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a partial translation and evaluation of the Soviet book Organization, Planning and Economics of Aircraft Production. The contributing authors are:

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INFORMATION REPORT INFORMATION REPORT

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Title: Organization, Planning and Economics of Aircraft Production [Organizatsiya, Planirovaniye i Ekonomika Aviatsionnogo Proizvodstva] Moscow, Oborongiz, 1963

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Table of Contents:

Purpose: [Excerpts from Preface]: In this book a complex account is provided of the questions of the economics of the aircraft industry, of its organization and planning of production in operation. Concrete questions of the organization of work of the enterprise are examined with respect to different types of aviation factories: aircraft building, engine building, instrument building and others. The special features of organization and planning of production for series as well as for experimental factories are examined.

The book provides a training aid for students in aviation institutes and perhaps also will be useful to engineering-technical workers of the aviation industry.

Reviewers: the Chair of Economics and Organization of Production of Kazan Aviation Institute and Docent A. A. Lapshin.

Editor: Candidate of Economic Sciences V. F. Novatskiy.

This training aid was written by a collective of the teaching faculty on the organization and economics of aircraft production of the Moscow Aviation Institute in compliance with the program of the one-term course offered by technical faculties of aviation institutes.

The introduction and Chapters 1, 2 and 11 were written by Professor N. A. Orlov; Chapter 3 by Candidate of Technical Sciences and Docent S. V. Moiseev; Chapters 4 and 19 by Candidate of Economic Sciences and Docent S. A. Sarkisyan; Chapters 5 and 10 by Candidate of Technical Sciences and Docent D. E. Starik; Chapter 6 by Docent P. G. Popov; Chapter 7 by Candidate of Economic Sciences and Docent E. I. Sherman and Candidate of Technical Sciences and Docent K. D. Zakharov; Chapter 8 by Candidate of Technical Sciences and Docent M. Z. Gendel'man, Candidate of Economical Sciences and Docent A. V. Glichev and Candidate of Technical Sciences and Professor A. N. Ter-Markaryan; Chapter 9 by Candidate of Technical Sciences and Professor A. N. Zhuravlev; Chapter 12 and 13 by Dr. of Economical Sciences and Professor D. P.

Andrianov; Chapter 14 by Candidate of Technical Sciences and Professor V. I. Tikhomirov; Chapter 15, 16, 17 and 22 by Candidate of Technical Sciences and Docent L. M. Ol'shevets; Chapters 18 and 21 by Candidate of Economic Sciences and Docent S. I. Didenko; Chapters 20 and 24 by Candidate of Economic Sciences L. M. El'bert; Chapter 23 by Candidate of Economical Sciences and Docent V. V. Chesnokov. The supervision of this collective of authors and the scientific editing has been provided by L. M. Ol'shevets and N. A. Orlov.

The collective of authors acknowledges with thanks the help of the reviewers and also of the workers of industry and the related chairs [departments] of aviation institutes, which they provided toward the creation of this training aid.

The authors request that all remarks and criticisms concerning the improvement of the book be forwarded either to the address of the publisher or to the Moscow Aviation Institute.

Review and Evaluation. Chapters II, IV, V and VI are of particular value in determining the present structure and general operations of the Soviet aircraft industry. Some of the criticisms of the industry, particularly regarding its failure to integrate more thoroughly with the non-defense industries of the Soviet Union, are particularly useful.

In tracing the historical development of the Soviet aircraft industry since the October Revolution, the textbook underlines the vast influence of mobilization for World War II on the growth of the industry, particularly through the massive relocation of airframe and engine plants in the Eastern portions of the country and the post-war re-establishment of those plants which had earlier been evacuated.

> In the years of the Great Fatherland War, the aviation industry played an outstanding role. In only one year (from December 1941 to December 1942) under conditions of evacuation of a number of factories to the Eastern regions of the nation and of constructing new aviation enterprises, the output of aircraft increased to 3.3 times and of engines to 5.4 times. In the subsequent years of the war, 120,000 aircraft were produced [in the USSR] during the same period that Hitler Germany, operating the aircraft industry of the European countries which it had occupied, produced 80,000 aircraft. (p. 13)

In Soviet terminology, the aviation industry is considered to include all plants which have as a primary responsibility the production of aviation products- airframes, engines, instruments (electrical and electronic) and equipment. The Soviet aviation industry, as a priority industry associated with national defense, has been less affected by the various industrial reorganizations of recent years. Following the dissolution of the Ministry of the Aviation Industry (MAP) during the general industrial reorganization of 1957, complete control of the aircraft industry including research, design, development, and series production of aircraft, powerplants and all related equipment, passed to the USSR State Committee for Aviation Technology (GKAT).

Some indication of the continuity of personnel and responsibilities which must have been preserved during this transfer is indicated by the following employment history of the current Chairman of the USSR State Committee for Aviation Technology, Pyotr Vasil'evich Dement'ev:

1941-1946 First Deputy Commissar of the Aviation Industry

1947-1953 Deputy Minister of the Aviation Industry

1953-1957 Minister of the Aviation Industry

1957-present Chairman of the USSR State Committee for Aviation Technology*

In the reorganization of Soviet industry in March 1963, the State Committee for Aviation Technology, along with other major Soviet State Committees, was placed under general control of the Supreme Council of the National Economy (VSNKh), which is in turn attached to the Council of Ministers. Other state committees with a similar level of authority and jurisdiction include those for Defense Technology, Radio-Electronics, Electronics Technology, Atomic Energy, and Shipbuilding.

* BSE, Second Edition, Volume 51, page 100.

Although the State Committee for Aviation Technology is seldom mentioned in the new textbook, the following statement taken from a discussion of the assignment of specializations to existing plants refers directly to the control of the State Committee over series production enterprises of the aviation industry:

> The right of determining the nomenclature of industrial production and defining the specialization of the branch enterprises was given to the State Committee for Aviation Technology in the same manner that other state committees received the same responsibility. (p. 83)

Organization of Industrial Processes. For purposes of definition, the authors divide the processes and activities of an aviation production enterprise into the following three broad categories:

a. Basic processes
   - materials prefabrication
   - materials fabrication
   - assembly
   - testing

b. Auxiliary processes
   - tooling
   - jigs and fixtures

equipment maintenance

energy transformation

c. Service processes

supply and warehouse inventory

general plant maintenance (p. 26)

Figure 5.1 (see figures at the end of this text) provides a breakdown of specific services performed under each of these categories and sub-categories.

Prefabrication is described as the manufacture of semi-finished items- castings, forgings, hot and cold stampings. "In modern aircraft construction, materials in the form of steel and nonferrous castings, welded pieces, stampings and sheet materials, parts stamped and formed out of plastic, and so forth, are widely utilized." (p. 25)

The fabrication stage "basically includes the fabrication of metal by cutting. To this stage also belong chemical-thermal, galvanic and electrical methods of processing and finishing of products." (p. 25)

Concerning new processes of materials fabrication, the authors comment:

In recent times a considerably closer relationship has begun to emerge between the prefabrication

and the fabrication stage. Thus, for example, the processes of cold stamping of sheet and rolled materials have acquired the nature of pressure fabrication which scarcely requires subsequent finishing. Casting under pressure, precision and other types of castings not requiring mechanical processing of the parts embrace, as it were, both the prefabrication and fabrication stages. A similar characteristic is found in the forge-press operations in connection with the increasingly greater use of coining processes. (pp 25-26)

The assembly stage, which in Soviet industrial terminology embraces component and subassembly processes through final assembly, accounts, according to the text, for up to 40 to 50 percent of the volume of work of an aviation plant. (Unfortunately, this figure is not related to a specific aspect of production such as floorspace or man-hours. In addition, the text only refers to an "aviation" plant rather than to a specific type of production, and so the statement can only be taken to represent an average based on all types of aviation production from instruments and equipment through engines and airframes. On the other hand, the figure of 40 to 50 percent for all types of assembly does represent a reasonable figure for an airframe plant.) In emphasizing the comparatively large portion of activity which is allocated to the assembly stage, the text poin s out:

A modern aviation engine has more than 5,000 designated parts and an aircraft of medium tonnage up to 300,000 parts. The requirements for the precision of manufacture and assembly of parts are being continuously increased. The assembly process of complex items of manufacture (machines, mechanisms, subassemblies, etc.) is also broken down into a number of constituent features of its processes, each of which consists of a number of consecutive operations. (pp 23-27)

A medium-weight jet aircraft of U.S. manufacture such as the Boeing 727 jet transport is calculated to have some 80,000 parts independent of standard fasteners and rivets. Consequently, the figure of 300,000 probably includes not only the details, components and assemblies of the aircraft but the standard parts such as nuts, bolts and screws as well. It certainly does not include rivets, because, as the authors state elsewhere, there are more than a million rivets in an aircraft of medium to heavy weight.

The final stage of the basic processes is testing, which, according to the text, is carried out initially at the plant. "At aircraft construction plants, the factory tests include a program of operations at the aerodrome section and at the flight test station (LIS) [of the plant]; at aircraft engine construction plants, the factory tests include checkout processes and tests of aircraft engines on

engine test stands; and in subassembly and instrument-building plants, they include the testing of subassemblies and instruments on special stands and in test stations." (p. 27)

Ever since the 22nd Congress of the Communist Party of the Soviet Union in 1961, the following key words, related to the development of industry in the USSR, have been stressed:

concentration
specialization
cooperation
combination

According to the program of the CPSU presented to the 22nd Party Congress:

> The development of specialization and cooperation and also the expedient combination of similar enterprises is one of the most important conditions of technical progress and of the rational organization of socialist labor.

The application of these terms individually or in combination refers primarily to a requirement levied on Soviet industry to achieve greater specialization in all types of manufacturing, and to eliminate the strong vertical structures still apparent in many phases of industry with their attendant duplication of production processes. It would appear from the text that

the aircraft industry, protected by the priority nature of its work, has maintained a relatively vertical structure, containing within its enterprises a number of specialized production facilities which duplicate activities of the Soviet industry at large- i.e. the manufacture by an aviation radio plant of end products which could best be produced by a plant of the electronics industry.

An attempt is made, in some of the following paragraphs, to define the general meaning of the terms listed above as they are currently interpreted in Soviet industrial practice.

Concentration. This term refers to the development of large-scale enterprise in order to lower the cost of production. The production enterprise of high concentration is assumed to be the most economical, but the authors make an important qualification by pointing out that the tendency toward concentration in a small number of large facilities must be controlled for strategic reasons and also in order to reduce the burden on the national transportation network. The historical Soviet tendency toward bigness, is, however, evident in the discussion of concentration of production, and it is clear that large-scale enterprise is still highly favored.

At the present time, the industry of the USSR in its level of concentration of production occupies

first place in the world. Thus, for example, in the manufacturing industries of the USSR, 65 per cent of all workers and employees are concentrated in enterprises with work forces of over 1,000, and these enterprises put out around 75 per cent of all products. In similar enterprises of the USA, only 33 per cent of workers and employees are concentrated, and they account for only 36 per cent of the total volume of production.... Aviation production, in comparison with other branches, is characterized by a higher degree of concentration. (p. 61)

Within the aviation industry, the highest degree of concentration has been attained in aircraft construction and engine construction enterprises, a fact which is explained by the special complexity of design of aircraft and engines. (p. 65)

In a manner characteristic of Soviet textbooks, the authors conclude by saying that concentration of production does not necessarily require an endless growth of an enterprise- that increase in the volume of production can occur not only as a result of the expansion of existing enterprises or construction of large new plants, but that it can also be achieved by the putting in to service of several smaller plants which have in combination the same productive capacity. In other words, concentration can also be achieved by its opposite, dispersal.

The usual economic advantages of large-scale over small-scale enterprise are listed: the higher degree of intra-factory division of labor; the increase of productive capacity at a faster rate than capital investment in the expansion of a plant; the better rationalization of raw material utilization; the organization of special shops using the waste products from the basic manufacturing processes; the reduction of time required to put a new item into series production; and the greater means available for improvement of worker housing, restaurant services, and the operation of clubs, kindergartens and recreational activities.

The argument against massive concentration begins with the statement that construction of large-scale enterprises is not always economically or strategically advisable. The following line of argument is taken:

> The construction of excessively large enterprises can lead toward the organization of plants putting out unique products (for example, a specialized factory manufacturing landing gear for all aircraft construction plants). The development of unique [i.e. single-product] plants would lead toward a breach in the complex development of economic regions of the nation and toward excessively long-range transportation. The construction of unique factories is inadmissible from the standpoint of strategic requirements, since the putting out of commission

> of such a plant would lead toward disruption of the output of a whole branch of industry. Thus, in the aircraft industry, it is more expedient to build "understudy" plants, that is the construction of several enterprises putting out one and the same product. The complexity of the problem of establishing the scale of an enterprise is further aggravated by a long list of contradictory factors. A comparison of the production process in the manufacture of hardware in enterprises turning out a single type of product has demonstrated that the lowest factory costs can be obtained, as a rule, in large-scale enterprises. But if one takes into account transportation costs, transportation volume, the necessity for complex development of the [economic] regions, the strategic and related requirements, then instead of a single large unique plant, it is more rational to develop several medium or small-sized "understudy" plants. (pp 66-67)

An apology is formulated for the industrial gigantomania of the 1930's by stating that the scale of industrial enterprises must be decided to some extent by the problems of a given historical stage of socialist development. Admitting that, in the course of the first and second five-year plans, the Soviet government concentrated primarily on the creation of giant enterprises, the authors explain that this course of action was dictated by the limited re-

sources of the nation, particularly in the availability of qualified cadres. During this same period, according to the text, the experience of the capitalist nations in the development of industrial enterprises was utilized to a great extent, implying that the faults of capitalist industrial planning were necessarily and unavoidably incorporated into Soviet industrial planning. The authors then go on to state one of their major theses with regard to the aviation industry, which, it should be remembered, incorporates the manufacture of airframes, engines, instruments, and equipments:

> At the present time, under the conditions which have now been achieved of a high degree of development of production, it is more expedient, as will be seen in our further remarks, to build, along with the large-scale enterprises, also the medium and small-sized highly specialized factories. (p.67)

The discussion of concentration closes with the general observation that, in present-day Soviet aviation enterprises, as a result of the introduction of new industrial technology, the total number of plant workers is decreasing while the number of engineering and technical staff is increasing. Even under these circumstances, the text points out, the scale of production is increasing, an evidence of the fact that the degree of concentration in Soviet industry is presently still on the increase.

Specialization. While the term concentration refers primarily to the scale of industrial enterprises, specialization of production has reference to the "homogeneity and seriality of production", in other words to highly repetitive serial production of a reduced number of standardized products. Typically, specialization of industry can refer in Soviet usage both to specialization of enterprises as a whole or to what is termed intra-factory specialization, in other words the specialization of different sections of a plant which may or may not be closely related to one another. These contradictory definitions tend to make even standard terminology somewhat ambivalent. Rather than indicating a lapse in the logical processes of the Soviet authors, it may represent a device by which the authors can discuss the Soviet aviation industry in real terms while at the same time paying tribute to the dictates of the 22nd Party Congress.

In their discussion of specialization, the authors come fairly close to making direct criticisms of the strongly vertical structure of the aircraft industry in the Soviet Union. These criticisms of the existing conditions provide the soundest basis for estimates of the current structure of the Soviet aviation industry. The authors begin by using the example of a specialized metal prefabrication plant:

> In specialized factories for the production of aviation products, cold rolling equipment is utilized approximately two times more efficiently

than in corresponding sections of aircraft construction and engine construction plants. Specialized enterprises were the first to use the most modern equipment (cold forming, screw upsetting and automated lines.).(p. 69)

At the same time, in the tooling sections of the aviation and other factories, production retains a small-scale series character. As a result, the labor costs of producing taps, micrometers, smooth plugs and other instruments in specialized factories are two to five times lower, the annual output of production per unit of floorspace is two to three times greater and the output of production per unit of capital investment is approximately 1.5 times greater than that of the instrument sections of the aviation plants.

It is clear therefore that, despite the official efforts of the government to promote greater specialization throughout Soviet industry generally, the aviation industry under the State Committee continues to be as it was under the Ministry, a vertically-integrated monopoly essentially independent of other fabricating industries. It has its own facilities, either separate or within the airframe and engine plants, for the manufacture of auxiliary equipment, instruments, and other intermediate products which are in-

corporated in the final output of completed aircraft. It is also clear, however, that some requirements are met by subcontracting or purpose from the general industry:

> ... About 50 percent of the manufacturing cost of an aircraft is accounted for by purchased products and semi-manufactures. Aviation plants maintain industrial relations with hundreds of enterprises both in the aviation and other branches of industry, obtaining from them large quantities of the most diverse products, including certain tools, and in part castings, stampings, electro-technical and other products (p. 78).

> The aviation industry, in contrast with other types of manufacturing, is a complicated field, uniting all the areas of manufacture of aviation products (airframe building, engine building, instrument building, radio industry, etc.). The manufacture of aviation products [and this clearly includes aircraft electronic equipment] is concentrated 90 to 95 per cent in the aviation industry. In aviation plants, aviation production is predominant and accounts for 85 to 95 per cent of the total volume of production (p. 70).

The authors claim that, under the program of the current seven-year plan (1959 to 1965), measures are being

implemented toward further specialization of semi-fabricate production and the production of standard "normalized" components. One of the examples chosen is the automotive industry, in which it is said that assembly plants will be freed from the manufacture of products not compatible with their basic profile.

With regard to specialization in the semi-fabrication of metal parts, and apparently referring to industry as a whole rather than the aviation industry, the authors state:

> It is believed that, by organizing specialized production, the number of sections turning out fasteners can be reduced to one twelfth and and of sections producing castings and stampings to two-thirds the present number. According to preliminary calculations, as a result of the specialization of castings and stamping production alone during the seven-year plan, a saving on the order of 1.1 billion rubles will be obtained. The total share of tool plants in the production of standardized and normalized tools should be increased about 2 times. In machine building, it is planned to increase significantly the degree of specialization in the production of gears, chains, reduction drives, electrodes, plastic parts and many other items of production.

> Increased work toward the specialization of production in the aviation industry is also scheduled during the seven-year plan. (p. 70)

In the current Soviet industrial theory, specialization of industrial production is divided into three basic categories:

a. Article specialization- the specialization of plants for the production of specific complex finished products.

b. Component specialization- specialization for the production of different finished parts, components and sub-assemblies.

c. Technological stage specialization- the specialization of plants in a given category of technological processes, such as stamping, forging or casting.

According to the authors, article specialization, or specialization according to finished products, such as airframes, engines, instruments and equipment, has been achieved to a comparatively higher degree in the aviation industry than in other branches of Soviet industry. The authors state, however, that article specialization, which calls for a reduction in the variety of parts and equipment produced by a given plant, must be subordinated to the need

of a rational distribution of specialized production for strategic and economic reasons. Within the heavy machine-building industry, the authors single out two large plants, Uralmashzavod in Sverdlovsk and Kramatorskiy Zavod at Kramatorsk, as examples of plants with too low a degree of specialization, indicating that these plants are called on to manufacture complex and diversified products in single copies.

Aviation plants, on the other hand, have apparently achieved a high degree of specialization. According to the text:

> Airframe plants are specialized by the flying weight of the aircraft (light, medium, heavy) and even by different types of aircraft. Aviation engine-building plants are specialized by type of engines- piston or jet engines- and also by different types of jet engines (turbojet, turbofan, etc.)

The text makes clear that the degree of article specialization in the aviation instrument and equipment plants is lower than in the airframe plants, a fact which is hardly surprising. What is interesting in the discussion of this subject is the confirmation that there are radio equipment, instrument, electronics and other specialized plants which belong exclusively to the aviation industry and not to the

corresponding branches of the civilian industries. The authors state in passing that the manufacture of many instruments which are now being manufactumed by the aviation industry should [probably] be transferred to instrument-building plants of general industry. The pertinent passage reads as follows:

> The degree of article specialization in instrument building is lower than in airframe factories. The nomenclature of items of manufacture in instrument-building plants is still very large. Thus, for example, in one of the smaller instrument-building plants, the nomenclature of manufactured items totals 150 separate designations.
>
> Nearly the same situation exists also in factories which are producing aviation radio equipment. Therefore, the development of article specialization in the aviation industry requires first of all an increase in the degree of specialization in the radio-technological and instrument-building plants by means of redistribution and selection of a unified list of products. The manufacture of many instruments, such as manometers, thermometers, potentiometers, and other control and measuring devices which are being widely utilized in different areas of industry, should be transferred to the general instrument-building plants serving

all industries [i.e. removed out of instrument-building plants of the aviation industry]. (pp 70-71)

Component specialization is described as "specialization according to production of different finished parts of a complex finished product: individual details, components, and sub-assemblies". This type of specialization depends, of course, on the degree of standardization and unification of components in different mechanical systems. After advancing the usual arguments for interchangeability of fittings, components, and sub-assemblies, the authors go on to charge that the present level of standardization in Soviet industry is failing "by a long way to answer the problems of development of mass specialized industry."

With particular reference to aviation manufacturing, they charge that the per cent of standardized and normalized components is significantly lower than the national industrial average because most of the components in the aviation industry are made according to narrowly specialized norms of individual plants. The text states:

> In aviation enterprises, about 90 per cent of the standardized and normalized components falls into narrowly specialized categories of items; (parts for airframes are designated by the letter 'S' [for samolet, or aircraft] and parts for engines by the letter 'M' [for motor, or engine]), so that the total list of non-standard components

utilized in the aviation industry is large and the possibility of interchanging different design elements is small. (p. 73)

Continuing under the heading of component specialization, the authors launch an outspoken attack on the present tendency of the aviation industry to retain control over the manufacturing processes which are unrelated to the final output of the aviation plants. Their argument runs as follows:

> The production of components, the technology of which differs sharply from the technological processes of the main production ought to be removed from aviation factories. This is true above all of non-metal items of manufacture-- items made of leather, plastic, organic glass, rubber, textiles and wood. Plastic components are being especially widely applied in radio technology and instrument building [here the authors are apparently referring to radio and instrument plants of the aviation industry], for terminal plates, flywheels, commutaters. The scattering of production of plastic components leads towards poor utilization of equipment, especially of the single-purpose high-pressure presses. Of the total number of presses with which the plastics industries are equipped, only around 26 per cent are in the enterprises of the chemical industry. Because of this fact, plants of the chemical industry

process only about 50 per cent of pressed plastic materials. The production of manufactured items from textiles and fibers (coverings, casings, etc.) should be delegated to enterprises of the light industry and of the textile industry; the manufacture of wood and cardboard packaging- to local industry. By this means progressive technological processes could be utilized in manufacture. At the present time the production of items made from non-metallic materials in aviation factories is often carried out by hand methods.

In the construction of aviation products, a huge number of fasteners is used. Thus, for example, in the construction of a heavy aircraft over a million rivets can be counted and hundreds of thousands of nuts, fasteners, and other minor structural components. In different types of aircraft, more than 50 per cent of such details are identical and standardized. The largeness of volume, the similarity of design, and the use of similar parts for different products are creating the opportunity for centralization of production of the standardized and normalized components in the aviation industry within the boundaries of economic regions of the nation. (p. 73)

The inference is probably justified here that, even though some 50 per cent of the fasteners and fittings used in airframe construction are identical and standard, each airframe plant is nevertheless producing such details and components for itself. Otherwise, there would seem to be little reason or necessity for urging the standardized production of such components on the aviation industry.

As a final confirmation of the present tendency of the aircraft industry to hoard all types of production even remotely connected with the final output of aircraft, the following statement is useful:

> It is more expedient to place in factories of the electrical industry the production of such items as resisters, condensers, regulators, electric motors, and transformers. (pp 73-74)

Another form of specialization is stage or technological stage specialization, which refers to specialization by process- casting, forging or heat-treating- rather than by product. As the Soviet authors point out, the stage specialized enterprises almost always put out a product which "undergoes additional mechanical or other processing in the factories which manufacture the final product." In other words, stage specialization is centered on the pre-fabrication processes.

The authors attack the present tendency of the aviation industry to carry out its own prefabrication and tooling operations and calls for the release of these activities by the aircraft industry to the machine tool industry at large. The specific passage reads as follows:

> It would be rational to transfer all manufacture of standardized (normalized) cutting and measuring instruments, dies for stampings, press forms, machine tool accessories and forms for casting under pressure to the tool making plants, and to concentrate the manufacture of special tools in special sections [of the aviation industry] by sorting out the related categories of tools and redistributing their manufacture among the appropriate sections of related factories. There has been successful experience in the specialization of production of special tools in several of the engine-building plants, where, as a result of the organization of special sections, the output of tools from the same floor space has increased five to ten times. (p. 75)

In their summary statement on the desirability of specialization of all types, the authors make the interesting comment that through specialization of production, it is "sometimes possible to come to grips with the stagnation of departmental workers who are striving to keep a maximum

amount of production 'to themselves' in order to depend less on other enterprises."

In closing their discussion of specialization and the means of achieving it, the authors point out that separate methods must be applied to the Western and Eastern regions of the nation. They point out that a growth of industrial capacity is called for in the Eastern parts of the nation-- presumably east of the Urals-- under the latest program of the Communist Party of the Soviet Union. As a result, they report, it will be more rational to build new specialized plants in the Eastern regions; and to re-allocate and reorganize the production of existing plants in the Western region.

Cooperation. This term, one of the least precise in the current Soviet industrial terminology, apparently refers simply to the industrial supply relations among specialized industries-- i.e. the supply of raw materials, details, parts, components, sub-assemblies, and assemblies from one to another plant. Cooperation is defined primarily as a tangible result of specialization, and the categories listed for cooperation tend to parallel the specialization categories. The authors do, however, point out that:

> There is also cooperation which derives from the excess versus shortage of productive capacity. In this type of cooperation, the production links [established between enterprises] arise not as a

> direct result of specialization but as a result of the presence of excess productive capacity at one enterprise and a shortage at others, such as may develop in connection with quantitative and qualitative changes in the production programs (for example, an aircraft enterprise manufacturing castings for an automotive plant). (p. 77)

In our opinion, sufficient evidence is available to conclude that very little of the aviation-associated production is carried out by non-aviation plants; that there is still a strong tendency toward centralized and direct control over all types of the aircraft-associated production. The statement cited above does indicate, furthermore, that where surplus capacity exists within the aviation industry-- as it certainly must under present conditions of hoarding-- it is possible for an aviation enterprise to apply its surplus capacity to non-aviation production. It seems entirely probable that series production enterprises of the aviation industry-- plants for the production of airframes, engines, instruments and equipment-- might often be found utilizing their surplus capacity for non-aviation production in order simply to justify retention of the excess capacity. One example appeared recently in the western aviation press in a photograph by a British visitor to an airframe plant in Moscow manufacturing IL-18 turboprop transports which showed parallel production of

aluminum toy horses for [illegible] merry-go-rounds.

The current trend in Soviet industrial planning is to create relative industrial autonomy within each economic region. However, in relation to the aviation industry, the authors appear to recommend against this type of autonomy. They state:

> In the aviation industry, as a rule, it is impossible to limit cooperation to the boundaries of an economic region, since this would mean that each region would have to have a whole complex of enterprises supplying aviation production with the required products. (p. 78)

Returning to the question of excess capacity in the aviation industry, the authors state that during peacetime the productive capacity of the aviation industry is utilized to a considerably lower degree than during wartime. "Consequently," they say,

> the aircraft industry is able to use its excess capacity in satisfying the demands of other branches of the national economy. In doing so, one should select those items of civilian demand, the production of which will maximize the qualifications of the cadres and at the same time preserve the flexibility of aviation plants. (p. 78)

Further on the authors point out that:

> Cooperation between defense plants and enterprises producing non-military products properly organized within economic regions will ease and speed up the process of mobilization of industry in time of war. (p. 78)

This last quoted comment further indicates what is already known, that there is a sharp cleavage in the Soviet Union between defense and non-defense industries and that, at the local or regional level, there is very little lateral coordination between the two.

Combination.

A combine is formally described as "a form of production based on the concentration of products of different branches of industry into one combine-enterprise. Production forming an industrial combine must be organically inter-related with respect to technology, utility requirements, organization and economics."

The authors list two basic types of combines:

a. A combine based on the concentration of successive processing stages within a single

enterprise- for example a metallurgical combine embracing all operations from blast furnace through rolling mill for the production of steel.

b. Combines based on the composite utilization of raw materials, supplies and energy rather than on similarity of end product-- for example, a combine of nonferrous metallurigical enterprises with chemical production enterprises.

The authors point out that combines of the second type, based on the composite utilization of materials, have appeared in the aviation industry: large aircraft and engine construction plants have, as a by-product of their basic operation, manufactured articles for general consumption. This possibility would presumably occur in cases where scrap metals, such as aluminum alloys, are used for production of consumer goods by an airframe or engine plant as a side line.

The first type of combine, the one in which successive processing stages are joined in a single enterprise, occurs in aviation plants, according to the authors, when foundry and hot-stamping processes are combined with fabrication and assembly. The authors caution that such a combine is not intended as a favorable example and indicate that hot metal working plants are now independent branches of industry which should not be combined with conventional metal parts

fabrication in an aviation factory. A few paragraphs later the authors go on to say that "the presence of forge and foundries sections in aviation plants does not answer modern requirements."

Principles of industrial location. In line with similar statements by Sokolovskiy in Voennaya Strategiya [Military Strategy] (Oborongiz 1963), the authors criticize the irregular distribution of the aviation industry in capitalist countries and go on to point out that industrial location of the aircraft industry in the Soviet Union has been carried out on a rational basis in order to make optimum utilization of natural resources and to eliminate excessively long hauls in transportation and to provide strategic protection. The authors report that in the Soviet Union

> a planned movement of industry is being carried out to the East, where more than 75 per cent of the coal reserves, 80 per cent of water resources, 80 per cent of the forests, significant iron ore reserves, and basic resources of nonferrous and rare metals are located....
>
> At the present time, more than one-third of all industrial production takes place in the Eastern regions of the country.

> In accordance with the program of the CPSU, new energy sources and new macnine construction centers must be built in Siberia and Kazakhstan, and the construction of a third metallurgical base [sic] for the country must be completed in Siberia. A rapid build-up is contemplated for the energy, oil, gas, iron-ore and chemical industries in the Volga region, in the Urals, and central Asia and in the Northern Caucasus. In this manner, the gigantic scale of new construction will in the near future result in significant changes in the economic map of the country. (pp 81-82)

The authors state that, while each region has its own significant economic and industrial specialties, such specialization should be combined with the complex internal development of each of the economic regions independently. They then indicate that the aircraft industry must be viewed separately from the present trend toward relative autonomy of the economic regions. The text states the following:

> Aviation plants should not be built just in the West or just in the South, and airframe plants should not be located in one region while engine-building plants are located in another and instrument plants in a third.
>
> In selecting the location for the construction of aviation plants, strategic requirements are

also taken into consideration, among them the requirement of being located away from the country's borders and away from large plants of other industries which might by the nature of their work reveal the whereabouts of an aviation plant. (p. 82-83)

Basic Production Groups in Aviation Plants. The production process, according to Soviet terminology, and the related plant facilities normally fall into three general categories: basic, auxiliary and service.

The basic sections of the plant are those used directly for the manufacture of the main products. They accommodate all stages of production and are sub-divided into prefabrication, fabrication, assembly and testing sections.

The auxiliary sections of a plant serve to support the work of the basic sections and assure uninterrupted flow of activity in the basic sections. The auxiliary sections can be divided in a number of ways. In general, their main task is to provide and maintain all the tooling and equipment required for production in the basic sections, the various types of energy required, including electricity and compressed air and also repair, maintenance, and modernization of plant and equipment.

The service sections are those which are needed for the general support of the basic and auxiliary sections.

They provide storage facilities, control, general supplies, maintain inventories, perform testing of materials, tools and instruments and provide other services, such as packaging and shipping.

Intra-plant specialization. In general, the sub-divisions of the plant correspond to the classification of a finished aircraft product, such as final assemblies, sub-assemblies and components. The typical form of specialization within an airframe plant is specialization by categories of assembly, such as fuselage, wing or empennage. This same form of specialization for shops [tsekhi] also reaches down into the sections, as for example the following sections of an empennage shop: stabilizer, rudder and elevator sections. The authors state explicitly:

> The production output of an aviation factory influences the structure of the plant by the design-technological breakdown. Thus the major parts of an aircraft (fuselage, wings, empennage, etc.) predetermines the profile of the major assembly shops of an aircraft construction factory (see figure 5.1). Specialization of the mechanical, mechanical-assembly, and metal welding shops in an aircraft engine factory has developed under the influence of the construction-technological breakdown of a ramjet engine with a centrifugal compressor (compressor

body, compressor rotors, turbine rotors, combustion chamber, fuel injection with nozzle junction box assembly, etc.) (see figure 5.2).

The authors then point out that, in sub-divisions below the assembly level-- i.e. into parts fabrication and prefabrication-- specialization moves from the article specialization into the process specialization according to the various metal-forming and treating processes employed in the fabrication of parts. The authors use the example of an engine plant, avoiding as always the use of airframe plants as specific examples. This device confirms the greater Soviet sensitivity about information on airframe plants and, consequently, their greater importance in an arms control environment.

> If the structure of production were formed only through the influence of the design-technical breakdown of the engine, then the plant would have the article-sub-assembly specialized shops, each shop with a complete manufacturing cycle. In each of these shops several operations- forging, casting, sanding, metal welding, heat-treating, assembly and other types of work- would take place. However, in terms of modern methods and techniques of production, the provision for all of these types of processes in all of the specialized shops can result in a lower utilization of expensive and highly productive

equipment. This consideration has led to the creation within factories of separate, specialized stamping, forging, casting, heat-treating and coating shops (p. 97).

In conclusion, the authors call for further specialization primarily at the semi-fabrication end of the production cycle-- the processes dealing with semi-fabricated parts and components, the sub-contracting of which would permit a decrease in the number of basic shops in the air-frame plant itself. The authors call for the organization of new plants to produce semi-fabricated materials, components, sub-assemblies and even final assemblies. In closing they say that the conditions must be created for the manufacture of many semi-fabricated articles, assemblies and components by independent production facilities.

Composition of the Basic Production Shops and Sections in Aviation Plants. Going back to the definitions of the basic production processes, the authors make an attempt to categorize the activities within each of the sub-divisions of the basic activity of a plant: prefabrication, fabrication, assembly and testing.

The prefabrication shops perform the forging, casting, and rough machining of metals. The authors state that the most highly developed forging and casting shops are in the engine manufacturing plants and that 9 to 10 per

cent of labor in engine manufacture is used in casting process. In addition, they state that numerous types of casting shops exist in a single engine plant, corresponding to either the technological specialization (for example, precision casting) or the article specialization (for example, aluminum or magnesium alloys).

In the prefabrication stage of airframe construction, according to the authors, preliminary stamping work takes up the largest share. They state that while in engine production stamping processes account for 3 to 4 per cent of the total of labor they account for 8 to 12 per cent in the construction of light aircraft: "More than half of all the components of a light aircraft are manufactured in the preliminary stamping shops, and the nomenclature of each shop reaches several thousand component designations." Laboring the obvious, the authors state that in the fabrication stage of the basic production, the technological rather than article specialization is much more likely to obtain. They point out that article specialization commences in the assembly shops, but that in the fabrication sections of a plant, the specialization by type of process-- and covering a fairly wide range of articles-- is more likely to be found: "... the general mechanical shop of one of the aircraft construction factories consists of four sections: turret lathe section, for fabricating large components; milling section; fitting section; and a section for the assembly and test of auxiliary fittings." In the article specialized shops, there are also article specialized sub-sections

concerned with a single component of a major assembly, for example, a section for the components of the forward landing gear wheels and a section for the components of the main landing gear or for components of the hydraulic assemblies of the landing gear.

Implying that such conditions do not presently obtain, the authors say that it would be desirable "to have sub-sections specialized for the manufacture of constructionally and technologically similar parts. In this regard a great deal of help can be found in the dassification of components according to design-technological indices. Thus, all mechanically fabricated components of a light aircraft are divided into 28 classification (brackets, fittings, arms and levers, cylinders, wing bolts and so forth)".

The authors then proceed to a relatively useful discussion of the organization of assembly shops in aviation enterprises. They appear to refer to the work of the final assembly shops as installation-assembly operations and to that of the intermediate assembly shops as mechanical-assembly operations.

The most widespread development of the intermediate assembly shops has taken place in the airframe plants. In the majority of cases, these shops are organized according to an article

designation, i.e. in each shop there are concentrated the sub-assembly, panel, jig and jigless assemblies of one or several final sub-assemblies.

In some plants there are intermediate assembly shops which carry out the assembly of components (frames and ribs) for all the sub-assemblies of the aircraft. The establishment of such a shop permits better assembly mechanization and the adoption of multiple assembly mechanisms.

The forms of specialization of sections of the intermediate assembly shops are of three types: article specialization, in which the section is responsible for the assembly of all parts of a given unit (including sub-assembly, panel, jig and jigless); technological specialization, according to the assembly stage, in which each section carries out one aspect of the assembly operation but on all the sub-assemblies. As experience shows, the last form of specialization is the most advisable. In this form, the sections for sub-assembly and panel assembly manufacture sub-assemblies and panels which are constructionally and technologically similar (for example, double or single curvature panels). This condition creates

> the prerequisites for increasing the level of work- mechanization, for better use of the floor space and for the adoption of standardized multiple devices. (p. 106)

Another important statement, permitting a clear definition of activities in a final assembly shop as opposed to intermediate assembly operations, is the following:

> Work on the mating of intermediate assemblies, on systems installation and testing, on electric cable installation, on the installation of instrument panels, etc., is carried out in the final assembly shop of the airframe plants. (p. 106)

Organizational Structure of Aviation Plant Management. After reviewing the basic chains of command within an aviation enterprise, the authors point out that, due to the complexity of aviation products, the frequent changes in the nature of the product, and the high demands on quality control of the products, the management control apparatus occupies a proportionately higher weight in the total organizational structure than in other types of industry:

> Multi-component aviation products and the large number of varied operations which are carried out in the manufacture of components, sub-assemblies

and final assemblies increase the role of the production and planning-expediting system (section chiefs, team leaders, distributors, planners, expediters, etc.). (pp 122-123)

The following material is quoted directly from the text:

At the head of each enterprise is the director, an agent of the government. He is chosen by the Sovnarkhoz (and in experimental enterprises by the State Committee for Aviation Technology) and, according to the principle of one-man management, acts as the manager of all the production-economic activities of the enterprise.

The director must organize the work of the whole collective in such a way that he can guarantee the output of a high quality product in the quantities contemplated by the plan, so that he can create the necessary conditions for the constant perfection of production and carry out economy measures in all facets of the production-economic activities of the enterprise. The director carries out inspection and daily control of the production process, is responsible for the selection and proper distribution of the cadres throughout the plant and guarantees the observance of plan, fiscal and labor discipline. [Note here that he is not responsible for Party discipline]. The director

is responsible for the filfillment of agreed-upon obligations to other enterprises (the timely delivery of a finished product in a cooperative agreement, the timely payment for delivered goods, etc.). The director is responsible for establishing excellent work conditions in the enterprise, and he looks after the improvement of the cultumal and daily conditions of the workers.

The director is given extensive rights. These rights were established by resolution of the Council of Ministers of the USSR on 9 August 1955 and in various other decisions.

With the aim of achieving considerable independence and effectiveness in management, the directors are given the right to: ratify the technological industrial fiscal plan of the enterprise in regard to all qualitative and quantitative indices in the event of need to change, within the limits of a quarter, the plans for hardware production (except for mass produced goods and with the consent of the customer); to ratify on the basis of the enterprise's yearly plan the monthly plans for capital construction and for putting new capacity into operation, and also the yearly, quarterly, and monthly plans for capital maintenance and repair with limited funds set aside for

that purpose; in time of need to make the necessary expenditures for the reconstruction of separate assemblies and for the modernization in accordance with the amortization calculations; to sell surplus materials, equipment and other valuable materials not used in the enterprise; to acquire special equipment, instruments, and materials for carrying out scientific research and experimental design work within the limits of the ratified estimate; ratify and change the structure and states of the shops and departments of the factory management within the limits of the established enterprise plan for labor and number of workers and engineer-technical personnel; establish and change the rate of pay for the department workers within the limits of the official rate of pay and the ratified fund for wages.

The following basic departments of the factory management are directly subordinate to the director.

Planning-economic department (PEO) handles the working out of the entire complex of problems in the planning and economics and work analysis of the enterprise, and also controls the fulfillment of all planned tasks and norms as well as the limits and tasks for the shops and departments in terms of all indices; it organizes and guides the

statistical calculations in the enterprise, and handles the methodical supervision of the work of the economics shops.

In several aircraft construction plants there organized planning production departments (PPO) instead of the planning-economic departments (PEO); these have the function of effective calendar planning for all the activities of the enterprise. In small factories separate planning departments are created which carry out all the work in connection with production planning and dispatching.

The labor organization and wages department (OTZ) performs work in labor organization, tariffing, wages, and in norm setting. It develops the forms for labor payments and the system of premiums, and it controls the outgo of funds for wages.

The chief bookkeeping section organizes and performs all the bookkeeping accounts covering all the economic activities of the enterprise, the accounts of the utilization of resources in the enterprise, it controls the maintenance of fiscal discipline and the safety of socialist property.

The technical control department (OTK) supervises

quality control and product completeness, and it averts the possibility of waste in production. The chief of product quality control, like the chief bookkeeper, is selected or removed from his position only by a decision of the highest organs following the recommendation of the factory director.

The chief engineer is the first deputy director; with the director, he shares responsibility for the work of the enterprise. The chief engineer establishes the technical policy of the factory. He answers for the correct and rational organization of all technical preparation for production and for the fulfillment of the factory's technical development plan. All managers who carry out technical preparation and serial product production are subordinate to the chief engineer who is responsible for the control tests of an aircraft and its equipment.

The series-design department (SKO) carries out the final design work in conformity with series production, re-works experimental drawings into series production drawings, ensures production by providing working drawings, puts together specific components and sub-assemblies which form a completed hardware item, and makes changes

in the series drawings with the aim of modernizing and improving the design.

The department of the chief technologist (OGT) develops, introduces and perfects technological processes, develops special rigging, works out norms for the use of basic and auxiliary materials on hardware, and keeps an eye on the observance of technological discipline in the basic and auxiliary production shops. Departments for mechanization and production automation, which are subordinate to the chief technologist, are organized in several large factories. In large factories for aviation engines there is organized a department of the chief metallurgist, who carries out technological functions according to the group of hot-working shops.

The department of the chief mechanic carries out the maintenance of the production buildings, equipment and production and utility machinery; he supervises their exploitation, the fulfillment of planned preventive maintenance, the carrying out of modernization on the operating equipment in the factory, and the preparation of new and unique equipment.

The production chief is the deputy chief engineer

for production; his basic function is to guarantee the fulfillment of the production program by means of a regular output organization on the part of the basic shops. The production chief has either a production-dispatcher (PDO) department or a dispatcher department which controls and regulates the carrying out of the plans for the shops. The chief dispatcher of the factory is the head of the PDO.

In recent times councils on reliability and resources have been established in several enterprises under the direction of the chief engineer. The council on reliability and resources is composed of: the chief of the SKO, the chief technologist, the chief controller, the chief of production, and the customer's representative. The basic task entrusted to the council on resources and reliability is to improve the exploitational qualities of the product, and to increase its reliability. Questions of reliability and improving the resources of hardware are decided at the time of planning, technology evolvement, and production of the hardware. This is why such departments as SKO, OGT, OTK and the production chief should occupy themselves with such problems at the very first.

The carrying out of the seven-year plan for the development of the national economy demands the

most extensive increase in the level of production mechanization and automation as well as the intensification of the technological processes. This task can be successfully resolved by strengthening the organs of technical service in the factory (SKO, OGT, OGM, etc.). Nevertheless, several factories are using their engineering-technical workers incorrectly: as a result of the spread of administrative and management personnel the number of designers and technologists has decreased to 25-30 per cent of the total of the engineering-technical workers; at the same time in advanced factories, this figure is 50 per cent.

The second deputy director of the factory is the deputy for material-fiscal problems. Let us look at the functions of the departments which are subordinate to him.

The department of material-technical supply (OMTS) provides the enterprise with all the necessary materials, fuel, etc. The basic functions of the department are: making agreements with suppliers and controlling their fulfillment, organizing the reception, storage, and distribution of materials, and also the control of the use of materials by the shops. All the general factory material stores are subordinate to OMTS.

The fiscal-marketing department works out the financial plan for the enterprise and supervises its realization; it organizes the sale of the finished products, and develops communications between Gosbank and other financial organs.

The transportation shop organizes the transportation of cargo to and from the enterprise, is responsible for the proper exploitation of all transportation facilities under its direction and performs maintenance on them at the proper time.

This shop is also in charge of intra-factory and in small factories intra-shop transportation of products and materials.

The production cooperation department (OKSP) carries out the same functions as the OMTS but only in the purchase of semi-fabricated, prefabricated, and fabricated hardware. The OSPK does not exist in small factories.

The capital construction department handles all problems of construction and reconstruction in the enterprise. In factories with a volume of capital construction greater than 15 million rubles, the position of deputy director for capital construction may be established with the department

of capital construction being subordinate to that position.

The housekeeping (khozyaistvennyi) department is responsible for the immaculate condition of all parts of the industrial area (it tends to cleaning and planting) and it provides the enterprise with housekeeping inventory, and handles the office and factory printing office.

The assistant director for cadres is responsible for recruitment, training and distribution of personnel throughout the factory, as well as for plant security. The personnel and plant safety department (commandant's office and the bureau of absences) is subordinate to assistant director for personnel.

The assistant director for social-living conditions problems is found only in large factories. He manages the housing and communal services department and the living conditions institutions (nurseries, kindergartens, polyclinic, dining hall, etc.).