quality for photo interpretation purposes.
b. Photo scale as a limiting factor in interpretability.
c. Seasonal changes in light reflectance.
d. Increased accuracy of photo measurements for photo interpretation purposes.
e. Development of automatic and/or electronic techniques for photo interpretation."

In addition to the general resolutions, each working group of Commission VII presented specific resolutions which were also adopted by the Commission as a whole. *Working Group 4* (Vegetation) presented a *resolution* which has merit outside of the vegetation fields. This reads:

"Recognizing that problems in vegetation management are different in temperate, arid, and intra-tropical regions, Working Group 4 recommends that research in aerial photography and photo interpretation for vegetation surveys be encouraged in each region and believes that closer cooperation between research workers of all nations is essential to the national development of vegetative resources, particularly in the developing countries."

The last phrase of this resolution, "*particularly in the developing countries*," seemed to be the keynote of the entire meeting. The need for experimental verification of the "*analogous area*" *concept* of *photo interpretation* in largely unexplored parts of the earth was emphasized. Research in this area is necessary and falls within the area of interest of Subcommittee V. A current and active tabulation of air photo coverage available for all areas of the world would facilitate studies of comparative interpretation between "analogous areas." Commission VII of the International Society of Photogrammetry recognized this and adopted the following resolution at the 1962 meeting at Delft, Netherlands:

> It is advised that every country should establish a *Central Register*, in which records are kept of all aerial photographs that are made in that country for all purposes.

Implementation of this resolution would present a momentous task in extensively photographed countries such as the United States. A tabulation of existing photography would be of most value for countries where photographic coverage is scarce.

Closely allied to the need for studies of comparative photography of analogous areas in different parts of the world is the need for *studies of comparative photography* of the same area over a time span of several years. Pre-World War II photography is particularly valuable in this respect. The Cartographic Branch of the U. S. National Archives and Records Service reports:

> "On the basis of the kind and number of requests that we have been receiving for prints made from Pre-World War II Agricultural Adjustment Administration aerial photography, which is now in the National Archives, . . . there must be considerable research under way in which noncurrent photography is being used to obtain historical data and information concerning geographic change. . . . Since many of the phenomena recorded on this early photography have disappeared as a result of either natural processes or human activity, in many cases old photography is the only surviving record of past conditions. When compared with recent or current photos, a picture of change can be obtained which is not available from any other source. . . . The full research potential of successive series of air photo coverages has not been realized. Even the availability of such coverages does not appear to be generally understood or appreciated. We are now working on a compilation . . . of the early air photo coverages of the U. S. which are available in the *National Archives* (A. P. Muntz)."

In addition to these broad areas where research is needed, several specific needs have been reported during the past year by members of this subcommittee. Needs which are not included in the general categories already listed are mentioned below. The order of presentation does not imply order of importance.

Use of aerial photographs for *predicting snowmelt runoff* has received considerable attention in the past but has not found widespread application because methods for determining water content of the snowpack require extensive field work. A photo technique for determining water content of a snowpack would be most valuable (J. R. Meiman).*

Advances in automatic photo interpretation require improved capability for *qualitatively identifying the elements to be interpreted.* This seems to depend upon achieving consistent and reliable tonal qualities in the photography, or a valid system for compensating for tonal variations. Cross-checking of data from various sensors may also prove to be helpful. However, cross-correlations can only be established through specific research (J. P. Latham).

Diseases of forest trees caused by insects, fungi, or other organisms result in greater annual losses than forest fires. Early detection would permit quicker treatment and help minimize losses. Studies of special photography or other sensing devices which might permit detection of diseased or otherwise unthrifty trees before visible foliage changes would be highly desirable (R. B. Pope).

A technique for *identification of animals on aerial photographs for census purposes* would be of great value in range and wildlife management. The measure might be the number of individual animals per unit area, or biomass, measured through energy detection of some type—perhaps through infrared sensors. Another possibility is development of techniques for detecting and identifying tracks in snow which would permit study of animal movements (H. W. Steinhoff).

While it appears that the whole field of photo interpretation is finally starting to move, there seems to be a *dearth of information with regard to research techniques* in the photo interpretation area. Suitable guide lines regarding project design, data collection, and data analysis are badly needed. Tested, conventional techniques, developed and used in ground inventories and research, are not always applicable to photo interpretation where populations are measured indirectly rather than directly (M. R. Meyer).

The *tremendous potential of radar, infrared, and other aerial sensing systems* will never be exploited in the earth sciences unless research is undertaken to calibrate these sensors in terms of meaningful variables in earth science fields. Conventional aerial photography and

* Also see paper by W. J. Finnegan in PHOTOGRAMMETRIC ENGINEERING, Vol. XXVIII, (5) p. 782.—ED.

photo interpretation techniques will undoubtedly be used as tools in this research. Security classifications of the newer sensing systems may continue to restrict publication of research results but the research should be begun. When, and if, security restrictions are eased, work completed on a classified basis could provide a basis for rapid application of these sensing systems to earth science problems. However, research alone can never accomplish the implementation of any new technique. The potential user must understand his new tool. Therefore, earth scientists in all disciplines should take it upon themselves to learn the basic capabilities of these new sensors.

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*Human Factors in Image Interpretation**

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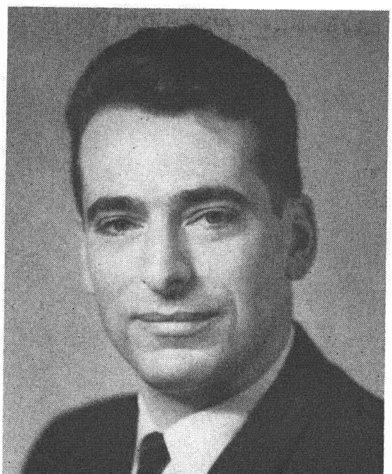
REPORT TO SUBCOMMITTEE III PHOTO INTERPRETATION COMMITTEE 1962-63 AMERICAN SOCIETY OF PHOTOGRAMMETRY 27 MARCH 1963

EVEN a cursory survey of human factors problems in image interpretation leads to the conclusion that the problems involved are manifold and extremely complex and that a broad, integrated program of research needs to be implemented. Today, interpreters are not only confronted with the problems of interpreting relatively large-scale, conventional black-and-white photographs, but they are also required to interpret small-scale and degraded photographs as well as radar, and infrared imagery. In addition, recent technological developments have increased the capacity of reconnaissance systems to obtain and process imagery at a rapid rate. The imagery obtained through this increased capacity and variety of image sources is ultimately placed before image interpreters who are asked to extract information to be used in important decisions.



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Yet existing knowledge about the basic psychological factors operating when interpreters examine reconnaissance imagery is severely limited. Relatively little is known concerning the perceptual and cognitive processes that occur when interpreters search imagery and make critical decisions concerning the presence or absence of significant objects. What clues or target signatures do interpreters use? What inferential processes do they employ? What are the effects of perceptual set, background information, stimulus quality, and personality variables on the speed, accuracy, and completeness of interpreters' final decisions? These are human factors questions; unfortunately, they are not easily answered.

Image interpretation is an extremely complex process. Impinging upon an interpreter's performance are factors related to his background, training, aptitudes, interests, and personality, as well as his momentary state of

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