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Chinese Industry from the Air

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How the photo interpreter helps locate and appraise key contributors to Mao-land industrial output.

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When the Great Leap Forward collapsed in 1961 a "cone of silence" descended over China. Mainland newspapers and magazines ceased to contain meaningful statistics on industrial activity in the country, radio broadcasts were emptied of all but propaganda, and travel by foreigners was largely restricted to tours of First Class Commune No. 1 and the Great Flood Control Dam of the Mangu. Even on purchases of plants and equipment from abroad there was often a costly forfeiture of associated guarantees because foreign technicians were not permitted to install them and the supplying countries were not even informed of their location. This almost complete blackout of information would have left the economic-industrial intelligence officer quite desperate had it not been for the arrival on the scene of daring Chinese Nationalist pilots flying used U-2 aircraft now withdrawn from their former duty over the steppes of the industrial giant to the north.

High-altitude photography of course brings important information to others in the community besides the economist, notably to military intelligence officers, but in this article we are concerned only with the service it performs for the disciples of Samuelson and Galbraith. Taken alone, its information on industrial activity in Communist China gives only a minimal foundation for intelligence estimates. When correlated with pre-blackout data and the limited current information that comes in from other sources, however, it enables us to draw many valuable conclusions about the Chinese economy today. Though its usefulness with respect to different industries varies from high to negligible, over-all it is comparable in significance for China to the annual statistical yearbook for Soviet industry.

Pre-Blackout Data

The basic store of information on Chinese industry goes back to before the Communist takeover in 1949; much of the mainland industrial base was established by then. The huge iron and steel complex at Anshan and many of the varied industrial activities at Shanghai and Wuhan and in other widespread areas were developed by the Japanese during their occupation. Then many plants damaged in the war were restored or reactivated, some with U.S. assistance, between 1945 and 1949, so that much information is available on these from Chinese Nationalist, Japanese, and U.S. sources.

During the first 10 years of the Mao regime, when there was a great deal of industrial expansion and modernization, the Communists reported openly about the progress they were making. This information was by and large reliable; the achievements of the Communists in this period, compared with the Nationalists' record, were impressive enough to need no embellishment. A considerable amount of accurate information thus came out of China up to 1959.

When in 1959 the Communists attempted to make it in one great leap to the forefront of the industrial nations of the world, they not only established completely unattainable goals but also reported incredible progress towards them. Almost all of the information they issued at this time was impossibly warped or exaggerated. Even so, placed against the previous reporting, it gave some insight into actual accomplishments. When the great silence enveloped the country in 1961, therefore, a good basic reservoir of data on the industrial establishment was available to the economic intelligence officer.

Aerial Photography: Spotting and Typing

Aerial photography's most obvious and most frequent contribution to the production of economic-industrial intelligence is in locating industrial facilities and discovering what they are for. In a somewhat less precise way it can help in determining a plant's operational status and in a few cases even in estimating its current rate of production. It can also follow the progress of new construction from the initial clearing of ground to the completion of an installation.

It must be kept in mind, however, that for the production of intelligence a good deal of information must be available from other sources than aerial photography, and studies in depth are required to create from it a useful product. The economic-industrial intelligence officer must weave together the photo interpretation of an installation with information from ground observation of it, reports on equipment housed in it, etc., and apply to all this his knowledge of the industry in question and the particular practices of the country.

Some industries are readily identified in aerial photos because of characteristic peculiarities either in the plant itself or in ancillary facilities. An excellent example of distinctive industrial configuration is presented by an integrated iron and steel plant, with its easily recognizable features such as blast furnaces, coke batteries, coke byproduct plant, open-hearth furnace buildings, and rolling mills. Another easily spotted industrial facility is the petroleum plant: the tank farm jumps out at the PI on his very first scan. The large power room buildings of a modern aluminum plant with their associated rectifiers and transformer stations are also easily distinguished even by the novice PI.

There are other industrial plants, however, that a trained PI can identify only by a careful scanning of the photograph. Falling into this category are copper refineries, fertilizer and most chemical plants, and cement (unless marked by horizontal rotary kilns) and lime plants.

Finally, some industrial activities cannot be identified from aerial photography at all. A striking example of these is the manufacture of titanium: in the United States two of the leading titanium plants are currently housed in old steel works, without any alteration of their outward appearance. An identification of these from aerial photography alone would be likely to be a false one, as steel mills of some sort.

The correct identification of an installation may depend on getting accurate measurements of its features. If it is co-located with others, relative size is often enough of a clue, but otherwise real measurements are necessary. A good clear U-2 picture will yield measurements of well-defined lines such as the clean sides of buildings to within 5 feet and of clearly discernible heights to within 10 feet.

Operational Status; New Construction

In many industries the most telltale sign that a plant is in active operation is the presence of smoke, steam, or dust. At an iron and steel plant, for example, the quenching of coke creates a heavy cloud of steam, and the open-hearth and Bessemer converter furnaces (for making steel from iron) and soaking pits (for equalizing temperatures in an ingot) emit smoke. Thermal power plants are usually heavy smokers. Cement plants in operation feature large quantities of smoke and dust. Many other industrial activities emit enough smoke or steam to be detected in the photography. Sometimes, as in power plants, the quantity of smoke may vary with the level of operation, but in most cases smoke only shows a facility to be active.

A better indicator of level of operation at many industrial plants is the extent of associated railroad activity. Many plants require a constant influx of raw materials and have a constant outflow of finished product by rail. The number of railroad cars at or near a plant is thus often significant. A stockpile of raw materials—coal, ores, etc.—can give' a clue to the operational status of a plant, but this indicator is unreliable and often misleading. Often the size of the stock of raw materials is inversely related to the operational level of the plant, and sometimes it is static regardless of plant operation.

An important variable in determining operational status is the frequency of photographic coverage needed. In a number of industries, fortunately, particularly those that use large furnaces, frequent shutdown is not practical. Once temperatures are raised to operating levels, operation is continued for a long time before shutdown for maintenance or other reasons. Thus one can forego aerial coverage for fairly long periods with reasonable confidence that if a plant of this kind was operating before and after, it was probably operating during the interval as well. The length of the period will vary among industries; the PI, as he progresses in the mastery of his profession, will use his judgment in respect to it.

At new construction in progress, aerial photography offers a ringside seat. Starts can be identified early if they involve clearing or grading the site, and the entire construction cycle can then be followed, including the laying of access roads or railroad spurs, the erection of security fences, and the completion of administration buildings. The enlargement of an existing plant can be watched in the same way. For the internal modification of existing facilities there are clues such as the presence of building materials or equipment, but the insight they offer is obviously quite limited.

An Iron and Steel Plant

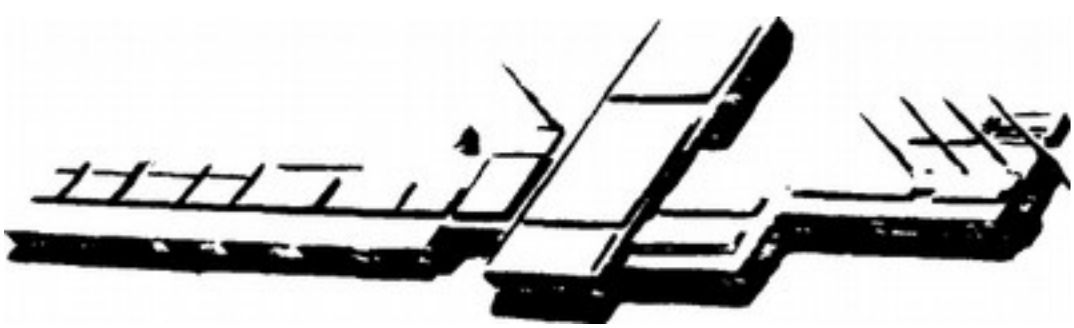
The Wuhan iron and steel plant will serve as a good example from this industry, showing how well it lends itself to identification. As can be seen from the aerial photograph in Figure 1 and the drawings in Figure 2, the basic features are readily identifiable. The three large blast furnaces that reduce the ore are easy to discern. Although their unique configuration precludes close measurement of their size, there is collateral information on the precise volume of almost all blast furnaces in China today; no new ones have been built for the past six or seven years. Of these, No. 1 has a volume of 1,386 cubic meters, No. 2 of 1,436 cubic meters, and No. 3 of 1,513 cubic meters.

The open-hearth building with six tall smokestacks also stands out. The smoke coming from the top of the building indicates that the shop was probably operating when this photo was taken even though no smoke can be seen coming from the stacks. Collateral intelligence puts six furnaces in this building, five large ones of 500 tons and one of half that capacity. One furnace to a stack is a common practice, although a number of plants have two on each. The open-hearth building is large enough to accommodate these six.

The soaking pit area, although its identification would be difficult for an amateur, can be seen by the trained PI. The same is true for the coke ovens, some of which steam shows to have been operating when the picture was made. The number of ovens per battery is very difficult to tell from aerial photographs, but for this again there is collateral information, much of it pre-Communist, on this and other iron and steel plants in China.

The rolling mill area, where the steel is worked beyond the ingot stage, can be delineated easily, but aerial photography provides the least useful information about this part of the plant. Collateral sources are unfortunately also the least informative on this subject, so that the weakest estimates about today's Chinese iron and steel industry are on its ability to turn crude steel into finished products. Overall, our best conclusion is that China does not have the rolling facilities to process all its crude steel. The number of rolling mills at Wuhan, however, indicates that this plant can roll all the crude steel it produces into some kind of finished or semifinished product. What the mix might be cannot be ascertained.

Figure 1.



Rolling mill, with soaking pit on right.

Open hearth building.

Blast furnaces.

By-products coke ovens.

In sum, the following estimates can be made on the Wuhan plant by evaluating the combined information from all sources:

Pig iron capacity is about 2.5 million tons per year with all three blast furnaces operating full time, according to collateral information. Aerial photography permits the conclusion that the plant was probably operating at a high rate throughout 1966, and a reasonable estimate of its pig iron production in 1966 would therefore be about 2 million tons.

A crude steel capacity of about 1.5 million tons is derived from collateral reporting. Aerial photography leads to the conclusion that the open-hearth shop was probably operating near capacity all through 1966, so well over 1 million tons of crude steel was probably produced. The excess pig iron is sent to Shanghai for processing.

Finished steel capacity is not given in collateral reporting, but the number of rolling mill buildings visible lends confidence to an estimate that all the crude steel produced here is probably rolled into some finished or semifinished form. Applying the usual rule of thumb that finished steel amounts to about 75 percent of the crude, we get somewhat near 1 million tons as Wuhan's finished product in 1966.

Aluminum

Probably the second most easily identifiable industrial facility is the modem aluminum plant. Because it recovers the metal by electrolysis, it must have an easily spotted transformer station and rectifier buildings, along with distinctive potroom buildings (the individual electrolytic cells are "pots"). As can be seen in Figure 3, showing the Fushun aluminum plant, the unique configuration of the potroom buildings is easily singled out by the PI. Their outside measurements (usually from 75' to 175' wide and from 450' to more than 1,000' long) are easy to determine, and there is a good rule of thumb for deriving plant capacity from area—1 ton of aluminum metal per year for every square yard of gross potroom floor space. At the Fushun plant gross potroom area is about 80,000 square yards. The indicated capacity of about 80,000 tons per year roughly confirms earlier collateral information that a capacity of 100,000 tons was planned. Aerial photography shows the plant is operating, probably close to capacity.

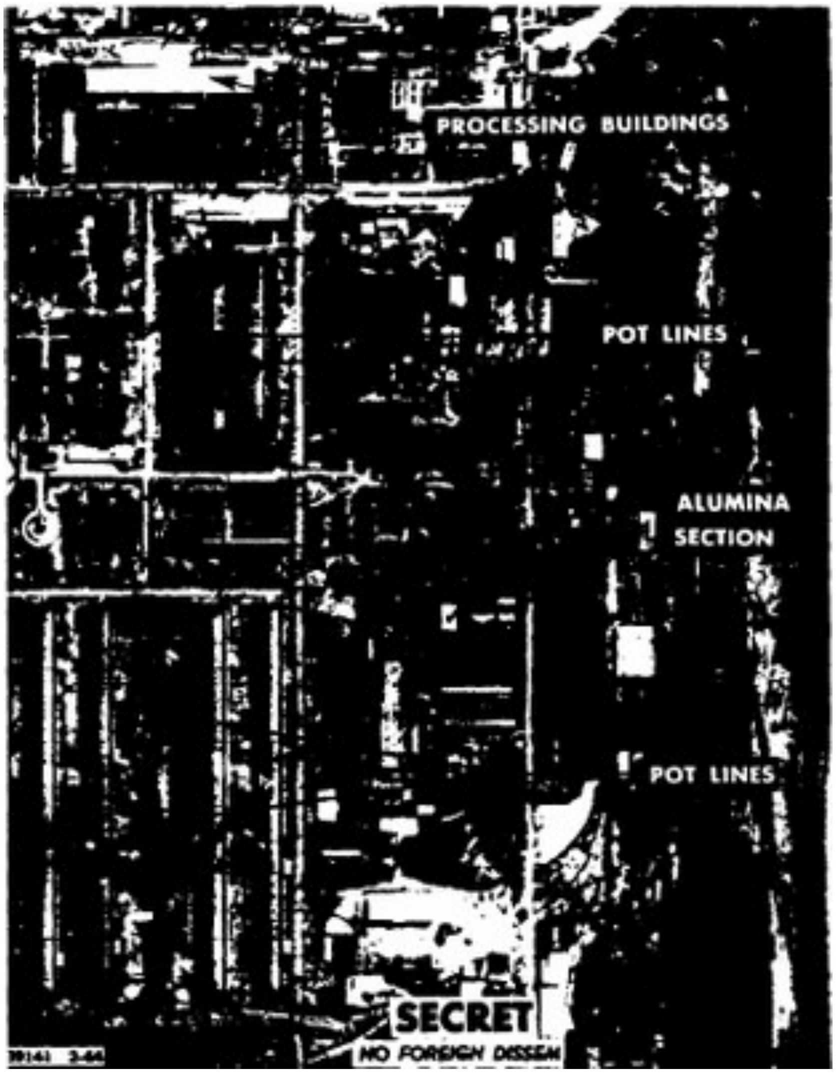


Figure 3.

There are two other completed aluminum plants in China, but photography showed only one, that at Pao-tou, to be operating in 1966. It has a potroom floor space of 22,000 square yards, so the whole industry could probably have produced a maximum of about 100,000 tons of aluminum in 1966. There are also four aluminum plants under construction in China, and their progress towards completion is currently being monitored from the air.

Cement

Although the cement industry is a decentralized one, spread out across China, photography is available on most of the major plants. When they are operating, large quantities of smoke and dust are emitted from the stacks, and this telltale evidence is clearly visible. With high-quality photography the number of kilns operating, out of the total number, can be determined, to give the percentage of plant capacity being utilized. Figure 4 shows a typical Chinese cement plant.

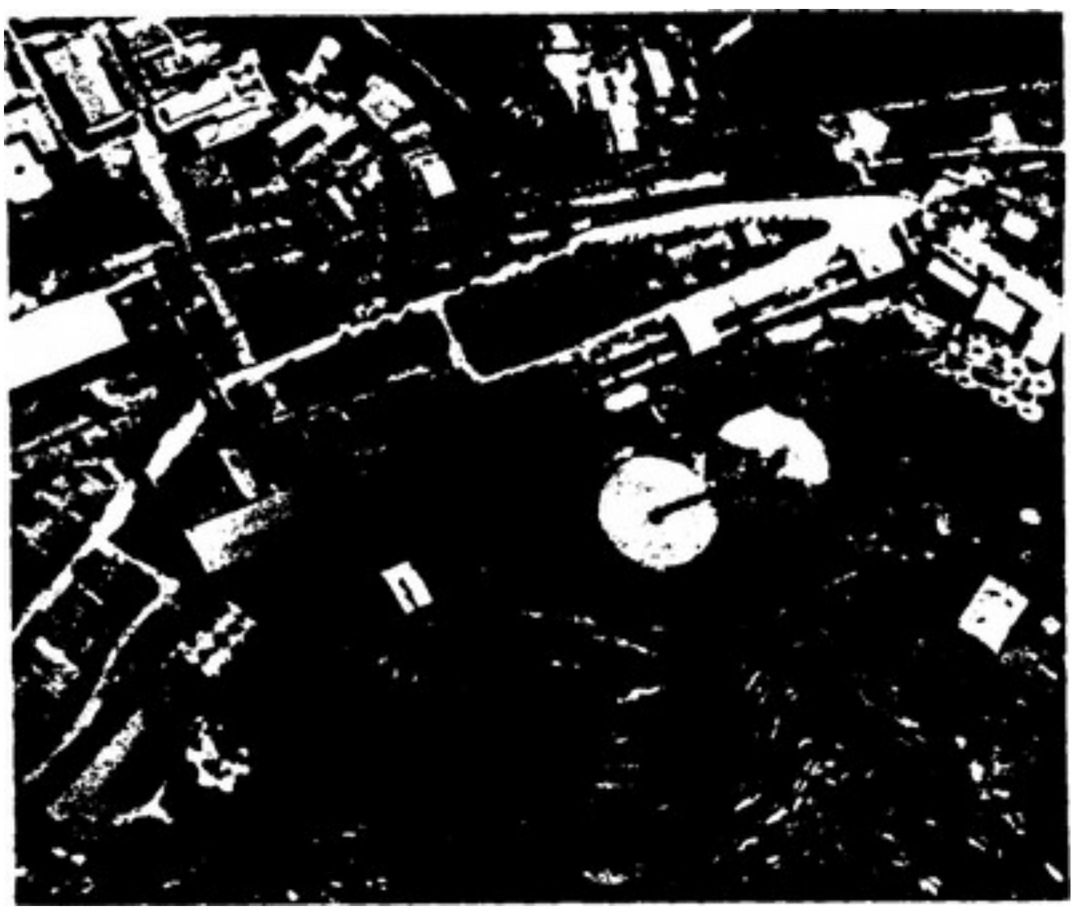


Figure 4.

Although cement is not itself an exotic commodity, an increase in its production is highly suggestive of industrial expansion. This was one of the early indicators of industrial revival in China after the collapse of the Great Leap. There is one reservation about cement output estimates made from aerial photography. The higher the quality of the cement a plant turns out in a given period of time, the lower the tonnage. The photography gives no insight into quality, and so collateral information is required for fully reliable production estimates.

Electric Power

High-altitude photography is of great value in determining the existence and location of power plants, and it gives reasonably accurate means for estimating their capacity. Successive photographs of the same plant show any additions to its capacity. Estimates of actual output, however, involve a great deal of subjectivity in interpreting the photographs. Estimates of the level of operation at time of photography are less than sure, and extrapolation from these to an annual output depends on the validity of a number of technical judgments and assumptions. Estimates of output derived from this source must therefore be regarded as indicating only a possible general order of magnitude.

With respect to capacity, the most accurate estimates can be made on the new Soviet-built plants in China, in which the turbogenerators are placed lengthwise in the generator hall. In these there are standard relationships between the layout and dimensions of the boiler house and generator ball on the one hand and the capacity and number of generating units installed on the other. The number of units and the capacity mix can be further pinned down by observing the wire leads from the generator hall and the boiler connections to the smokestacks. The standard relationships do not hold for other Chinese plants, in which the generator units are frequently placed crosswise in the hall. Here aerial photography provides only general indications of capacity such as the size and number of cooling towers, and collateral information is essential for the number and capacity of the generators.

For hydroelectric power plants, which are not standardized in China, aerial photography sometimes reveals the number of generator units installed, but often it can only assist in verifying or revising estimates of capacity based on collateral information.

Estimating the level of operation is extremely difficult. The main key from aerial photography is smoke, but this is an ambiguous indicator; the amount of smoke emitted from a stack depends on several factors, including the efficiency of the boiler, the type of coal used, and whether the boiler has just started operation. In the United States very efficient units with smoke-control apparatus may give off little observable smoke. It is believed that in China, however, with poor smoke-control measures and the use of poor-grade, high-volatility coal, more smoke coming from a plant means a higher intensity of operation. In a few cases the amount of steam visible has been used to estimate the level of activity at a power plant. Figure 5 shows the Kunming power plant emitting heavy smoke from its stacks. It is supposed to have been operating at a rather high rate when the photograph was taken.

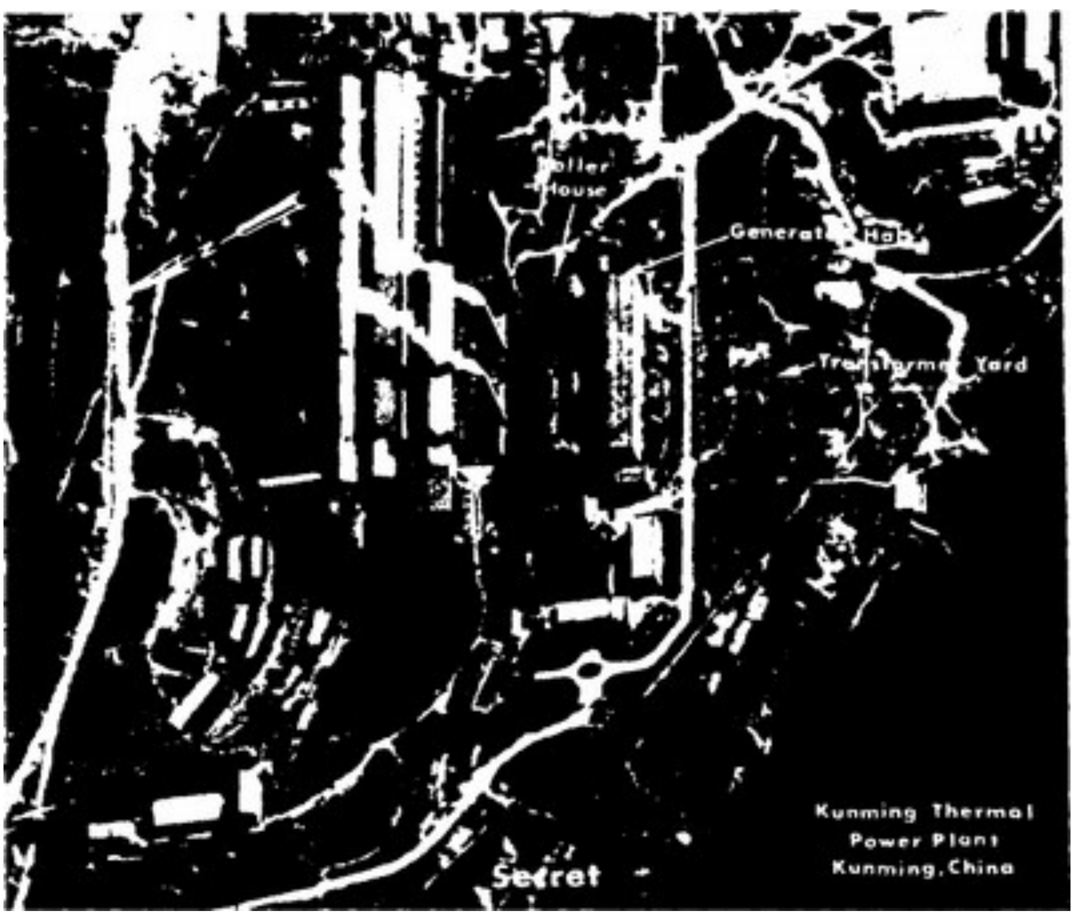


Figure 5.

Copper

Most of the Chinese copper production is concentrated at four large combination plants at mine sites. These plants process the ore, smelt it into blister copper, and then refine this electrolytically into commercially pure metal. The ore-dressing facilities, usually located on a hillside, can be distinguished by the steep roof-lines of the crusher and concentrator buildings. Dewatering tanks and tailing dumps are often also seen. The smelter usually has one or more tall smokestacks, anywhere from 300 to 600 feet high, from which comes a cloud of dense white smoke when the smelter is operating.

The refinery proper has no outstanding peculiarities which will invariably distinguish it from other types of industrial plants, but a number of features taken together suggest its purpose. The refining buildings include those with characteristic furnace stacks where the electrolytic anodes and commercial shapes are cast and the electrolytic tank house. A large power house or substation will be associated with the tank house and the casting building.

No reliable floor-space-to-output formulas have yet been developed for a copper refinery, but rough comparisons in size between the Chinese plants and those in the USSR where production rates are known give at least an order of magnitude for Chinese production. The analogy is more than assumed: the four major Chinese plants were built with Soviet aid and are of basic Soviet design. Although the Soviets withdrew before all of them were completed, most of the equipment had already been supplied. All four were operating in 1966 at what appeared under aerial surveillance to be good rates.

Railroads and Other Uses

Aerial photography is of little use in determining the production of railroad rolling stock, but it is a direct and accurate means of following the development of the railroad network of a country. It has been especially useful in application to the more remote areas of Communist

China. From the initial preparation of the roadbed through the construction of tunnels and bridges to the final laying and aligning of track, the whole construction process can be watched. Good quality photographs even show trains in transit on the completed lines. The determination of traffic density over a particular line, however, is a very difficult problem, and here the results from aerial photography, although some rather sophisticated methodologies have been tried, still leave much to be desired.

Some insight into capacities or operational levels of other sectors of the Chinese industrial base can be gained from aerial photography, and the purpose of new construction can often be determined if it is associated with a known installation. Plants pointed out by other sources can be watched and in some cases their operational status defined.

The over-all level of industrial activity in China can be surmised by projecting the activity in the key industries discussed above, particularly the iron and steel industry. Sometimes referred to as the "bellwether" of an economy, certainly steel output signals the general trend of economic activity in China, even though its correlation with GNP, national income, and the index of industrial activity is not perfect. The more skillful we can become in evaluating high-level photography on the most photogenic industries the better we will be able to assess the general economic situation in China.

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