apply quantitative and qualitative analysis to photo interpretation keys?

DR. YOUNG: If I understand your question properly, I don't propose at this point that we examine the method by which the photo interpreter's mind operates. What I am interested in is his end product; that is his report. If we know what kind of information we want (we don't always know this), we ought to be able to judge how much information the photo interpreter is recording in his report, and how much gain there has been through the use of the key; in other words, the total information that is requested, not the total information on the photo. For instance, the total information requested totals a hundred per cent; the photo interpreter is able to get sixty per cent without a key. By use of the key his report shows that he obtained seventy per cent. Then a ten per cent gain in information has been secured through the use of the key. The quantitative aspects of the studies that I propose are the examination of the photo interpreter's report. The photo interpreter himself operates in a very subjective manner. He examines a pair of photos and he comes up with something in his report. What I want to know is how much more information did he get from a key.

QUESTION: Isn't this a matter of training? Organizations like the Naval Photo Interpretation Center that have training facilities and that have to train multitudes of people, could evaluate the equipment very easily by using experimentally various stereoscopes and films in the student exercises. From this it could be determined whether one stereoscope or one film was experimentally better than another. It would be particularly difficult to circulate films among practicing interpreters and get their results back for final analysis.

DR. ROSCOE: The answer to your question is that testing equipment is not the function of the training agencies within the Services. Within the Military Services this function is assigned to some other agency. The Air Force, as an example. Such an agency is the Air Force Proving Ground Command at Eglin Air Force Base. The Proving Ground which does such proving and testing may go to the school to utilize the students as controls to test the equipment, but this testing would not be the responsibility of the training agency.

VALIDITY OF PI KEYS IN THE INTERPRETATION OF INDUSTRY*

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ABSTRACT

Industrial photo interpretation is defined. Its scope, objectives and limitations are examined. Procedures for doing industrial photo interpretation are discussed as well as the use and validity of keys in such procedures.

THIS paper will place two propositions before this panel for discussion:

First, that the subject matter of industrial photo interpretation can be organized and presented according to the "keys" method.

Second, that certain objectives of industrial photo interpretation can be achieved or furthered through using industrial keys.

The subject matter of industrial photo interpretation includes raw materials, equipment for physical and chemical processing, materials-handling and storage equipment, materials in-process, end products, the buildings housing any or all of these elements, as well as the functional interrelationships that bind them together.

What are the criteria by which we can judge or evaluate the propositions? Let

* Presented at 21st Annual Meeting of the Society, Hotel Shoreham, Washington, D. C., March 8, 1955, P.M.

us set up the following four:

1. There must be a series of discrete visual images that can be seen and described on whatever aerial photography is expected to be available.
2. There should be a relatively constant relationship between the visual image and its industrial function—a high expectancy that element *A*, when recognized, can be assumed to perform operation *X*.
3. The visual images must be capable of being arranged or ordered in such a way that the visual image for which a key has been prepared can be readily compared with the problem-image.
4. The system of recognizable visual images must represent or depict a large enough proportion of the total complex of functional relationships to permit the derivation of useful information.

Each of these criteria will be examined a little more closely.

The Discrete Visual Images of Industrial Interpretation

The objects seen at an industrial plant—the so-called visual images of industrial interpretation—show tremendous variation in size.

Industrial equipment may range in size from a screwdriver to a 500-foot long rotary kiln to a 3000-foot long building. Fortunately, the configuration of modern mass-product industry requires that the important operating elements either be large or, if small, that they operate in multiple units. This is reflected in an underlying positive relationship between the total monetary value created by the production activity at a plant and its total floor space (this ratio differs between industries) which says, simply, that important plants will be fairly large, at least. Furthermore, the visual images of the most important elements of industrial activity are, in large proportion, big enough to recognize and describe.

The high costs of building construction are helpful. Any plant could be built under one roof, greatly restricting its interpretability. The housing of large elements, such as petroleum refining installations, is not economically justifiable, nor, in many cases, is it technically feasible. The significant effects of this are, first, that much important and recognizable equipment is exposed to the view of the aerial camera, and second, that the tailoring of structures to fit equipment or activities offers clues as to what is going on inside the buildings.

Relationship between Visual Image and Function

This problem has two aspects: Do all objects that perform industrial operation *A* look alike; and, can objects that perform operation *A* look like those that perform operation *B*?

There are sound technical and economic reasons for having much of the equipment which is designed for the same purpose and which is placed in operation at roughly the same time look alike. Aerial photography, however, may record the existence of plants built at earlier stages of industrial development and containing old or obsolescent forms of equipment. While this is not an insurmountable obstacle, the necessity for accounting for historical series of equipment increases the difficulty of supplying universally usable keys.

Except for small, locally-developed industries derived from manual production methods, national variations in industrial equipment are minimal. The oxygen molecule is the same in India or in Canada.

The relationships between image and industrial function can be seen to fall into three categories:

1. Triple-threat images—where recognition of the image imparts complete knowledge of raw materials, process, and end product. Here are found those items beloved of photo interpreters—the blast furnaces, and coke ovens, and such elements as burner houses at carbon-black plants, aluminum powder producers, shipbuilding ways, and traversers at railroad car plants.
2. Single-threat images—where usually only process or function can be deduced. This category includes the great majority of recognizable industrial equipment. Examples are tanks, materials-handling equipment, chemical process equipment, stacks, vents, etc.
3. Images delineating volume of space

occupied—these comprise buildings for the most part. Top limits can be placed on the amount of floor space available at any plant through measurement and analysis of these images.

Organization

Let us limit our consideration of organization to the construction of a key designed to aid in the identification of industrial plants in terms of general kinds of industrial activity. The visual images can be grouped under certain categories which combine simple functional concepts with basic geometric forms. Suggested categories are: buildings; tanks, bins, ponds; operating equipment; connections between the foregoing three categories; walls and fences; materials or objects lying on the ground. It is believed that all visible industrial equipment can be grouped under these categories in a manner permitting rapid identification of problem images.

Maximum utility can be achieved by cross-referencing these categories with functional categories. This requires the analysis and comparison of industrial unit processes and unit operations throughout all industry. The final step should be the identification of all important industries in terms of the combinations of processes or operations occurring in, or forming the industries. A step-by-step procedure for use of this material can be outlined.

Derivation of Useful Information

Let us examine the role of industrial keys in the attainment of certain degrees of success in industrial analysis:

1. Separating industrial occupancy of land and buildings from other forms of human occupancy

It is the estimate of this author that at least 10 per cent of the 240,881 industrial establishments in the USA (1947 Census) can be identified as industrial. These plants employ 75 per cent of the total USA manufacturing labor force, and approximately 90 per cent of the USA labor force working in militarily important industries. Industrial keys used by relatively untrained interpreters should accomplish this task.

2. Distinguishing between industrial establishments

This is a relatively minor problem. Where it is important, industrial keys of the kind outlined in the discussion of "organization" above would be of minimum use.

3. Distinguishing between multiple production lines at the same plant

Conditions requiring this analysis occur frequently at chemical plants. Keys would be of minimum use in achieving this specific objective.

4. Identifying unit processes, unit operations, and general functions

This represents the best and most valuable use of keys. The importance of this phase of industrial analysis should not be under-estimated. Quick, economical, complete, and relatively accurate inventories of industrial potential of given areas can be made for use as bases or controls for estimates of many other significant industrial facts. For a large proportion of industrial plants which will be analyzed, this represents the most meaningful identification that can be made.

5. Charting complete process flow

Keys are useful in identifying specific points in the flow. Where direction must be determined, and where various operations must be interpolated and tested on the basis of available floor space, keys of the kind outlined in the discussion of "organization" above have limited value. It should be remembered that these observations have been restricted to the use of keys in industrial interpretation of a specific and limited nature. Detailed interpretation and analysis of industry has a use and need for keys of more complicated design. For example, I believe that much valuable work can be done in developing the testing of combinations of work station data against the photographically measurable floor space data, using linear programming methods.