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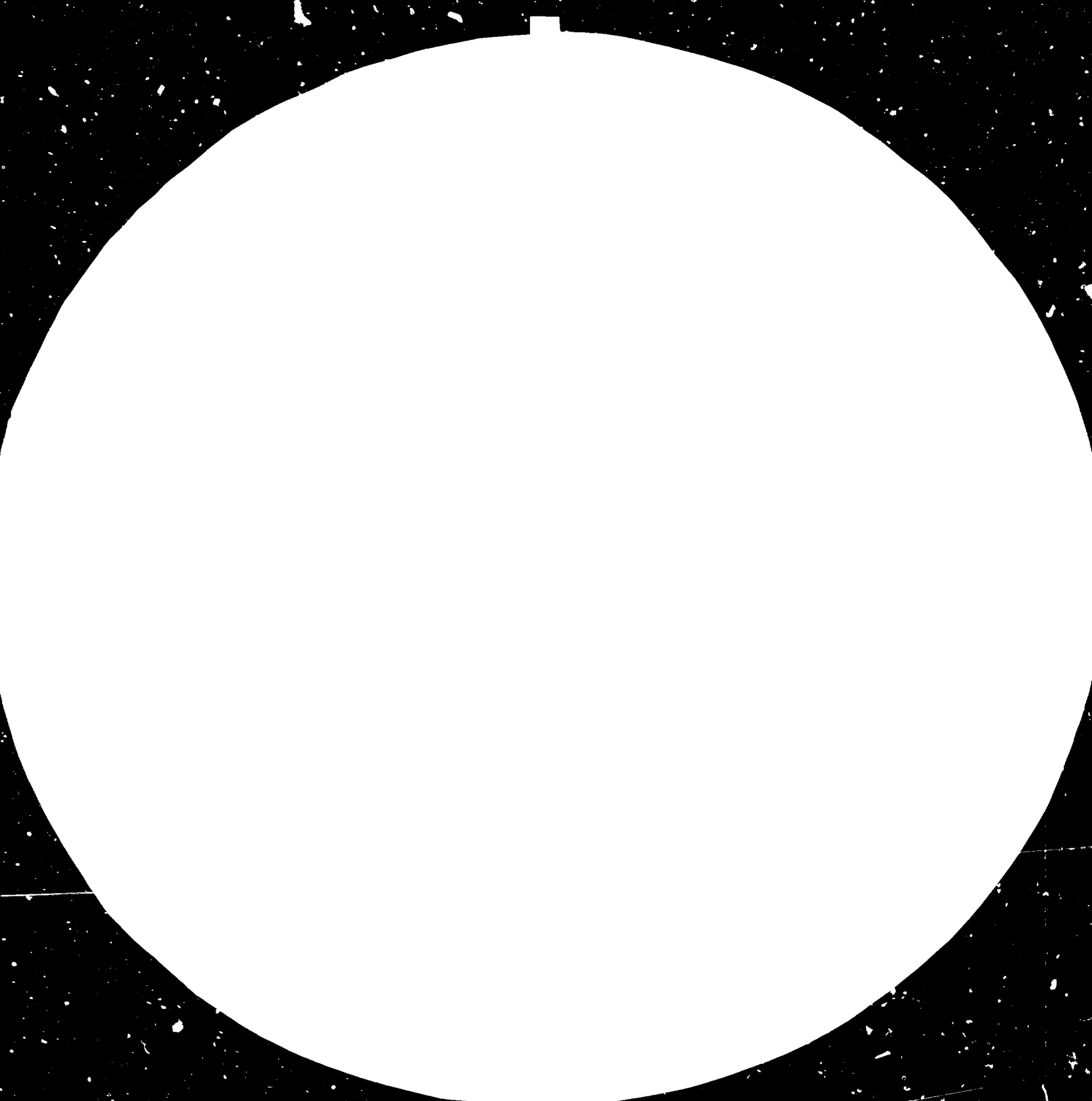

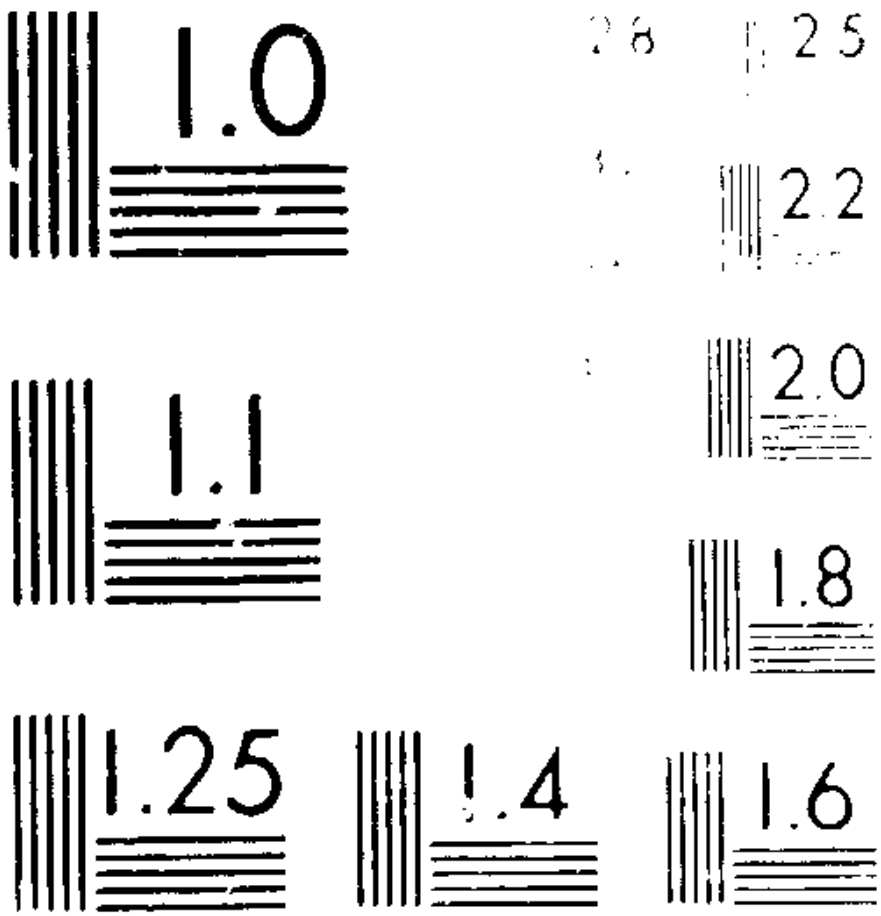
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THE USSR FOREST AND WOODWORKING INDUSTRIES

Sectoral Working Paper Series

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M. Burdin

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SECTORAL WORKING PAPERS

In the course of the work on major sectoral studies carried out by the UNIDO Division for Industrial Studies, several working papers are produced by the secretariat and by outside experts. Selected papers that are believed to be of interest to a wider audience are presented in the Sectoral Working Papers series. These papers are more exploratory and tentative than the sectoral studies. They are therefore subject to revision and modification before being incorporated into the sectoral studies.

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This document was prepared by two UNIDO consultants N.A. Burdin, deputy director of the VNIPIEIlesprom and V.A. Sylantyev, chief of the All-Union organization Soyuzbumzagranpostavka. I. M. Loginov, of the State Committee for Science and Technology, Moscow, acting as a UNIDO consultant, provided general consultation and overall coordination of the work. The designations employed, the presentation of material and the views expressed in this document are those of the consultants and do not necessarily reflect the views of the UNIDO secretariat.

Preface

This paper has been prepared in connection with the first world-wide study of the wood and wood-processing industries. It contains a description and analysis of the forestry and woodworking industries in the USSR. The information in this report has been used in the preparation of the world-wide study, however there are many details in this report which are not included in the main report. Thus this report is being issued separately in the Sectoral Working Papers Series.

This paper was prepared at the request of UNIDO, by experts from the Soviet Union.

The following UNIDO documents (including the present paper) have been prepared in the context of the world-wide study.

1. "First world-wide study of the wood and wood-processing industries", prepared by the UNIDO secretariat (UNIDO/IS.398).

2. "Wood resources and their use as raw material", prepared by the Food and Agriculture Organization of the United Nations (UNIDO/IS.399).

3. "A review of technology and technological development in the wood and wood-processing industry and its implications for developing countries", prepared by J.F. Brotchie (UNIDO/IS.-), in preparation.

4. "Environmental aspects of the wood and wood-processing industry", prepared by K.M. Strzepek (UNIDO/IS.394).

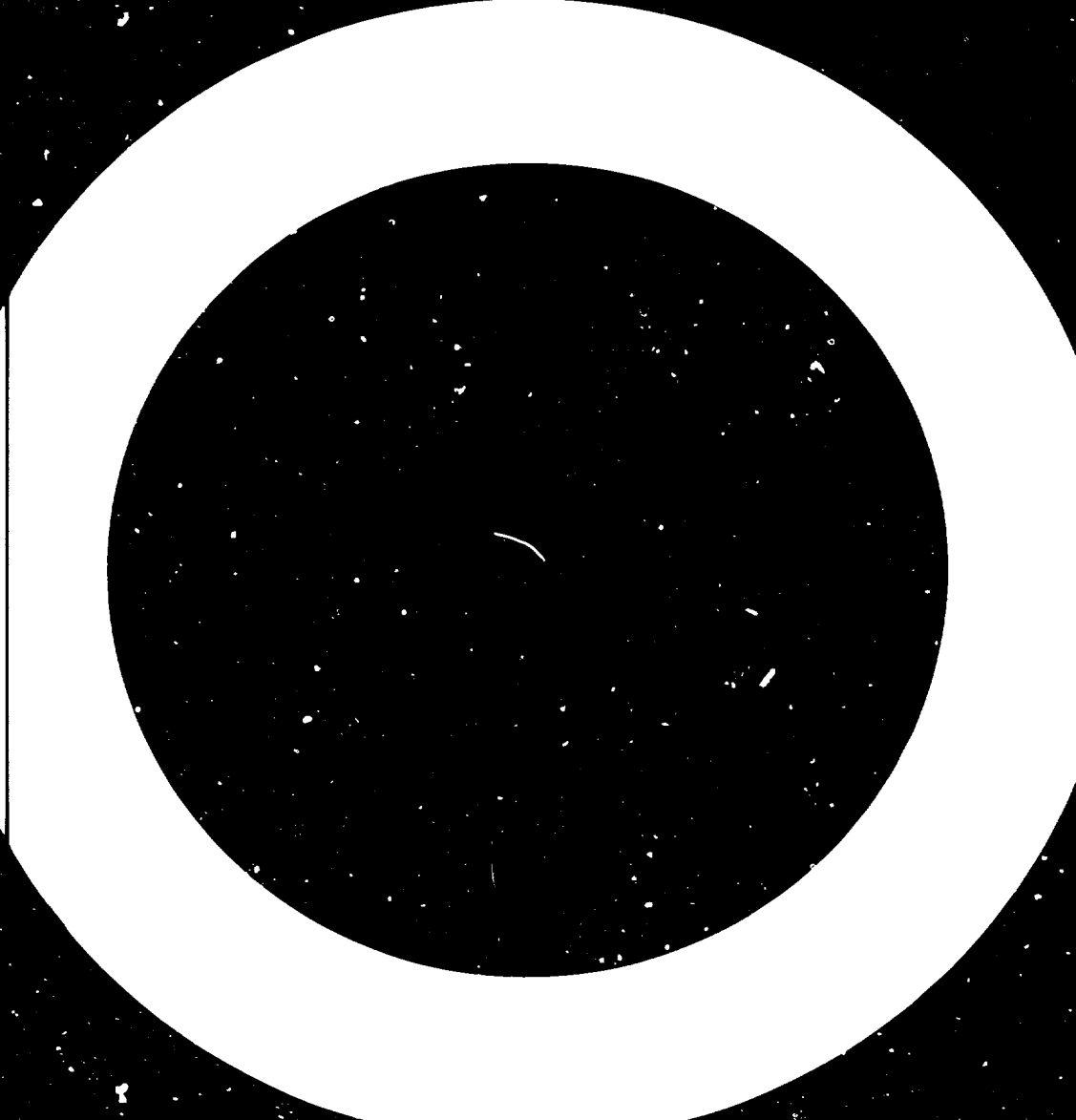
5. "Health and safety problems in the wood and wood-processing industries", prepared by the secretariat of the International Labour Organisation (UNIDO/IS.-), in preparation.

6. "Potentials and requirements of increasing the degree of wood-processing in developing countries of Asia and the Pacific", prepared by H.P. Brion (UNIDO/IS.395).

7. "Tariff and non-tariff measures in world trade of wood and wood products", prepared by the Secretariat of the United Nations Conference on Trade and Development (UNIDO/IS.396).

8. "The USSR forest and woodworking industries", prepared by N.A. Burdin and V.A. Sylantyev (UNIDO/IS.406).

9. "Wood and wood-processing industry as a consumer and supplier of energy", prepared by Swedforest Consulting AB (UNIDO/IS.-), in preparation.



CONTENTS

Tables

Figures

INTRODUCTION: PROBLEMS AND METHODOLOGY

Forests in the Union of Soviet Socialist Republics are the national property of the Soviet people. They are both a part and an object of the planned economy. In terms of area under forest and volume of growing stock and wood removals, the USSR is first in the world. Unlike other natural resources, the growing stock of wood is renewable and can even be increased by proper and efficient forest management. The availability of a substantial quantity of mature and overmature growing stock ensures the stable and planned development of all branches of forest-related industry to meet the ever-growing wood and wood-product requirements of the national economy. According to calculations by Soviet economists, however, wood harvests in the USSR and throughout the world are unable to keep pace with wood requirements. The most important trend in the Soviet forest and woodworking industry, therefore, is the growth in the production of efficient solid wood substitutes (manufacturing of particle board, fibreboard, plywood and paper board) compared with growth in the logging industry.

In the last few years, there has been a steady growth in the use of logging and woodworking residues in the manufacture of woodbased panels and pulpwood, hydrolysis and the production of medicines. The use of soft hardwoods has also been steadily expanding.

Progress has been achieved in the logging and woodworking industries by replacing manual operations with mechanized systems of new machines and equipment in the production processes and pre-processing auxiliary operations.

New machinery and technological processes are, in turn, specially designed to ensure a more comprehensive use of forest biomass and improved environmental protection. These new machines and processes are valuable both from the engineering and economic points of view. The new tree-length and whole-tree logging process, with subsequent transportation to the mill-yards, was first introduced into the USSR but within the last few years its use has spread to numerous other countries. Furthermore, the USSR is a leader in the mechanization of the major logging operations.

Developing countries with significant amounts of wood resources and expanding wood harvesting operations and wood-processing facilities can benefit greatly from a study and analysis of the forest and woodworking industry.

The USSR collaborates on a large scale with a great number of countries, including States members of the Council for Mutual Economic Co-operation (CMEA) and developing countries of Asia, Africa and America, in scientific and engineering aspects of the wood and woodworking industry. The collaboration covers the development of specific scientific research problems, project and design activities, engineering aid for logging and woodworking enterprises, construction, and the training of specialists.

The main economic and social development directives for the period 1981-1985 and up to 1990, approved at the XXVIth Congress of the Communist Party of the Soviet Union, called for the promotion of a long-term exchange of goods and all types of economic, scientific, engineering and other links between the USSR and developing countries, on a basis of equality and the continued provision of economic and engineering assistance to those countries in the construction of industrial enterprises, energy installations and other installations contributing to their economic and political independence.

The present study covers the main branches of the complex of forest-related industries in the USSR - forestry, logging and woodworking - analysing the engineering, technological and economic problems encountered. The basic methods used are those of systems analysis extending to the level of the individual production complex. The methods used to forecast developments in a particular branch are based on an economic and mathematical simulation model. These methods can provide a scientific basis for forecasting the volume of output and consumption of the principal forest products and could be of help in determining possible alternatives for the development of the forest and woodworking industry in different countries, taking into account the specific features of each country.

The main task has been to analyse forestry and woodworking in the USSR in order to be able to make sound recommendations and proposals for scientific and engineering activities, an optimal ratio of logging and reforestation activities, and an efficient production structure for the industry in developing countries.

With this in mind, the following questions have been considered:

(a) The general characteristics of the wood and woodworking industry in the USSR (stages of development of the industry and its role and importance vis-à-vis other branches of the economy);

(b) A description of forest resources;

(c) Technical, technological and organizational characteristics of the logging industry;

(d) The main trends in wood utilization;

(e) Technical, technological and organizational characteristics of the woodworking industry;

(f) The basic factors involved in increasing the efficiency of the industry;

(g) An analysis of specific problems;

(h) Means of forecasting trends,

(i) Collaboration with States members of CMEA and developing countries in the wood and woodworking industry: experiences and results.

Actual technical and economic indices have been used in the procedure to describe the state of forestry and the logging and woodworking industries. Mathematical simulation, grouping of statistics, and a comparative analysis of indices provided the basis for conclusions and proposals. Sources used included: official statistical papers published in the press; bulletins of the Central Statistic Agency and Foreign Trade Ministry of the USSR; books and booklets published by Lesnaya promyshlennost; VNIPIEILesprom information surveys; TsNIIME and VNIPIEILesprom research papers; scientific magazines published by Lesnaya promyshlennost and Derevoobrabatyvayushaya promyshlennost.

A full bibliography is annexed to the paper.

The authors are N. A. Burdin, doctor in economic sciences and Deputy Director of VNIPIEILesprom and V. A. Sylantiev, Chief of the All-Union Soyuzbumagranpostavka.

The second chapter has been written with the assistance of S. V. Potchinkov, economic sciences candidate. Both general consultations and overall co-ordination of the work were carried out by I. M. Loginov, senior expert of the State Committee for Science and Technology.

I. GENERAL CHARACTERISTICS OF THE WOOD AND WOODWORKING INDUSTRY IN THE USSR

A. Development of the wood and woodworking industry and its role and importance for the national economy

The wood and woodworking industry in the USSR has an important role to play in the country's economy. The annual share of the industry's output in national economic potential comes to over 3 per cent. Measured by its total employment level, the industry ranks high in relation to other countries. The USSR is now a leading exporter of forest and paper products.

More than 2,000 forest products are produced in the country. Owing to the development of new chemical and chemico-technical methods of production, the number of such products is steadily growing. Despite the availability of newly developed synthetic materials, wood remains one of the most widely used raw materials. There is practically no industry where roundwood or its by-products cannot be used.

The volume of pulp, paper and board production (as well as that of different dendro chemical materials, such as tars, phenoles, protein, ethyl alcohol etc.) increases annually hand in hand with the utilization of wood raw material. Without wood, it is practically impossible to increase the volume of industrial and civil construction or to develop properly such areas as mining, the motor-car industry, railway-carriage and railway-track construction, and the provision of electrical-power transmission and communication lines.

The development of the wood and woodworking industry in the USSR can be divided into several stages, each of which is closely related to the development of the country's economy from the October Revolution victory of 1917 up to the present moment, when the national economy can be said to represent a stage of full-fledged socialism.

Before the October Revolution, the exploitation of forest-land throughout the country was carried out on an irrational basis. Almost 80 per cent of the total timber harvested was used for fuel. At that time, manual labour was used for all logging operations, as there was no mechanization. Timber-sawing mills were as a rule equipped with one-log frames, and the furniture industry was characterized by primitive "rule-of-thumb" methods.

From the very early days of the socialist State, all forest resources were declared to be national property and were taken under the protection of the socialist State. The nationalization of all forest resources and their transfer to the public sector provided the economic basis for the creation and further development of the wood industry in the USSR. Lenin's fundamental principals became the basis for Soviet forest policy : State organization of the planned study and estimation of all national forest resources; State organization of the utilization of forest-related resources as the most important element of natural productive forces; and use of the advanced achievements in science and technology for the development of the forest industry taken as a whole.

The mechanization of logging operations (especially such labour-intensive operations as hauling, loading and transportation) was started during the first five-year national economy development plan. It was then that the transition from a small loggers' artel[1/] to a mechanized enterprise working all year round was begun and practically completed.

The problem of separating logging operations from hauling was solved by instituting a broad division of labour.

In order to further the development of sawmill production, it was important first to concentrate production and put the sawmills on a self-supporting basis. Increased sawmill productivity contributed to the development of a complex for processing raw material that made a reliable base for the production of prefabricated wooden houses, wooden planks for use in the engineering industry, structural elements and details and planed lumber. At the same time a start was made on specialization in the woodworking industry.

The production of woodworking machinery and equipment was organized on a large scale by the domestic industry. By 1941, as a result of the country's economic progress, wood and woodworking became a new and self-sufficient branch of industry.

During the Second World War the wood industry worked hard to satisfy military needs, and there was a sharp increase in the volume of timber cut in order to satisfy the country's fuel needs.

In the post-war period, the wood and woodworking industry underwent two stages of development:

(a) A period of extensive development to increase the output of timber-cutting and woodworking, during which new areas were developed to allow for the somewhat changeable pattern of wood consumption;

(b) A period of transition from extensive to intensive wood industry development in which growth rates and new trends in forest industry depended upon structural changes in wood consumption as well as upon the development of wood-processing industries in the forestry complex.

The period of extensive development was characterized by a rapid advance in almost all the sub-industries.

By the end of the period 1945-1955, the volume of wood haulage had doubled, the output of lumber production had shown a fivefold increase, that of plywood was five and a half times greater and that of prefabricated houses 15 times greater.

The main production processes began to be fully mechanized in that period: different types of power saws and gasoline-engine saws for felling and cross-cutting operations were put into production; and the industry was supplied with new types of machinery and equipment: crawler-type skidding tractors, skidding winches and mobile electric power stations.

1/ An artel is a collective enterprise of craftsmen.

An advanced and very important step in the development of logging technology was a new progressive method of wood removal, by tree-lengths instead of by short wood assortments. The new technology achieved a sharp reduction of labour-intensive operations performed directly at the cutting sites, most of which were transferred to the lower depot.

This advanced technology went hand in hand with appropriate forms of labour (cyclical labour, small staff teams etc.).

In the early 1960s, a new jaw-type loader was developed and subsequently used on a large scale, making it possible to separate skidding from loading; this led to the use of a more advanced technology at the cutting areas and landings. By using jaw-type loaders, a skidder could be freed from loading tree-lengths and used solely for its main function, skidding, with a resultant sharp increase of 15-20 per cent in production capacity per shift. The newly developed de-limbing machines began to be introduced, making it possible to de-limb trees measuring from 8 to 70 cm in diameter. Stationary semi-automatic lines for de-limbing trees, with a capacity of 200-240 cubic metres began to be used at the lower depot.

The trend in the timber-sawing industry was towards improved technology and production and optimization of the location of sawmills to bring them nearer to the sources of raw material. An all-round mechanized timber-sawing process, consisting in the cross-cutting of previously sorted bunches of logs into cants, became one of the main methods of cross-cutting coniferous raw material.

One of the most important results of technological progress in the wood and woodworking industry in the USSR was technological chip production based on the use of low-grade raw material. Technological chips became an important primary raw material to be used for the rapid increase in the output of fibreboard and particleboard. In 1960, particleboard output amounted to only 160,000 cubic metres; in 1970, a slight increase in chip production resulted in an output of 4 million cubic metres, or 12 1/2 times more than the 1960 output.

The output of the furniture industry was showing a steady growth, based on better structural design, a wider choice and better quality, as well as of more concentrated production and greater specialization.

A rapid development in timber-logging, sawmilling and the production of wood-based panels led to increased industrialization in the building of prefabricated wooden houses, which was usually carried out in large mills where there were saw shops equipped with dryer installations. Table 1 contains basic data indicating the trends in the main types of wood products output resulting from the rapid technological advances that took place in the Soviet wood and woodworking industry between 1913 and 1981.

Table 1. Output of forest products, 1913-1981

Product	Unit of measurement	1913	1940	1950	1960	1970	1981
Sawn wood	Million cubic metres	14.2	35.4	49.5	106.0	116.0	98.1
Particle board	Million cubic metres	-	-	-	0.16	2.0	5.4
Fibreboard	Million square metres	-	4.1	6.2	67.6	208.0	482.0
Plywood	Thousand cubic metres	240.0	782.0	657.0	1 354.0	2 045.0	2 035.0
Total haulage	Million cubic metres	67.0	247.0	266.0	369.5	385.0	358.2

Source. The USSR National Economy in the Period 1922-1982, Anniversary Statistical Article Collection (Moscow, Finansy i Statistika, 1982), pp. 200-202.

In 1966, the full mechanization of such operations as tree felling, hauling, loading, transportation and cross-cutting was practically completed. Data on the mechanization of the main logging operations between 1950 and 1981 are shown in table 2.

Table 2. Mechanization of logging operations

Operation	1950	1960	1965	1970	1975	1981
	(Percentage)					
Felling	38	97	99	100	100	100
Skidding	29	92	96	100	100	100
Loading	15	86	93	100	100	100
Hauling	56	95	99	100	100	100
Cross-cutting	55	95	99	100	100	100

Source: Tatarinov, Logging Operations (Moscow, Forest Industry, 1979), p. 9.

The introduction of advanced machinery and equipment has resulted in a permanent increase of labour productivity and fixed capital per worker engaged in material production. For example, during the period 1940-1981, labour productivity in the wood and woodworking industry more than quadrupled.2/

2/ The USSR National Economy in the Period 1922-1982, Anniversary Statistical Article Collection (Moscow, Finansy i Statistika, 1982) p. 163.

B. Forest resources: general characteristics and basic principles of multiple-use forest

The importance of forests for the national economy is determined by the resources they contain. Forest resources include not only wood but also wood substances, foliage, resin, nuts, mushrooms, berries, herbs, game and some protective functions. In the present paper, particular attention is paid to wood as a raw material.

The present and long-range potential of the wood and woodworking industry depends very much on the volume and quality of the species contained in the national forest resources.

According to data provided by the Food and Agricultural Organization of the United Nations (FAO), the total forested area for the world as a whole amounts to 4.1 billion hectares. The USSR leads the world in the size of its forested area and in its forest resources, with 21 per cent of the world's forested area. It accounts for more than a quarter of the world's growing stock (more than 81 billion cubic metres). Data on the fluctuations in growing stock and forested areas between 1961 and 1978 are given in table 3.

Table 3. Forest resources in the USSR, 1961-1978

Indices	Unit of measurement	1961	1966	1973	1978
Total area covered by forests	Millions of hectares	738.1	746.8	768.8	791.6
Public forests	Millions of hectares	705.9	720.6	748.8	772.2
Total volume of growing stock	Billions of cubic metres	80.2	79.7	81.9	84.1
Volume of growing stock from public forests	Billions of hectares	78.0	78.0	80.4	82.4

Source: The USSR National Economy in the Period 1922-1982, Anniversary Statistical Articles Collection (Moscow, Finances and Statistics, 1982), p. 389.

The most prevalent species of softwood in the USSR are larch, pine and spruce, representing more than 83 per cent of the stock and more than 70 per cent of the forested area). Birch and aspen are the common broadleaf wood species. The average annual increment per hectare of forest is comparatively low, amounting to 1.35 cubic metres; this is accounted for by unfavourable climatic conditions in the most heavily forested areas. The annual harvested

volume per hectare in the country as a whole amounts to less than 0.5 cubic metres, which demonstrates the country's potential to intensify its silviculture. An important feature of the country's wood resources is their classification into mature forest, forest approaching maturity, middle-aged forest and young stand. Mature forest is predominant in the USSR, thus creating favourable conditions for timber-logging. The forced cutting method generally used in mature and over-mature forests is considered to be both natural and necessary. This principal fully corresponds to the silviculture methods used in the USSR, because mature and over mature forests are usually characterized by a low annual increment and a large volume of forest litter. Here it should be emphasized that wood, unlike gas, oil and coal, is naturally renewable.

According to their importance for the country's economy, as well as their location and functions, all forests can be classified into three groups. The first group includes forests performing the following functions:

(a) Water protection (restricted forest-belts along the rivers and lakes and lakeside storage etc., including restricted forest-belts intended to protect the spawning grounds for valuable food-fish);

(b) General protection (anti-erosion forests, including those located on the steep slopes of mountains; protective public forest-belts and protective forest-belts located along railways and highways);

(c) Sanitation (urban forests: "green zones" around the cities, towns and other populated areas, as well as around different industrial enterprises; forests to protect the sanitary zones of water-supply springs and health-resorts.

The first group also includes forest reserves, national and natural parks forests of scientific and historical significance, natural monuments, forest-parks, nut-tree zones, fruit-tree stands, forested areas in the tundra and sub-Alpine forests. Owing to the growing significance of environmental protection and recreation and to the expansion of existing cities and industrial centres and the construction of new ones, with the simultaneous growth of population, the importance of the first group of forests is continually increasing. The second group includes forests growing in regions with a high population density and a well-developed transportation network. Their functions are largely of a protective nature, with limited exploitation; moreover, this group includes forested areas with scanty raw material resources, so they require more intensified silviculture methods in order to preserve their protective functions. The third group includes forests growing mainly in densely forested areas, which are exploitable enough to satisfy the demand of the economy for raw materials without damaging the forests' protective functions.

The classification of forest subdivisions into different groups and categories and the use of differentiation methods in forestry and silviculture are of particular importance for rational exploitation and conservation of wood resources in order to meet the interests of all sectors of the economy while taking into account multilateral significance of the resources.

Government bodies responsible for forest planning, management and utilization, bearing in mind the importance of forests and natural conditions for the economy, can institute the following measures:

(a) Promotion of a sustained, inexhaustible and rational utilization of forests, with a view to achieving a balanced development of the national economy and to meeting the people's need for wood and wood products;

(b) Intensification of water protection and general protection measures, sanitation and other useful natural forest functions in the interests of the people's health, as well as for environmental protection and the further development of the economy;

(c) Extended reproduction, improvement of the composition of wood species and of the quality and productivity of the forests;

(d) Anti-fire measures, and disease and pest protection;

(e) Promotion of a rational use of national forested areas and other types of areas covered by forests.

"Multiple-use forestry" refers to the extraction of all types of the wood raw material and the use of the forests' functions in the interests of the national economy.

Forest use in the USSR is characterized by certain specific measures. The most important standard index of forest utilization under the natural conditions prevailing in the USSR is considered to be an allowable cut, which is determined on the basis of the methods providing for a continuous and inexhaustible use of all wood raw material resources. The three main methods of forest use adopted in the USSR are major produce cutting, intermediate cutting, and minor produce cutting.

Major produce (final-yield) cutting means that mature stands, as well as stands growing in flooded areas or damaged by wind, storms, fire or pests, are to be cut for timber. Major produce cutting methods are generally used in the third category of forests and sometimes in forests in the second group. For major produce cutting in the third category, measures are chosen that can achieve efficient and rational exploitation of the forest and simultaneously promote the renewal of high-grade wood species while protecting all the useful functions of the forests, as well as their efficient exploitation.

The intermediate cutting method includes logging operations and felling carried out for improvement and sanitation purposes. It is applied to forests in each of the categories mentioned above.

The minor produce cutting method excludes both major and intermediate cutting. The main functions of secondary forest use are haymaking, cattle-grazing, planting of bee-gardens, harvesting of mushrooms, nuts, berries and herbs; hunting, recreation and scientific research. Thousands of tons of berries, mushrooms, nuts and honey are harvested annually in the forests of the USSR. Various types of tree-cutting methods are developed and used, each of which takes into account special-purpose forest use, peculiar biological features of the main regenerating species and variety of climate and economic conditions throughout the USSR.

There are three types of major produce and intermediate produce cutting methods used in the USSR: clear cutting, gradual cutting and selection cutting. Depending on specific regional conditions and special-purpose forest use, each group has its own variants. Cutting methods and systems, that varied according to the category of forests, growing conditions and main regenerating species, were taken as the basis for the regional cutting rules that are now in widely used in the USSR.

The goal of an "improvement" cutting method is to raise the productivity of the forest stand by shortening the mature period, to improve sanitory conditions in the forests, to intensify the forests' protective functions (water-protection, soil-protection, sanitary, aesthetic and other functions). At the same time the method provides an additional source of raw material to be used for the development of high-volume consumer goods production.

Improvement cutting starts from the formation of the young stand and ends 10-20 years before the approved final-yield cutting age in softwood forests, and 5-10 years before in hardwood forests. Depending on the age of the stand, four types of improvement cutting are used: secondary; cleaning; light thinning; and heavy thinning.

Both natural and artificial regeneration methods are used for forest regeneration in the USSR. With a view to natural forest regeneration, tree-cutting technology providing regrowth conservation is used on a large scale. In forest-growing areas where natural regeneration is practically impossible or takes a long time, artificial regeneration comes into effect, with an annual volume of more than 1 million hectares. As a rule, softwood species are chosen for planting: pine, spruce, and larch; in regions with a warm climate oak is chosen.

The area devoted to arboreta is being constantly expanded, as is the number of seed-farming research works. The main planting operations, including the planting of saplings, are fully mechanized.

A great deal of drainage work is being carried out in all the swampy forested areas. The vast areas of forest in the USSR require permanent and systematic fire and pest control. In dense taiga areas, air patrols are used for fire-prevention.

C. The state of the art of the logging industry

The USSR leads the world in volume of wood hauling. The logging industry is an important sub-industry of the complex of forest-related industries. Mechanization and the organization of industrial production are both highly developed.

At present time, the main logging operations, namely felling, skidding, loading, hauling and cross-cutting, are fully mechanized. A distinguishing feature of scientific and technological progress in the industry is the new trend for comprehensive mechanization of all logging operations with the ultimate aim of totally doing away with manual labour. The USSR has the highest level of mechanization of felling, de-limbing, skidding and loading operations in the world. In a five-year period, the volume of work done by machines has increased many times over. Logging and tree-length hauling are

the main technological operations in the Soviet timber industry. This technology creates favourable conditions for the mechanization of labour, as it allows a minimum number of operations to be carried out at the felling sites. In turn, it makes it possible to mechanize all tree-cutting operations with the help of single-purpose or dual-purpose machines (that is, felling, felling and bunching, felling and skidding, and de-limbing machines). In enterprises equipped with modern tree-cutting machines, estimated labour productivity for the main logging operations (felling, de-limbing and skidding) has more than doubled.

Different systems of machinery are used, which take into account the variety of climate and logging conditions throughout the country. The first type is designed for timber harvesting in thick forest on flat and hilly terrain (without regrowth). This type of system includes feller-skidders, BM-4A, and a self-propelled de-limbing machine, LP-33. The self-propelled de-limbing machine is included in the system when tree-length removal is likely to be required. Trees or tree-lengths are loaded with the help of a PL-2 overhead loader. The second type of machinery system is designed for timber harvesting in medium density forests with regrowth and those growing on a flat terrain. It includes a feller-buncher, equipped with a full rotation manipulator and a grip-cutting device (LP-19) and also a wheeled or crawler-type skidding tractor, together with a self-propelled de-limbing machine (LP-33) with a non-stop mechanism for hauling up logs (LP-517) and a log-hoisting device (LP-233). For the loading of trees and tree-lengths the same loader is used as in the first type of system (PL-2). The feller-buncher (LP-19), equipped with a 8-metre radius manipulator and 3-ton capacity, enables the fallen trees to be transported in a vertical position and afterwards stacked smoothly on the ground. The fact that there is practically no loss of wood-pulp when trees are felled with this machine is a great advantage, especially in low temperatures, when wood becomes more brittle, and the gentle lowering action prevents the breakages that usually occur in felling operations. This method provides maximum protection of the tree-crown, especially when the crown is to be utilized, and of the young stand, which is, in turn, a prerequisite for successful logging operations. The third type of machinery system is designed for timber harvesting in the medium-density forests (generally without regrowth) on flat and hilly terrain. It includes a feller-skidder equipped with manipulator (LP-49) designed for tree felling and bunching during clear cutting operations. The system also includes a self-propelled de-limbing machine (LP-51 or LP-33) used when the removal of tree-lengths is likely to be required. A TT-4 skidding tractor can be used as a base vehicle for a single- and multi-operation logging machine. A manipulator and rotary grip-cutting device enable the operator of the LP-19 machine to carry out auxiliary operations to help in tree-felling and skidding. This type of machine is most efficient for the cutting of trees knocked down by wind or storm, which can be bunched and transported to the loading site without any additional labour. The fourth type system is designed for timber harvesting in low-density forests, generally without regrowth. This system includes a feller-skidder equipped with an LP-17 manipulator and a grip-cutting device, as well as a self-propelled de-limbing machine (LP-30B) and an overhead loader (PL-1). An LP-17 feller-skidder equipped with a grip-cutting device and providing different degrees of manoeuvrability is subject to same operational conditions as an LP-49 feller-skidder of LP-49 type. It can be successfully used for tree-cutting operations, especially for trees knocked down by wind or storm, as well as for other preparatory and auxiliary operations.

A self-propelled LP-30B de-limbing machine is generally included in the system when the removal of tree-lengths is likely to be required. With this type of machine, the de-limbing can be done successfully both by feeding either the butt-end first or the crown first. The machine is designed for bunching tree-lengths and simultaneously aligning the crown or butt-end, thus creating the right conditions for subsequent skidding and loading operations.

This system is widely used, especially in northern regions of the European part of the USSR, where thin-stemmed spruce and mixed species predominate on loose ground. While new types of tree-cutting machines are being developed, a great deal of attention is paid to forest exploitation and the problem of reducing the volume of roundwood losses and of ensuring environmental protection. All the machines used for tree-felling are equipped with chain-saws, which unlike other cutting methods, do not produce cracks in the valuable butt-end of the tree. Chain saws allow maximum stump-height cutting, this increasing the volume of stems to be exploited.

For growing areas where natural conditions make it difficult to use feller-bunchers and feller-skidders, petrol-powered saws, crawler-type skidding tractors and de-limbing LP-30 or LP-33 machines are used. Logged timber is generally transported to the low landings by means of trucks. Depending on freight turnover, climate and wood-growing conditions, timber-carrying trains are divided into the following three groups: light truck-trailers mounted on a ZIL-157 (ZIL-131) base with a 2-ton load capacity; medium-type trains mounted on a MAZ-509 base with 17-ton load capacity; and heavy trains mounted on a KRAZ-255L base with 25-ton load capacity. Light trains are generally used for short distances. Medium and heavy trains are used for long distances along forest roads with a high turnover and reinforced with asphalt, gravel or concrete. Tree-length loading is generally done by means of overhead hydraulic loaders.

The most common form of technology for the hauling of timber in the USSR consists in the direct removal of tree-lengths to the low landings. This method keeps total expenditure to a minimum amount per cubic metre compared with the cost of logging shortwood at the felling site itself, although the latter method is still in use in some areas. Low landings are used not only for the temporary storage of roundwood materials, but also for such operations as unloading of tree-lengths, cross-cutting, sorting and stacking, as well as the de-barking of pulpwood and props, wood-waste processing for the production of technological chips, and delivery of finished forest products to the consumer.

The most advanced technological equipment is supplied for low landings located at points where forest roads are adjacent to wide-gauge railway lines. The concentration of production and a year-round schedule of work at the low landings create favourable conditions for the mechanization and automatization of all the production processes.

Operations at these low landings are carried out in the following sequence: tree-lengths or trees with crowns are transferred from the timber-carrying trains to a specialized site where an additional de-limbing operation is carried out, in which the trees are directed to the de-limbing line and the limbs and crown cut off.

De-limbed tree-lengths are first automatically cross-cut into wood assortments according to the pre-set length and afterwards, by means of different conveyors, are sorted by species, grade and end-use. The assortments are fed out from grading pockets and are then stacked by loading cranes equipped with clamp-hooks and loaded into wagons or special trucks for delivery to the consumer. There are two types of automatically controlled low landings, with single-flow and multiple-flow production lines, depending on their capacity. The single-flow line capacity amounts to more than 200 cubic metres per shift. It includes de-limbing and cross-cutting machines and a sorter-conveyor.

Special types of machines (both stationary and mobile) have been developed for use in different climates and economic conditions for the organization of large-scale low-landing operations and ultimately for a wider use of pulpwood obtained during the removal of trees or tree-lengths.

All systems of forest machinery will be improved so as to ensure an increase in productivity and a drop in metal consumption in the process of building low-landing construction works. One of the means developed for improving low-landing equipment is the use of a frame-block construction which requires a much lower expenditure on building and equipment mounting operations.

Along with the main timber logging operations, a great deal of attention is being paid to preparatory and auxiliary work, i.e. the maintenance and repair of forest roads, the preparation of felling sites for cutting operations, equipment and power supply. In timber enterprises, all these operations are carried out by specialized teams of forest workers. All the operations they are engaged in are largely mechanized.

Timber-logging technology and forestry needs are to be brought into line, as this is one of the pre-requisites for efficient production.

The interests of the USSR national economy call not only for efficient timber-logging but also for successful forest regeneration. That is why the most rational timber logging methods are to be chosen. Under certain growing conditions, regrowth can be conserved. Special attention should be paid to forestry needs when timber-logging operations are carried in mountainous areas. In these conditions, a skyline logging method is generally used. Helicopters are being used in skyline operations on an experimental basis.

The development of advanced timber-logging technology has not only led to an increase in productivity but has also helped to solve many social problems, such as the total substitution of machines and machinery for manual labour. The USSR must now solve the problem of how to eliminate manual labour in the forest industry. Within the period 1975-1982, the productivity of such fully mechanized operations as felling, de-limbing, skidding and cross-cutting has increased several times over. New social achievements resulting from the introduction of advanced technology are closely related to changes in the professional structure of the forest industry: the number of skilled workers and operators has shown a sharp increase, while the number of unskilled workers has decreased.

Technological and scientific progress has greatly influenced the level of general and specialized education and has helped to eliminate occupational disease and injuries. Safe working conditions and improved sanitation are indispensable to the socialist State economy.

The growing output of timber-logging is partly accounted for by the availability of skilled workers. Throughout the USSR, all logging operations are carried out by a permanent staff of forest workers. Only a limited number of seasonal workers, primarily from rural regions, are taken on for winter logging operations. In many parts of the country, towns are being built for forest workers, equipped with all the necessary public services - health and cultural, educational and sports facilities. Houses and public services are placed at the forest workers' disposal free of charge. Forest workers are taken to the felling sites by special transportation also supplied free of charge by the forest enterprises.

In view of the continuity of progress in forest technology, a permanent educational system has been organized for improving the qualifications of forest workers. On finishing secondary school, young people are intitled to free training in special forest schools and colleges, where they can learn various trades, for example that of timber-logging operator, adjuster-metal-worker, fitter etc. Any worker who wishes to change trades (for instance, from operating a skidder to operating a feller-skidder) can learn the new trade in a special training school or directly at the felling site without giving up his job and without any charge.

Increased efficiency in timber-logging depends very much upon having the right labour organization. The most advanced structure uses an expanded mixed team of workers. In this system several teams work independently on the different operations, under one team-leader, who is responsible for the whole complex of activities. The high productivity of these forest teams is due to the advanced technological methods used, strict discipline, the time-saving manoeuvrability of machines and workers and permanently staffed forest teams, highly qualified workers, interchangeability of operations, and full realization of the principal of free-will in team staffing.

A permanent concentration of production and specialization is necessary in low landings to ensure efficient logging. A recent trend towards the expansion of production in low landings has made it feasible to introduce highly efficient machines and machinery. The volume of wood processed in low landings has increased from 100,000 to 200,000 cubic metres and has led to a reduction in expenditure of 8-14 per cent. One effective measure is to shorten the list of names of wood assortments processed in low landings. With the advanced technology used in low landings, it is possible to reduce the labour required for all low-landing operations by one and a half or two estimated man days per 1,000 cubic metres of processed wood.

One of the main prerequisites for increasing the volume of logging is a national organization of maintenance and running repairs. A special system of planned preventive maintenance and running repairs is used in the USSR. It requires a whole complex of organizational measures in order to ensure safe operating conditions for machinery and equipment over its entire service life while at the same time increasing productivity and reducing maintenance costs.

The Soviet logging industry is supplied with both mobile and centralized maintenance stations where all operations are carried out by workers with special qualification.

A wide network of forest roads is essential for really efficient logging operations under all-year-round climatic conditions. Forest roads with a reinforced surface can ensure a regular pattern of operations.

Efficient production depends largely upon such factors as location of the enterprise, capacity for medium tree-lengths and composition of natural wood species, utilization of raw material as a whole at the felling sites, level of exploitation of machinery and equipment taken by time and capacity, and stimulation of the economic and material interests of forest workers.

D. Present situation of the woodworking industry

Woodworking is a multi-product industry. It includes sawmilling, the manufacture of particle board and fibreboard, standard house construction, plywood and furniture production, packaging, match manufacturing and other sub-branches.

In the USSR, modern woodworking is characterized by a high level of engineering and the availability of skilled labour, which are essential factors in promoting national output in terms of the planned volume and assortment of products.

1. Sawmilling

The USSR has the greatest output of sawnwood in the world, more than 20 per cent of world production. In the period 1970-1980, the country's annual output was 100-110 million cubic metres, 80 perccent of the output being softwood lumber. Trimmed lumber production is of primary importance.

Sawmilling in the USSR is based on large-scale industrial enterprises functioning year-round. The enterprises are equipped with highly productive machinery and progressive technology systems, e.g. systems with chip and saw headrigs, producing chips for industrial use and lumber. The equipment of large-scale sawmills also includes machinery for quality sorting, trimming and sorting to length.

In the sphere of shipping, lumber packaging is now widespread owing to the high productivity of this method (the volume of packaged lumber has doubled or even tripled).

Efficiency depends greatly on the concentration of industry.

It should be emphasized that the concentration index for sawmilling is the annual sawnwood output of an enterprise (mill) in cubic metres.

In sawmilling in the USSR, both units of machinery and technological processes can be concentrated. The concentration of units of machinery means an increase in the capacity of sawmilling headrigs per unit and their share in sawnwood production. Concentration of technologies means an increase in the productive capacity of technologically homogeneous mills, based on growth of

capacity per unit, number of machinery installed at the mills and their share in the volume of general output. Research indicates that sawmilling concentration should first take the form of unit concentration, i.e. by increasing capacity per headrig; and then, technological concentration should grow out of this primary concentration. It has been calculated in sawmills with a capacity sufficient to process annually 115,000, 236,000, 351,000 and 430,000 cubic metres of saw timber, the technical and economic indices would show the following percentage changes:

(a) Reduced summary inputs per cubic metre of lumber: 100, 94.5, 92.5, 88.6;

(b) Annual income: 100, 245, 380, 519;

(c) Productivity: 100, 105,0, 118, 139.

Further increases in the efficiency of the woodworking industry depend on specialization in the mills, particularly sawmills.

Specialization develops in two ways: according to the end-use of the product (article specialization); and by reducing the types and sizes of softwood (technological specialization).

Specialization has been shown to lead to growth in the productivity of sawmilling frame units and of sorting and drying equipment and to a reduction in raw material inputs. At the same time specialization and, in particular, the sorting of lumber into different thicknesses, are economic from the consumer's point of view. The sorting and cutting stations of a sawmilling line would alone produce savings of about 2.2 roubles per cubic metre of lumber.

The most important technological trend in sawmilling is the development of wasteless wood-processing, in which all the raw materials are used in a closed-cycle mill for the wasteless manufacture of finished products.

Efficiency is further increased by the growing output of lumber sorted into lengths and thicknesses, the use of new methods for modifying wood, resawing and manufacturing laminated lumber and complete automatization of all production processes.

2. Production of particle board

Particle boards are manufactured from flat and thin wood particles bonded with synthetic adhesives in a hot pressing process. The main sources of raw material for this process are low-quality wood and softwood and hardwood residues.

The raw material input is 1.5 cubic metre per cubic metre of particle board in a high-productivity modern line with effective machinery for proper wood chipping and fractionating. The most significant areas of consumption are the furniture and construction industries. Particle-board production is characterized by high growth rates. Between 1970 and 1980, output of particle board in the USSR almost trebled. In 1960 the output was only 161,000 cubic metres, in 1970 it had already reached 1,991,000 cubic metres, in 1975 it

amounted to 3,994,000 cubic metres and by 1981 it was about 5,800,000 cubic metres. As the assortment of particle board changes, the proportion of particle boards for panelling and of thin sanded boards is growing.

The manufacture of particle board is characterized by a high degree of concentration, leading to an impressive growth in technical and economic indices (see table 4).

Table 4. Technical and economic indices in the particle board sector by different degrees of concentration

Indicator	Technical and economic indices by production line reconstruction and expansion stages with capacities of 1,000 m^3		
	90	120	190
Production capacity (m^3):			
Per day	296	395	660
Per hour	14.3	19	33
Output per worker (m^3 per year)	784	920	1 140
Specific raw material input (m^3/m^3)	1.62	1.55	1.55
Prime cost of the product (roubles per m^3)	76.70	73.20	71.10
Revenue (1,000 roubles per year)	3 182	4 698	6 870
Economic effect compared with new construction	1 460	1 500	3 600
Costs compensation times	in normative terms		

3. Fibre-board production

Output of fibreboard in the USSR amounts to almost 500 million cubic metres. Fibreboard is a high-quality and comparatively cheap panelling and construction material. It is not subject to cracking, and has great bending strength and elasticity. Soft fibreboard is manufactured in conjunction with hardboard.

Fibreboard is produced from wood residues and low-quality roundwood. The dry and wet methods of manufacturing are the most widely used. In the wet method mats are formed using a water medium; the wet mats are then cut into separate pieces and subjected to hot pressing. In the dry method, fibre board mats are formed from air-dried wood-fibre material. The advantage of the wet method is that it eliminates the possibility of ignition and is a stable

process. The advantage of the dry method is that it decreases water consumption. The dry method includes the following operations (irrespective of the line equipment used): handling and storage of chemicals and raw materials; pre-processing of chips; steaming and reduction of chips to fibre; preparation of binders and hydrophobic additives; process for blending fibre, binders and additives; fibre-drying; mat-forming; pre-pressing; pressing and panel conditioning; mechanical processing of panels.

4. Packaging and container products

Packaging and container production is geared to meeting all the requirements of the economy in the transportation of ever-increasing volumes of agricultural, fishery, food, and textile products and goods etc. The manufacturing of wooden containers has led to a steady growth in the use of soft hardwood and low-quality wood. The structural composition of packaging and containers is changing and the manufacture of advanced types such as thin-sided containers is increasing steadily.

5. Plywood

Along with traditional types of plywood, large-size, waterproof and decorative plywoods are being manufactured. Uses for these types of plywood are growing in number.

According to expert calculations, by substituting large-size plywood for lumber, it is possible to effect savings of 300 roubles per cubic metre. The production of plywood involves automatic peeling, clipping and trimming machines and units for applying adhesive, as well as multi-daylight presses and other equipment.

6. Construction of wooden housing

In both urban and rural districts, housing construction in the USSR is characterized by high growth rates. Wooden one-storey housing is being developed on industrial scale. The production of wooden houses is concentrated in the large enterprises. Experience has shown the desirability of building pre-fabricated wooden houses in rural districts, taking into account the traditional features of the rural way of life. Pre-fabricated houses are being produced with improved architecture and planning, incorporating cattle-sheds, a poultry-yard and garage. Plywood, fibreboard and particle board are widely used in housing construction, along with solid wood materials and other insulating materials. In residential housing and buildings with a social purpose, soft and hard fibreboard is used for the manufacture of panel doors, panel facing and the built-in furniture. Soft fibreboard is used for thermal and acoustic insulation in standard housing construction.

In standard housing, the more progressive methods of construction are encouraged, with the use of large panels. These methods use less lumber per unit of useable area constructed, and the assembly index is higher than when houses are built of squared timber and with a small wooden-panel frame.

At present, prefabricated panel housing, both in the USSR and abroad, is geared to increasing the size of prefabricated elements; the output of particle board is therefore increasing and the thermo-mechanical properties and strength of different types of board, constructional, thermal-acoustic insulating, decorative, have been improved.

Heavy specialization, unified construction and longer-lasting, more reliable houses are characteristic of wood-housing construction in the USSR. The output of joiners and construction elements is said to be steadily increasing.

7. Furniture industry

The development of the furniture industry is related to the improved well-being of the Soviet people and the rapid growth in the construction of housing and community-service buildings. The furniture industry accounts for about 50 per cent of the production of the woodworking industry as a whole. Growth rates in the last 15 years have put the furniture sector in the forefront of the wood and woodworking industries. The product line is constantly being changed mainly owing to the higher output of new items to meet higher demand. In the period 1976-1980, the selection of furniture has undergone a full renovation.

The most important factors in increasing productivity in the furniture industry are specialization, concentration and co-operation. Furniture manufacturing plants are chiefly large-scale, specialized lines with high-productivity equipment. Specialization is achieved by establishing base mills and shops for the manufacture of differnet elements at various processing and finishing levels: panel-facing, half-processed cants, moulded soft elements, synthetic veneer, furniture panels etc. The growth of specialization is closely related to in-branch and inter-branch co-operation. The use of prefabricated elements and shipment of fittings shorten the technological cycle, improve the quality and comfort of the furniture and increase output.

Labour productivity at the specialized plants is 1.5-2.0 times higher than at plants with a closed technology cycle.

E. Consumption of forest products in different branches of the economy

The consumption of forest products is illustrated in table 5.

Table 5. Consumption of forest products by different branches of the economy, 1975 and 1978
(Percentage)

Branch	1975	1980
Construction	18.4	15.0
Containers and packaging	18.6	19.4
Pulp and paper industry	10.7	12.4
Furniture production	7.2	8.6
Woodworking and machinery construction	6.0	6.3
Repair and maintenance	8.7	8.7
Mining	4.0	3.3
Manufacturing of forest products	9.4	10.1
Other requirements	17.0	16.2

Source: "Lesnaya industrya", Lesnaya promyshlennost, 1980, pp. 213-222 and Rational insustrial wood use in the national economy (TsNIITEIGossnab, 1975), pp. 14-31.

Economic development, technical progress and the creation new advanced materials all affect the consumption structure of forest products.

The construction sector is easily the largest consumer of timber in the economy, mainly because of the vast amount of fixed capital construction, housing in particular. The USSR is a world leader in housing, cultural and service construction. In recent years, the specific share of timber consumed in the construction sector underwent a slight decrease, owing to the growing use of concrete, linoleum and metal, as well as the growing proportion of prefabricated elements (windows, doors and laminated constructions) in shipments of construction material.

The input structure (e.g. substitution of plywood and panels for industrial wood and lumber) plays an important role in improving the utilization of forest products. Between 1970 and 1981, the consumption of unprocessed industrial timber was roughly halved, while that of particle board and fibreboard increased sharply. It is important to note that the use of panels in standard housing construction not only produces industrial wood savings but also increases productivity, i.e. labour intensiveness is decreased (see table 6).

Table 6. Input of wood and labour intensiveness for different types of wooden houses

Type of construction	Wood input per square metre of living room (cubic metres)	Labour intensiveness in the construction and assembly of 1 square metre of living room (man-days)
Small-size panel with fibre board	1.03	1.8
Frame construction with fibre board	1.04	2.3
Squared timber construction	2.1	6.0

Source: S. P. Rebrin, E. D. Mersov and V. G. Evdokimov, "Fibreboard technology", - Lesnaya promyshlennost", 1982, p. 12.

The pulp and paper industry is one of the biggest users of wood. The need for wood raw material grows with the rate of increase in the output of pulp, paper and board. Within the last few years, the structure of wood consumption has changed, and the use of chipped logging and mill wood residue has been expanded.

It is of the utmost importance to increase the proportion of soft-wooded broad-leaved species (especially birch) used in the production of pulp and paper. In the period 1970-1981 the utilization of industrial chips grew by a factor of 2.5 and that soft hardwood by a factor of 2.7. At present, every fifth ton of pulp is produced from industrial chips, i.e. chipped wood residues.

The roundwood input for container manufacturing is steadily decreasing. The pattern of consumption of forest products is characterized by a growing share of paperboard and an increasing use of return packaging and container, with a saving in industrial wood of about 250-300 m^3 per million tons of containerized goods for transport.

Industrial roundwood savings in the mining industry are related to further changes in the fuel balance (a decreasing share of coal and a growing share of oil and gas) and open-cut coal mining, replacement of wooden pit-props by metal ones etc.

Wood savings in furniture manufacture are achieved by improved design, use of non-wood materials (steel tubes, polymer materials, thin wood-based panels). Softwood is saved by using soft-wooded broad-leaved species, laminated lumber made of glued short-size lumber, making greater use of veneer-glued curved elements and furniture panels cut to shape and size, and replacing wood by synthetics. In joinery and the manufacture of construction items (in particular parquet manufacturing), wood savings are effected by using residual and low-quality wood.

F. Use of wood residues

Consumption of wood both in the USSR and in other countries will increase as a result of population growth and the development of wood-consuming industries. Logging rates are already lagging behind wood product requirements at a time when the demand for wood raw material is growing rapidly. Research and studies show that at present and in the near future, the efficient processing of wood residues would be a decisive factor in the expansion of wood resources and the intensification of forest management. In future, the biomass of all forest species should be involved in economic processing and use.

In the present study, the notion of "wood residues" includes all residual wood raw material and timber generated in logging and primary processing, sawmilling, woodworking, furniture, plywood and wood-based panel manufacturing etc., residues increase the cost of raw material to the consumer.

Wood residues are classified by place of origin, physical and mechanical properties, economic accessibility etc.

The place of origin and physical and mechanical properties of the residues may be classified as follows:

(a) Logging residues in the woods and on wood-handling landings, including stumpwood, roots, limbs and twigs, tops, leaves or needles, butt off-cuts and slovens;

(b) Piece-wood wastes derived from sawmilling and wood-working processes, i.e. logs and lumber off-cuts, slabs, planks, veneer and panel off-cuts, peeling residues, torn veneer and block off-cuts;

(c) Soft sawmilling wastes, i.e. sawdust, shavings and sanding dust;

(d) Bark derived from the debarking process;

(e) Other wood wastes;

(f) Use of green tree-mass (needles and foilage with twigs of up to 8 mm).

Volume and trends in the utilization of wood residues are determined not only by processing possibilities but also by economic considerations, e.g. pattern of consumption, production costs, transportation costs, price of the substitute materials. The incorporation of wood residues into industrial processing would help to solve many economic and social problems, in particular, by:

(a) Increasing the profitability of logging and woodworking;

(b) Using labour resources more efficiently;

(c) Reducing distances and costs involved in the transportation of forest goods through the use of local raw materials;

(d) Reducing logging expansion requirements;

(e) Improving forest use in wood-deficit areas;

(f) Reducing environmental pollution and releasing land areas occupied by dumped residues.

The processing of 1,000 cubic metres of wood residues that at present remain unused would reduce the areas logged by 6-10 hectares and the volume would provide an additional 200 tons of pulp, 600-700 cubic metres of particle board or 120,000 square metres of fibreboard.

Since not all the wood residue can be utilized economically enough, the real prospects for industrial use would have to be estimated from the economic point of view.

The normative profitability of processing raw material and manufacturing prefabricated and finished products (industrial chips, pulp, panels, fodder, yeast, consumer goods etc.) is accepted in the USSR as a criterion for the economic accessibility of resourses. In practice, the criterion is applied by proportioning the two cost values:

(a) Marginal (maximal) wood-residue prices or prices for a wood-residue prefabricated product that the producing enterprise can afford to pay while preserving a normative level of profitability;

(b) Normative (estimated) costs of collecting wastes and processing them into prefabricated products that would allow the supplier to sell to the consumer while maintaining his supplying side profitability level.

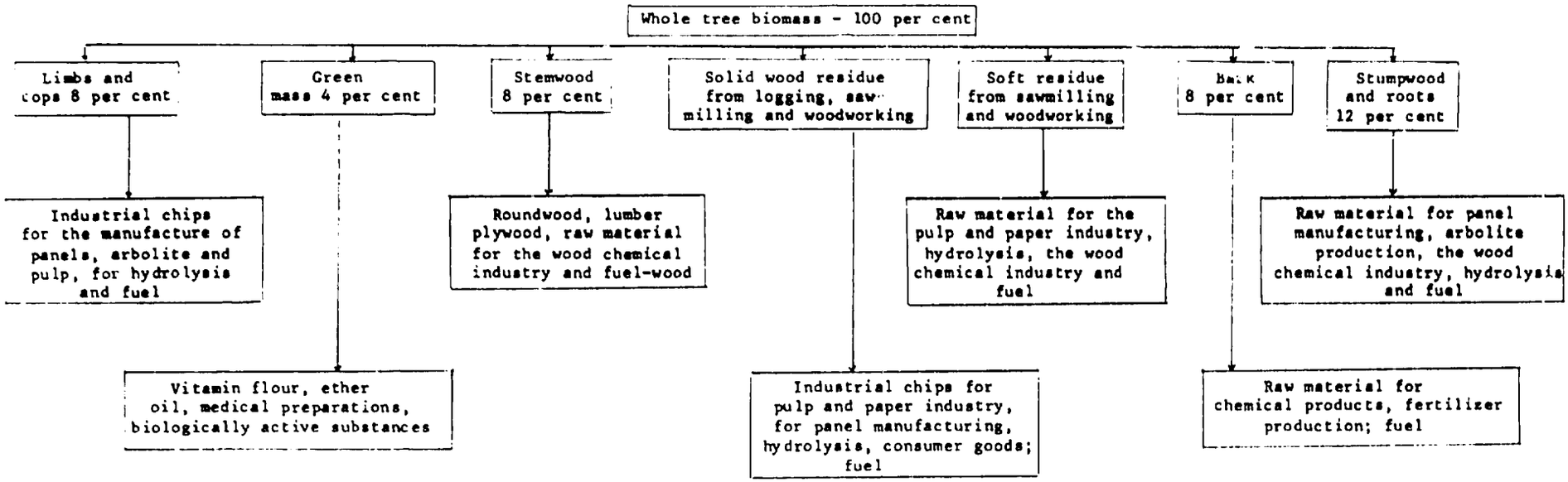
The efficiency of wood residue depends to a large extent on the concentration of residues at the processing place. It has been calculated that the minimal concentration level of economically accessible wood residue for processing depends on many factors, for example, trends in utilization, means of transportation and distance to consumers, processing labour intensiveness etc. Figure I shows the main ways in which the tree biomass, including wood residues, is used.

The efficient use of wood residues provides additional raw material without increasing the volume cut. Industrial processing increases the finished product yield from the raw material at hand, and the products (paper-board, panels, technical paper) meet consumer requirements much better than does solid wood. Panel products obtained from 1 cubic metre of raw material, and packaging paper-board produced from the same volume of wood residues would replace 2.5 cubic metres of lumber.

G. Wood used for energy

The problems of using wood for energy play an important role in the forecasting and planning of the forest and woodworking industry. All countries with a well-developed wood industry are doing research on the subject. According to FAO and ECE data, the possibilities of wood as a natural and renewable energy source are far from being exhausted. The FAO and ECE papers indicate that, according to theoretical calculations, it is possible to meet 10 per cent of the annual energy requirements using forest biomass for fuel.

Figure I. The most important uses of tree biomass



Wood can be used for generating energy by burning the wood biomass direct burning and by processing it into solid or liquid fuel etc.

Wood has a number of advantages over other fuel-energy sources: it is the only type of fuel that can renew itself naturally; and wood-burning in modern burners has no adverse environmental impact.

Wood accounts for just over 1 per cent of the fuel output in the USSR. This small proportion is due to the significant volume of coal, gas and oil inventories and output.

The wood and woodworking industry in the USSR uses wood residues for fuel, but only those that are uneconomical for industrial use. Wood residues are used for energy mainly in house and industrial heating systems with steam-generating installations.

With the development of chemical and mechanical processes that use logging and woodworking residues, the quality of the residues left over for fuel has gone down. Logging residues (limbs, twigs and bark) usually used in burner-boiler systems are characterized by low thermal qualities, high ash generation and high moisture content.

In order for bark to be used as fuel, it has to be reduced to fragments, distributed and stored, and the inter-operational dry material transported.

In the USSR, the concept has been developed of an interseasonal storage yard for low-quality wood residues situated right next to a boiler shop. The yard is provided with a ventilation system to maintain the required temperature.

If necessary, low-quality wood residues are transported by motor vehicles to a special landing where they are separated from mineral contaminants (soil and stones).

If the residues are free from contaminating matter, they are directed immediately to the storage yards of the boiler shops. The yards (landings) are equipped with machinery and devices for handling residues (including boiler feeding devices).

In order to increase the efficiency of methods for burning wood residues, research is being done on further improvements in the technological processes involved and developing special equipment for the collection, handling and transportation of logging residues, rational systems for storing fuel chips, automated systems for fractionated wood-burner in-feed, the development of new burners and the improvement of existing designs, as well as the development of pre-drying equipment (before in-feed) etc.

One trend in the expansion of wood-fuel utilization is the planting of special "energy" forests on waste and unused agricultural lands. This trend contributes to a better environmental protection control.

II. DEVELOPMENT PLANNING AND FORECASTING OF THE WOOD AND WOODWORKING INDUSTRY IN THE USSR

The development of the wood and woodworking industry in the USSR is based on planning. Planning and forecasting are the most important factors in the management system of a socialist economy.

The most significant challenge of planning is to base national tasks on product output expressed in terms of specified volumes, assortment, quality and time, at minimal costs. Time planning includes prospective, current and operative planning. Prospective planning includes five-year planning and long-term forecasting systems.

The long-term plans and forecasts for the industry are developed for periods of 20 or more years. The challenge for long-term plans and forecasts is to act as a basis for the most important directions to be taken in the development of the sector. Long-term plans are based on five-year plans and are developed for decades. The five-year plan is the most important part of perspective planning and in it the activities of the wood and woodworking mills and integrated interprises are specified. It is developed for each year separately, and is broken down as follows:

(1) The most important indices of production efficiency and development;

(2) Production and selling sector;

(3) Development and management of production engineering;

(4) Engineering and economic norms and standards;

(5) Capital construction;

(6) Labour and manpower;

(7) Cost price, income and profitability;

(8) Economic incentive funds;

(9) Finances;

(10) Environmental protection control and rational use of nature resources;

(11) Collective social evolution.

The importance of further improving forecasting methods and their wide application in forest-related management practices is increasing under the prevailing large-scale and sophisticated structure of product manufacturing and the immense and far-reaching challenges for the national economy.

Methodologically speaking, forecasting of the growth of the wood and woodworking industry is based on a combination of long-term scientific forecasting methods, taking into account objectively developed trends, and

active measures designed to influence trends in the interests of the national economy and the growing importance of forests in the social and economic life of the society. Moreover, progressive trends may be seen in the domestic and foreign development of machinery, processing technology and organizational logging practices. In forecasting, assumptions, estimates and preconditions describing temporary pressures and trends should be avoided. Wood and woodworking industry forecasts should be developed hand in hand with forestry, pulp and paper industry forecasts, as well as with forecasts for other co-operating branches; in particular, a dynamic accounting is necessary of mature growing stock and of the volume of wood cut. The above-mentioned forecasts and perspective planning are developed by means of an economic-mathematical simulation system used for seeking a long-term optimal development strategy and the calculation of variants of the five-year and ten-year plans using an automated system. Figure II illustrates the system used to forecast and plan the industry.

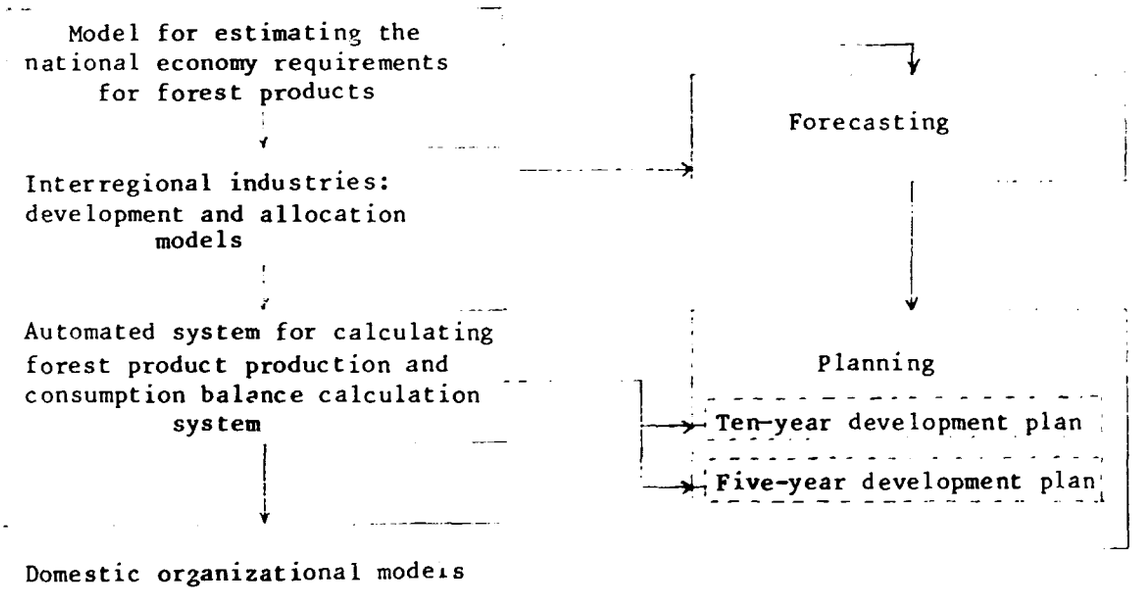
Forecasting must be able:

(a) To estimate the national demand for forest products;

(b) To estimate possible forest resources and their marketability;

(c) To optimize the territorial and technological structure, taking into account the given level of national economy requirements for forest products and possible limiting factors, depending on fuel, raw material, electric power, water supplies etc.

Figure II. Forecasting and planning system



Econometric methods are used to determine the national demand for forest products. Models have been developed to describe the correlation of exogenous and endogenous factors (see figure III). Those factors determine the development of requirements. With a view to obtaining more reliable and stable linkages, one-factor and two-factor regression models (with autonomous

trend factor) are used. Variable characteristics are chosen out of number of functions analysed by sliding-exam methods, in which different sampling lengths are used and the stability of the parameter estimates is studied:

$$y = a_o + a_1 x_1 + a_2 x_2 \ ;$$

$$y = a_o + a_1 x_1 + a_2 x_2 + \frac{a_3}{t+c} \ ;$$

$$y = a_o \left[a_1 + \frac{a_2}{t+c} \right] x_1 + a_3 x_2 \ ;$$

$$y = a_o + a_1 x_1 + \left[a_2 + \frac{a_3}{t+c} \right] x_2 \ ;$$

$$y = \left[a_o + \frac{a_1}{t+c} \right] x_1^{a_2} x_2^{a_3} \ ;$$

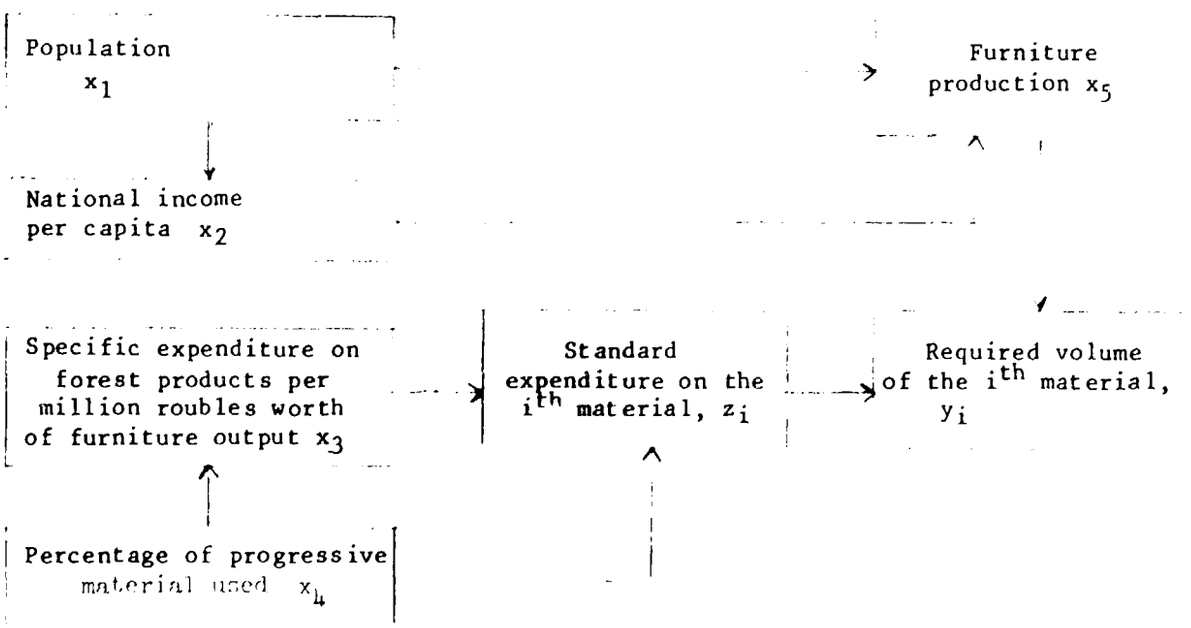
$$y = a_o x_1^{a_1} x_2^{\left[a_2 + \frac{a_3}{t+c} \right]} \ ;$$

$$y = a_o x_1^{a_1} x_2^{a_2} \ ;$$

$$y = a_o x_1^{a_1} x_2^{a_2} e^{-a_3 t}$$

and others, where a_o, a_1, a_2 and a_3 are estimating parameters t is time and e is the base of the natural logarithms, about 2.72 and c is a constant, taking into account saturation effects and shift ($5 \leq c \leq 15$); it is determined experimentally.

Figure III. Block-scheme of correlation in the model for forest product requirements in the furniture production sector



The models for determining forest product requirements in furniture industry is represented as follows:

(1) $x_1 = x_1 (t)$

(2) $x_2 = x_2 (x_1\ t)$

(3) $x_4 = x_4 (t)$

(4) $x_3 = x_3 (x_4, t)$

(5) $x_5 = x_5 (x_1, x_2, t)$

(6) $z_i = z_i (x_3, x_4, t)$

(7) $y_i = x_5\ z_i$

Forest product consumption models are developed in the same way for all other sectors (construction industry, maintenance-repair service, machinery production, exports).

The principle task of forecasting is to determine the optimal structure of a forest complex. The task includes optimal allocation of industries throughout the country, forest-use strategy, raw material policy and technology for the optimum use of raw material. There is an additional variant providing optimal use of raw material by optimizing production and transport inputs while paying due regard to the most fundamental principle of industry allocation in the USSR: ensuing effective labour distribution within economic regions in order to achieve a more complete and effective use of natural resources and overall economic development in the regions and also to promote formerly underdeveloped regions.

Optimization of a forest complex at the forecasting stage is developed according to an aggregate regional network but using a well-defined technological structure. A specially developed interregional allocation and development linear model is used. It includes a system of production and consumption balance equations and regional product interchange, and resource and capacity limiting factors. In the balance correlation some product group substitution is allowed for and the model is supplied with additional correlations regulating consumption structure spheres in accordance with technical, technological and social requirements.

A further scheme detailing a perspective plan is achieved with the help of an automated system of territory forest product supply and consumption balance calculations (ASBC).

ASBC is a complex of interrelated optimizing and simulating models. The principal scheme is described in the following blocks:

(1) Input of initial information on logging volumes and assortment structure;

(2) Input of initial information of the allocation of woodworking enterprises and final consumption of forest products;

(3) Standard information bank;

(4) Consumers of forest products preliminary calculations for every territorial unit; estimation of forest product surplus and deficit;

(5) Calculation of the forest product production and consumption balance for the country as a whole and for large regions;

(6) Balancing of production and consumption for large regions - at this stage a group of experts makes the principal decisions on changes in industry allocations and makes the necessary corrections in the initial information; the calculations are repeated until desired results are obtained;

(7) Balancing of production and consumption for smaller territorial units (regions, republics, forest complexes). The results are analysed and, if necessary, corrections are made in the initial information and standard basis, and the calculations are repeated.

Five-year industrial development plans are prepared for forest complexes and groups of enterprises, using models for the optimization of the intra-regional organizational structure. The most important objective is to determine the optimal structure and scale of the enterprises and also to work out transportation schemes for supplying those enterprises with raw materials and semi-finished products.

One of the most important factors determining the efficiency planning and forecasting in the wood and woodworking industry is rational distribution of logging and woodworking enterprises.

A regional distribution of industry saves on investment and operational costs saving and fosters multiple forest resource utilization and regional development. It also ensures growth in social labour productivity.

That is why regional construction plans must have an accurate economic basis, which takes into account all the repercussions in various areas of co-operation (supply of raw materials, final product consumption etc.) and in the sphere of transportation.

The allocation of the wood and woodworking industry in the USSR is determined according to scientific principles based on socialist economic laws and first of all on the laws of planned development of the social economy and steady growth in social labour productivity.

Some general principles are common to all branches of industry:

(1) As far as is possible, production facilities should be allocated nearer to sources of raw material and product-consuming regions, with a view to distributing industries rationally throughout the country and saving transportation costs. In accordance with this principle, some branches of industry should be located close to the resources (e.g. logging), in consuming areas (e.g. furniture production), or near low-cost energy sources and water sources (e.g. pulp and paper industry);

(2) There should be a rational distribution of labour between economic regions, as well as integrated economic development in the regions;

(3) Environmental concerns must be kept in mind. The steady technical progress realized in limited natural resources determines the location of certain industries, bearing in mind the need for reproduction of renewable natural resources, the reduction of water and air pollution and the improvement of the human environment.

In addition to general national economic factors limiting the choice of location of an industry, there are, in the wood and woodworking industry, some specific factors - climate, for example, and source of transportation.

Factors determining the distribution of the logging industry include:

(a) Allowable cut volume in accordance with the requirements of forest-management agencies;

(b) Age composition of the stands - when mature and over-mature stands predominate, the volume cut should be increased;

(c) Composition of the stand in terms of species and size characteristics of the trees (volume per hactare, average tree-length). All other things being equal, it would be more efficient to allocate logging to regions where the inventory characteristics of the stand are higher (softwood species predominating, high volume of growing stock per hectare etc.).

The natural conditions determining the location of the logging industry also affect the allocation of the woodworking industry; it is advisable to locate sawmills where there are large stands that provide a high lumber yield. Climate has an impact on the distribution of industries, particularly in relation to the different labour and living conditions of the population in different regions.

For estimating wood resources for allocations in the woodworking industry, the following classifications are necessary:

(a) Potential resources determined on the basis of forest inventory data;

(b) Real physical resources determined in the same way as potential resources, subtracting inevitable losses in the course of logging and transportation;

(c) Economically accessible resources, estimated, taking the accessibility criterion into account, when the utilization and processing of resources is economically reasonable with existing technology and production management.

To avoid poor decisions in distributing different branches of forest-related industries, only economically accessible wood resources should be taken into account.

Demographic factors include: (a) population density; (b) specific proportion of rural to urban population; (c) age and sex characteristics of labour resources; (d) characteristic qualifications of labour; and (e) availability of social services for the population.

Demographic factors have a great influence on the distribution of labour-intensive industries, first and foremost on the logging industry.

In estimating allocations, it becomes clear that demographic factors run counter to natural factors, for forest resources are mainly distributed in the unpopulated or poorly populated regions of Siberia and the Far East.

Scientific and engineering progress influences industrial distribution through the following most important economic factors: (a) specific capital investment in construction; (b) labour-intensiveness in the manufacture of different products; (c) input of fuel, electric power and chemicals; and (d) cost price of the products.

The distribution of forest-related enterprises is greatly influenced by concentration of production, co-operation and specialization.

The growth in concentration is governed by increases in the raw material basis on one hand and in the number of consumers on the other hand. As a result of such growth, transportation distances are increased; in addition, the distribution of large-scale enterprises complicates the choice of construction site.

Specialization, particularly technological specialization, lessens the dependence of woodworking industries on raw material sources by distributing the various enterprises; this very factor makes it economically effective to allocate furniture manufacturing to densely populated areas with poor afforestation. At the same time, transportation costs are decreased owing to the easier handling of processed and more transportable materials.

The co-operative factor has a particularly great influence on the distribution of woodworking industries, above all on the reduction of transportation costs. Combining production facilities slightly reduces the effect of the transportation factor owing to the involvement of local secondary raw material resources and semi-finished products in the production processes.

The impact of the trensportation factor on allocation efficiency is estimated quantitatively by the following indices: (a) average distance the raw material is transported; (b) share of transportation costs in the cost price of the product; (c) average distance the finished product is transported.

On the basis of the planning and forecasting methods in the wood and woodworking industry described above, the development trends for a specific forecasting period may be examined.

The most important economic and social development directives in the USSR for the period 1981-1985 and up to 1990, approved at the XVIth Congress of the Communist Party of the Soviet Union, envisage an increase in output of 17-19 per cent in the forest and woodworking industries in the five-year plan period alone.

The supply of high-productivity machines and equipment for logging, road-building and timber-handling operations is also envisaged.

Output in the woodworking industry is expected to increase at higher rates than logging. In the period 1981-1985, particle-board output should increase 1.5 times, and fibreboard output 1.3-1.5. Furniture production is expected to expand significantly and furniture articles to improve, becoming more comfortable and of higher quality. Labour productivity should increase by 16-18 per cent.

Logging technology will remain traditional i.e. tree-length removal will predominate, but there may be some shifts in the use of whole-tree biomass. The specific share of whole-tree removals will increase and an entirely new technology for whole-tree chipping in the woods will be developed.

In the longer term, i.e. in the next 20 years, the most important challenge will be to increase the efficiency of social and economic production, through a growth in engineering research, the integrated use of wood raw material and the progressive development of forest products.

In the final analysis, the development of an integrated forest enterprise is directed towards a steadily growing supply of forest products to meet the demands of the economy with adequate volumes and quality while at the same time reducing to a minimum the inputs of labour, raw material and energy.

On the basis of the above challenges, a number of general and specific economic and management problems have to be solved.

(1) The level of production engineering in all branches of integrated forest enterprises should be increased by introducing new machinery and advanced technology and expanding, rebuilding, and re-equipping existing production facilities. New machinery and equipment are to be developed so as to replace manual labour by machinery, thus increasing productivity and decreasing labour, material and energy inputs.

(2) Achievement of an integrated and rational utilization of all wood harvested, including secondary resources and low-grade timber, is one part of the second problem. In addition, there should be a further orientation towards the development of efficient industrial wood-substituting materials (particle board, plywood, paper board etc.) and a growth in chemical wood processing. Production of efficient wood-substituting materials should be increased 1.8-2.5 times, with only slight growth in harvested volume.

(3) A wider and more efficient use of soft hardwood is envisaged for pulp and paper manufacturing, and for wood-based panel production and hydrolysis.

(4) Forest use should be improved and expanded in the Europe-Ural zone by intensifying final and intermediate cutting and reconstructive cutting so as to replace unproductive and low-quality hardwood stands by highly productive and high quality softwood stands, and by constructing medium and small capacity plants for chemical and mechanical and chemical wood processing.

(5) In heavily forested regions integrated forest enterprises should be created with a view to securing a full forest management cycle, from growing and harvesting to wood processing.

(6) The construction of standard wooden housing for rural populations should be carried out more speedily, and the demands of integrated agricultural and industrial enterprises met through the installation of wood hydrolysis production facilities, packaging manufacturing and facilities for the manufacture of other forest products.

(7) Every effort should be made to increase forest productivity on the basis of a sustained yield, as well as to improve protection from forest-fires and insect-pest control.

(8) Wood use in wood-consuming branches of the industry (pulp and paper, sawmilling and woodworking, mining, construction, packaging industries) should be improved through the progressive development of standards for raw material inputs per unit of finished product as well as the introduction of new processes and products.

(9) Further improvements should be made in workers' living and working conditions by strengthening health and safety controls throughout the production cycle.

All the above steps are in complete accordance with the most important economic strategy challenge of the Communist Party: the steady growth of material and cultural well-being, the creation of better conditions for all and personal education based on the further growth of social production, labour productivity and increasing social and labour activities by the Soviet people.

III. EXPORTS OF FOREST PRODUCTS

Foreign trade in the wood and woodworking industry is one of the major forms of Soviet economic co-operation with other States, thus playing an important role in increasing the development of the national economy and meeting the requirements of a socialist society.

Exports of major wood materials and pulp and paper goods from the USSR in the period 1930-1981 are shown in table 7.

In the period 1960-1981, the turnover of foreign trade in wood and pulp and paper goods increased 7.9 times, and rose to 3.4 billion roubles, including exports amounting to 1.98 billion roubles (see table 8).

In the same period, USSR exports in major wood materials and pulp and paper articles grew faster than production (see table 9). Thus, plywood and furniture production rose by a factor of 1.5 and 5.2 respectively, and export values by a factor of 2.5 and 21.8; pulp and paper production increased 2.8 and 2.3 times, while exports increased correspondingly 10.7 and 11.0 times.

In the period 1970-1981 paperboard production increased 1.4 times and exports increased 2.9 times, while fibreboard and particle board production increased 2.2 and 2.7 times and exports 4.5 and 2.8 times.

It should be noted that in the USSR export of wood products that are subjected to heavy mechanical, chemical-mechanical (furniture, plywood, plates) and chemical (chemical wood pulp, paper, paperboard) processing have the highest production rates. This tendency is also characteristic for world trade in the 1980s, as shown in table 10. Exports of the majority of the goods mentioned in terms of production are also steadily increasing.

Thus, in the case of chemical wood pulp, the share of exports in production increased in the period 1960-1981 from 12.8 to 15.8 per cent, that of paper from 5.2 to 12.2 per cent, furniture from 1.1 to 4.8 per cent, plywood from 9.9 to 1.2 per cent and paperboard (1970-1981) from 9.8 to 10.9 per cent.

The growth of fibreboard and particle board exports was approximately porportional to the growth in production. The increased share of more heavily processed wood products improves the export structure and increases its effectiveness. Along with the growth of currency prices, it contributes to an increase in income for every cubic meter of wood conventionally exported. Thus, in the period 1970-1979 this index increased 28 times.

The socialist countries and first and foremost member States of the Council for Mutual Economic Assistance (CMEA) are the greatest traditional importers of wood exports from the USSR.

The USSR supplies to other member States of the CMEA coniferous sawnwood representing more than 46 per cent of total exports, plywood amounting to 51 per cent, fibreboard and wood-article boards more than 74 and 84 per cent respectively, furniture 95 per cent, roundwood 19 per cent, pulp 57 per cent, and paper and paperboard 77 per cent.

Table 7. Exports of major wood materials and pulp and paper from goods from the USSR, 1930-1981

Year	Sawlogs (millions of cubic metres)	Sawnwood (millions of cubic metres)	Pulpwood (millions of cubic metres)	Plywood (thousands of cubic metres)	Particle (thousands of cubic metres)	Fibreboard (millions of square metres)	Chemical wood (thousands of tons)	Paper and paperboard (thousands of tons)
1930	1.5	4.5	3.3	7.6	-	-	-	3.1
1939	0.1	3.2	0.7	120.0	-	-	-	2.7
1950	0.1	1.0	0.1	48.3	-	-	67.9	30.2
1960	1.5	5.0	1.0	129.1	-	-	243.7	122.5
1965	4.6	8.0	4.2	190.0	62.3	12.0	261.9	242.0
1970	7.3	8.0	6.0	281.4	145.0	41.6	447.8	721.6
1975	9.3	7.8	6.8	302.5	274.0	72.2	514.9	924.7
1981	6.2	6.9	5.8	324.3	362.2	95.6	843.6	1 047.1

Source: Statistical year books for foreign trade in the USSR covering the periods 1955-1959, and 1959-1963 and the years listed in the table.

Table 8. Growth in exports of wood materials and pulp and paper articles from the USSR, 1960-1981

	Export values (millions of roubles)					Growth over 1960 (times)		
	1960	1970	1975	1980	1981	1970	1975	1980
Total	275.8	771.7	1 430.9	2 084.4	1 979.9	2.8	5.2	7.5
Wood materials	234.8	592.1	1 117.3	1 612.3	144.2	2.5	4.8	6.8
Furniture	1.2	6.8	16.9	26.2	27.8	5.6	14.4	21.8
Fibreboard	-	8.1	22.0	30.3	36.7	-	2.7[a/]	3.7[a/]
Particle board	-	7.7	13.8	19.3	22.1	-	7.7[a/]	9.3[a/]
Total pulp and paper articles	40.0	156.9	260.8	472.1	515.7	3.9	6.5	11.8
Pulp	22.6	59.4	93.4	220.7	241.1	2.6	4.1	9.8
Paper	17.4	68.2	116.6	171.6	187.8	3.9	6.7	9.8
Paperboard	-	29.3	50.8	79.8	85.8	-	1.7[a/]	2.7[a/]

Sources: Relevant statistical yearbooks.

a/ Over 1970.

Table 9. Share of exports in the production of wood materials and pulp and paper articles in the USSR, 1960-1981

Product	1960	1970	1975	1980	1981
Roundwood					
Production (millions of cubic metres)	370	385	395	357	358
Exports (millions of cubic metres)	4.4	15.3	16.9	13.9	14.3
Exports as percentage of production	1.2	3.9	4.3	3.9	3.99
Sawnwood					
Production (millions of cubic metres)	105.5	116.4	116.2	98.2	98.1
Exports (millions of cubic metres)	5.0	8.0	7.8	7.1	6.9
Exports as percentage of production	4.7	6.9	6.7	7.2	7.0
Plywood					
Production (millions of cubic metres)	1.3	2.0	2.2	2.0	2.0
Exports (millions of cubic metres)	0.129	0.28	0.302	0.314	0.324
Exports as percentage of production	9.9	14.0	13.7	15.7	16.2
Fibreboard					
Production (millions of square metres)	7.0	208.3	408.6	468.9	481.9
Exports (millions of square metres)	-	41.6	72.2	90.8	95.0
Exports as percentage of production	-	19.9	17.6	19.4	19.8
Particle board					
Production (thousands of cubic metres)	161	1 991	3 996	5 118	5 390
Exports (thousands of cubic metres)	-	145.0	273.9	332.2	32.2
Exports as percentage of production	-	7.3	6.8	6.5	6.9
Furniture					
Production (millions of roubles)	1 101	2 790	425	5 352	5 717
Exports (millions of roubles)	1.2	6.8	16.9	26.2	27.8
Exports as percentage of production	1.1	2.4	3.9	4.9	4.8
Pulp					
Production (thousands of tons)	1 900	3 951	5 140	5 192	5 317
Exports (thousands of tons)	243.7	437.8	515	821.2	843.0
Exports as percentage of production	12.8	11.0	10	15.8	15.8
Paper					
Production (thousands of tons)	2 334	4 185	5 215	5 288	5 399
Exports (thousands of tons)	122.0	475.2	617.0	646.5	658.8
Exports as percentage of production	5.2	11.3	11.8	12.2	12.2
Paperboard					
Production (thousands of tons)	893	2 516	3 368	3 445	3 555
Exports (thousands of tons)	-	247.0	307.7	371.9	388.4
Exports as percentage of production	-	9.8	9.1	10.8	10.9

Sources: Statistical yearbooks for foreign trade in the USSR, various years; Statistical Yearbook of Member States of the Council for Mutual Economic Assistance, 1982 (Moscow, Statistika, 1982).

Table 10. Structural changes in the export of wood materials and pulp and paper articles for the USSR, 1970 and 1980
(Percentage)

Product	1970	1980
Total roundwood	45.8	40.0
Sawlogs	21.8	18.7
Pulpwood	17.9	16.5
Sawnwood	40.1	34.1
Plywood	1.9	2.3
Fibreboard	1.1	1.6
Particle board	0.5	2.9
Pulp	6.6	11.8
Paper and paperboard	4.0	7.3

Source: Statistical yearbooks for foreign trade in the USSR, various years.

Hungary is the biggest consumer of Soviet roundwood, while the German Democratic Republic is the biggest consumer of coniferous sawnwood, furniture and paper and paper goods.

The exchange of assortments of furniture, paper and paperboard between the USSR and other member States of CMEA has been successfully expanded on the basis of specialization and co-operation in the production process.

The export of Soviet materials and pulp and paper goods to the developing countries, to which the USSR supplies coniferous sawnwood, sawlogs, plywood, pulp, paper, paperboard and matches is growing.

The USSR traditionally exports to the developed capitalist countries roundwood, coniferous sawnwood, sawlogs, pulpwood, pit-props, plywood, furniture, plates, pulp and paperboard.

Japan and Finland are the biggest importers of Soviet wood (roundwood and sawlogs).

In the USSR the conditions are favourable not only for a considerable increase in wood exports but also for fundamental changes and improvements in the structure of such exports; the percentage of products undergoing a higher degree of wood processing will keep increasing, which will make it possible to improve the effectiveness of exports and increase the profit on every conventionally exported cubic metre of wood.

The priority in supplies of wood materials and pulp and paper goods goes to the socialist States, and particularly to States members of CMEA. Wood exports to the countries of the socialist community comply with the all-round programme of socialist economic integration and long-term one-purpose co-operation programmes. Specialization and co-operation in the production process are continuing to grow.

Thus, on the basis of specialization and co-operation, the exchange of assortments of products of wood-processing, paper and paperboard between the USSR and other members of CMEA is expanding in every possible way.

The structure of wood exports to the developing and developed capitalist countries, including exports based on compensation agreements, is improving.

IV. FOREST AND ENVIRONMENTAL PROTECTION CONTROL

The development of effective and improved environmental protection control systems is a part of economic and social planning and forecasting in the forest and woodworking sector as well as in the Soviet economy as a whole.

Scientific and technological progress opens up prospects for the growth of industrial branches, which have a negative impact on the environment through air and water pollution with the emission of toxic gasses and poisonous water effluents, besides large amounts of residue litter in nearby areas.

In the USSR, special State and social efforts are directed towards a more rational use of natural wealth and the reproduction of natural resources, along with the prevention of environmental pollution.

In Principal Trends of Economic and Social Development in the USSR for the Period 1981-1985 to 1990, it is stated that improvements in technological processes and means of transportation should be directed towards a reduction in environmental pollution and for this purpose it is necessary to increase the output of high-efficiency gas and dust-collecting apparatus, equipment for cleaning waste water, as well as other devices and automatic stations for State control of the environment.

Forests in the USSR are the property of the State and the forests contribute significantly to environmental control. The constitution of the USSR envisages that measures will be taken to ensure a scientifically based rational use of forest land and plant world, as well as the restoration of natural wealth, including forest resources.

The useful characteristics of the forest are widely known: they clean the air of dust and carbides, restoring the air-oxygen balance and soil-water balance.

Environmental control challenges are multiple in nature, including rational forest land use, more complete utilization of forest biomass, forest reproduction and increased productivity of forest land, as well as forest fire control and protection and insect and pest control. The challenges also include the creation of forest zones around villages and towns and the organization of forest management so as to ensure health protection and the recreational functions of the forests.

To improve the water and soil protection functions of the forests, special protective forests, to which access is banned, have been created in recent years along the rivers and channels and around lakes and reservoires.

The most important activities in the environmental protection and control system are those directed at the improvement of logging methods.

Thinning improves the composition of forest stands and increases wood yield per area cut, in addition to which, the rotation becomes shorter and timber quality improves. Thinning creates better sanitary conditions for tree-growing and makes the trees more resistant to unfavourable growth factors. A more complete and rational utilization of whole-tree biomass would make it possible to reduce the forest area cut.

In mountain forests, logging operations should be carried out in accordance with natural protection requirements, with precautions against soil erosion and slides.

Forest reservations are of special importance for environmental protection; they are used for observations of natural processes and laws are made with subsequent analyses of the data collected in order to estimate the future development of natural processes.

An expansion is envisaged of the forest protective strips in the steppe and forest-steppe zones of the USSR, taking into account the favourable impact on the productivity of agricultural land. These protective forests reduce the strength of winds and whirlwinds, and their velocity in fields between the forest strips. The forests increase air humidity and reduce soil drying. Gorges and gullies are planted with protective forests, thus preventing their expansion.

To control and prevent forest fires, special aircraft are used in the USSR, as well as forest observations and fire control stations. The forest insect and pest protection system includes special forest management activities and biological methods.

Forests in the USSR constitute free rest and recreation areas for working people. Forest-parks, green forest zones and protective forests around the towns are opened for recreational purposes. Therefore, in accordance with decision by the Party and Soviet Government, in the period 1981-1990 a number of new young forests are to be planted around populated centres and towns, and existing forests are to be improved.

There will be further construction of special recreation centres, motels, camping sites etc, reducing the adverse impact of intensive forest use for rest and recreational purposes. Further scientific and research studies are envisaged on problems of forest management in recreational forest areas.

V. INTERNATIONAL CO-OPERATION WITH STATES MEMBERS OF CMEA

In the wood and woodworking industry, the USSR is undertaking wide-production ranging activities in the commercial and scientific and technical fields in co-operation with other States, with great potential for development.

The USSR attaches great importance to the further development of foreign economic ties with the socialist States and, first and foremost, with member States of CMEA.

In the wood industry, the USSR is taking an active part in socialist integration and international distribution of labour.

The complex programmes for the further intensification and improvement of co-operation and the development of socialist economic integration, adopted in 1971, as well as the elaboration and adoption long-term programmes of co-operation in the second half of the 1970s, made it possible to shift from the traditional trade of wood and the products of wood processing to a new, much higher, stage and form of economic relations between the socialist States.

The following modern forms and methods of economic and scientific and technical co-operation between the USSR and member States of CMEA in the wood and woodworking industry are being further developed in the 1980s:

(1) Mutual planning activity;

(2) International specialization and co-operation;

(3) Joint construction and operation of joint enterprises;

(4) Joint capital construction and development of the countries' production capacity so as to increase its exports to members of CMEA;

(5) Soviet assistance in the building of industrial units;

(6) The use of contracted building and mounting enterprises, manpower and the material resources of the USSR, including turnkey contracts, in building up production capacities;

(7) The mutual supplying of wood materials and pulp and paper goods on the basis of long-term trade agreements and treaties;

(8) Supplying by the USSR to other countries of equipment, machines and spare parts for the wood, pulp and paper and woodworking industry on the basis of long-term trade agreements and treaties;

(9) The use of credits of the International Investment Bank (IIB) for building up production capacities;

(10) Co-ordination, co-operation and joint industrial and scientific tests, development work and the introduction of new techniques and technology;

(11) Setting up of international teams of scientists to solve major production and scientific problems;

(12) Co-operation in tasks involving the versatile unification and standardization of the wood, woodworking and pulp and paper industry;

(13) Co-operation in the training of national specialists.

Planning activities carried out jointly by the USSR and other CMEA member States involves various forms of co-operation, such as consultations on the major problems of economic policy, co-ordination of the five-year plans, joint prognosis for the development of production, exchanges of experience in the science and technology aspects of branch planning, and production management.

Planning co-ordination is the main form of planning activity undertaken. Co-ordination presupposes a complex solution of the "science-technology-production-exchange" cycle.

In the course of its implementation, the directions and subjects of scientific and technical co-operation and international specialization and co-operation are co-ordinated. The USSR and other member States of CMEA, when planning the development of the wood-logging and processing branches, take into account the favourable opportunities created by integration.

Thus, 80-100 per cent of the roundwood and sawnwood requirements of Bulgaria, Czechoslovakia, the German Democratic Republic, Hungary and Poland are met by the USSR. Bulgaria also obtains its newsprint requirements from the USSR.

A prospective form of production co-operation lies in joint efforts by interested countries to create new industrial enterprises, and reconstruct and modernize functioning ones, including those created on compensation agreement terms.

One example of such co-operation between the USSR and member States of CMEA (Bulgaria, the German Democratic Republic, Hungary, Poland and Rumania) is successful co-operation involving third-country credit from France in constructing on USSR territory the biggest integrated unit of the Ust-Ilimsk wood industry complex since 1981.

The enterprise is provided with modern equipment and technology, which enables complex wood-processing to be carried out.

The creation of such a complex makes it possible to improve the national economy requirements of the USSR and other countries (member States of CMEA) in the woodpaper industry.

Countries participating in the construction complex have the possibility, taking into account the chemical wood pulp produced by it, to expand the exchange of assortments of certain kinds of paper and paperboard on the basis of production specialization.

Another example of production co-operation involves the services of Bulgaria and the Democratic People's Republic of Korea in working the wood resources of the USSR.

The arrangement was set up in 1967. On the basis of an inter-State agreement on co-operation between the USSR and Bulgaria, several highly mechanized timber enterprises were established in the Komi Autonomous Soviet Socialist Republic by their joint efforts. In 1967 on the basis of the inter-State agreement between the USSR and the Democratic People's Republic of Korea, co-operation in wood logging in the Far East region was also begun. Bulgaria and the Democratic People's Republic of Korea refund to the USSR the cost of timber logged and other expenses by logging and transporting for the USSR a certain amount of wood and other products.

In the 1970s, Bulgaria took part in the expansion of the Arkhangelsk pulp and paper group of enterprises in the USSR by providing a certain number of builders. In exchange, Bulgaria gets chemical wood pulp from the enterprise.

In the early part of the 1970s, Soviet organizations, together with the Finnish firm Perusjuhtuma, completed the construction of a big Priozersky forest enterprise in the Karelian A.S.S.R.

On the basis of compensation agreements, there has been a thriving co-operation between the USSR and Japan, making use of the latter's equipment and machines to develop Far Eastern wood resources. As a result of these agreements, Japan has become one of the biggest consumers of Soviet wood materials.

In other countries, especially the socialist ones, production co-operation in the 1970s has been very much developed, for example in the form of USSR economic and technical assistance in the construction of new industrial enterprises and the reconstructing and modernizing of existing ones.

As a result of such co-operation, additional production capacity has been created for wood logging and removal and for the production of sawnwood, parts of wooden houses, pulp and paper goods that go towards meeting these countries' requirements in such products.

The USSR is working hard to develop the wood and woodworking industry in Mongolia. With the assistance of the USSR, several wood-logging and woodworking enterprises have been formed, operating Soviet equipment in compliance with Soviet technology.

Several enterprises are being constructed on a turnkey basis, supplemented by Soviet labourers and material resources, with the participation of contracting organizations.

The development of the wood industry in Mongolia has great social and economic importance, as it increases employment in industry and contributes to the setting up of national personnel and the provision of housing made of wood materials.

Production co-operation and economic co-operation member States of CMEA in the wood and woodworking industry promoted the rather rapid development of this branch.

Specialization and production co-operation in the wood and woodworking and pulp and paper industries are important prospective forms of an international socialist division of labour.

In the 1970s, a number of long-term specialization and production co-operation programmes in this field were prepared on the basis of agreements and treaties, which were added to and extended over the period 1981-1985.

In the wood and woodworking industry, the USSR has many years' experience in the training of national staff, mainly in socialist countries such as Bulgaria, Mongolia and Viet Nam. The following measures provided the most effective methods of staff training:

(a) Group and individual training on the work-site (in shops, laboratories etc.);

(b) Training in training centres set up with the help of the Soviet Union;

(c) Training in vocational establishments and enterprises in the USSR;

(d) Training in higher and secondary special educational establishments, both in the USSR and other countries;

(e) Consultations with national staff by Soviet specialists working in planning and management organs, as well as those engaged on scientific research designs.

VI. CO-OPERATION BETWEEN THE USSR AND DEVELOPING COUNTRIES IN THE WOOD AND WOODWORKING INDUSTRY, AND RECOMMENDATIONS FOR THE DEVELOPMENT OF THE WOOD AND WOODWORKING INDUSTRY IN THE DEVELOPING COUNTRIES

The USSR assists and develops economic relations with developing countries on a democratic and just basis and on the basis of sovereignty, equality and mutual interest.

The main forms of co-operation in the wood and woodworking industry at present consist of technical assistance in constructing industrial enterprises, foreign trade in wood and pulp and paper goods, production co-operation and assistance in training local staff.

Such co-operation is mainly developed on the basis of bilateral inter-State agreements which ensure a steady basis for co-operation, introducing planning elements, as well as securing a ready market for product of the wood industry in developing countries and permitting a regular supply of Soviet goods to those countries.

Production co-operation in the establishment of industrial enterprises and modernization and reconstruction of existing ones in developing countries greatly affects the foreign economic ties of the USSR with those countries. It affects the consolidation of the State sector of economy, increases the rates of economic development and strengthens the position of the developing countries in the world economy and world market.

As a rule, the USSR provides technical assistance in construction of industrial enterprises on the basis of long-term inter-State economic and technical agreements.

Soviet economic and technical assistance to developing countries is directed first and foremost towards the development of the industrial spheres of the countries' economies, creating the material and technical basis for doing away with the aftermaths of colonialism and building the foundation for a modern economy.

One example of such assistance is the construction of a 4,500-ton capacity plant for gum-resin production in Nepal with USSR technical assistance. In addition to gum resin, the plant will also produce turpentine. Favourable climatic conditions were responsible for the construction of this enterprise in Nepal, because of the plentiful supply of raw resin from local woods.

Soviet assistance in the construction of the plant is of great importance for the Nepalese economy as it increases the country's export potential and the employment of its people, not only at this plant but also in the woods when gum resin is being collected. The plant is being erected in accordance with the Soviet project and will be provided with standard Soviet equipment. Soviet specialists are taking part in the construction, building on the technical assistance experience gained by the Soviet Union when building wood, woodworking, and pulp and paper industry enterprises in Bulgaria, Romania, the Lao People's Democratic Republic and other socialist countries.

In Lao People's Democratic Republic enterprises for the logging and removal of tropical wood species are being constructed with Soviet assistance, on a compensation basis; great emphasis is placed on different types of national training personnel. The Soviet Union began to provide assistance in the harvesting of wood resources in Laos, through inventory operations, and in projecting wood-logging enterprises supplied with Soviet logging and road constructing machinery based on modern mechanized production methods.

The Lao People's Democratic Republic has large and valuable tropical wood resources and the development of the wood industry is of great importance for the country.

The Lao Government prepares and carried out the plans for making the wood industry a developed branch of the economy, based on modern mechanized production methods. With the assistance of Soviet specialists, forest inventory and wood construction work are being put into practice, and the development of large forest tracks of tropical wood is being organized.

USSR timber exports to the developing countries are mainly structured on the basis of the tasks set for Soviet assistance in establishing the national economy, carried out in accordance with economic and technical co-operation agreements. Most of the Soviet exports to this group of countries consist of production goods. There are also some exports of consumer goods.

Coniferous sawnwood materials from the USSR are exported to Algeria, Egypt, Iran, the Lebanon, Saudi Arabia, the Syrian Arab Republic and Tunisia; chemical wood pulp goes to Egypt and Thailand, paper and paperboard to Egypt, India, Iran and Thailand, plywood to Egypt, matches to Afganistan, Rwanda, Saudi Arabia, Tunisia, Yemen and Zambia.

The structure of USSR timber material imports from the developing countries is determined by the demands of the people's economy and the aspiration to help the liberated countries in the development of their national industry.

For example, as there are no valuable species of wood in the wood raw material base in the USSR, such as those needed for the production of quality furniture, high-grade parquet and other articles, the USSR is constantly increasing its imports of tropical woods from developing countries (see table 11).

Specific pecularities of a national and economic character should be taken into consideration when working out offers and recommendations for the wood and woodworking industry in the developing countries. The main directions taken in those countries will greatly depend on the state of their national economy, forest provision, accessibility of the forests for exploitation, state of wood potential and renewal of wood stocks.

To overcome backwardness and create an independent national economy, it is very important for the developing countries to expand their wood and woodworking industry. It is important for them to increase forest productivity, to renew forest resources, to prolong wood use and to change over from selective cuttings to final and conditionally final cuttings. The increasing price instability of tropical wood in the 1970s had a negative effect on wood plantation and led to the exhaustion of tropical wood

Table 11. Growth of USSR imports of valuable hardwood species, 1960-1981

Species/Product	Unit of measurement for quantities	1960		1970		1975		1980		1981	
		Quantity	Cost (millions of roubles)	Quantity	Cost (millions of roubles)	Quantity	Cost (millions) of roubles)	Quantity	Cost (millions of roubles)	Quantity	Cost (millions of roubles)
Deciduous hardwood species	Thousands of square metres	480.3	1.14	180.3	0.49	518.6	-	597.1	2.7	605.8	3.05
Valuable species for parquet	Thousands of cubic metres	...	...	68.5	2.2	177.6	14.4	195.2	27.3	257.6	35.07
Logs for plywood	Thousands of cubic metres	20.1	2.6	55.6	7.2	45.7	8.2	51.8	14.6	37.6	12.6
Single-layer plywood	Thousands of square metres	9.8	3.3	12.3	5.4	12.6	6.9	53.5	23.6	37.7	19.1

Source: USSR Statistical Year Books for foreign trade, in the period 1960-1981, USSR imports increased 2.7 times, single-layer plywood 5.8 times and in the period 1970-1981, plywood 4.8 times; imports of logs from valuable species increased 15.9 times. In 1981, the main suppliers to the USSR of hard deciduous species were Viet Nam and Romania, of logs from valuable species, the Ivory Coast, the United Republic of Cameroon, the Congo and Liberia, of single-layer plywood, Romania and Austria and of plywood, Romania.

resources. The degeneration of wood due to unsystematic wood cuttings and the yearly campaigns to set fire to forest land for farming purposes contribute to the exhaustion of such resources.

In many producing countries, the problem of wood renewal and achieving improved management of the wood economy has become very acute.

Under these circumstances, it is necessary to pay attention to making inventories first of all of tropical wood in the developing countries, so as to be able to determine wood potential (wood stock, species and age, forest composition, possible volumes of wood, logging removal) on the basis of comprehensive objective estimation. The wide experience of the Soviet Union and other socialist countries in this field can be used when carrying out inventory work in the developing countries.

It is expedient to prepare and put into practice in every developing country an organizational and technical system aimed at increasing wood productivity, with a view to securing additional wood resources to speed up mature and declining forest cuttings, to change over to final and conditionally final cuttings, to increase the assortment of commercial and trade types of logged wood and to intensify wood renewal.

In many developing countries, but first and foremost countries with wood resources, the wood and woodworking industry is of prime importance. It must not only meet thhe increasing requirements of developing countries for wood for manufacturing plywood, furniture, pit-props, sleepers and joinery and construction goods (parquet, window-sashes, door frames etc.) but also to provide raw material, of which there is a growing consumption for processing into pulp and paper and wood-chemical products and manufacturing fibreboard and particle board.

The availability of substantial wood resources in developing countries and the development of industry for logging and the processing of wood make it possible to increase employment and promote the training and strengthening of local personnel.

Taking into account the experience of Japan and some Latin American countries in using cheap species of tropical wood for pulp and paper production, it is expedient to study the problem of setting up this type of production in the developing countries. It will make it possible to increase the utilization of complexes, currency earnings from exports and employment. One way of tackling the development of the wood and woodworking industry is to foster co-operation between developing countries and wood-importing countries on the basis of production co-operation, including a compensation.

The setting up of mixed companies on the basis of share participation by socialist and developing countries is of some interest It contributes to an effective passing on of experience, scientific and technical knowledge and technology, and to more successful traning of local staff, strengthening and production and commercial activity of interested countries on a mutually beneficial basis.

At the end of the 1970s, according to UNIDO data, there were more than 100 mixed enterprises in which CMEA participated, including five wood-industry enterprises.

Thus, since 1968, Bulgaria and Guinea have been running a mixed enterprise to exploit Guinea's wood resources. Bulgaria supplies machines and equipment to the joint enterprise and provides it with specialists for the logging and processing of wood. Part of the produce is sent to Bulgaria to pay for its share in the venture. The availability of substantial wood resources made it possible for the enterprise to become the biggest exporter of tropical wood products derived from wood-processing.

Now, developing countries are already providing more than 40 per cent of the crude wood, more than 10 per cent of the sawnwood and approximately half of the plywood exports. Parallel with this, there are great possibilities for promoting wood exports in the developing countries.

The United Nations Conference on Trade and Development included tropical wood in the list of 18 raw goods (the Nairobi list) which are of essential importance for developing countries.

Research has shown that the export potential of industry engaged in tropical wood logging and processing in the developing countries greatly depends on their supplies of wood, economic development, accessibility of wood for exploitation and geographical situation.

About 3 per cent of the world's industrial wood consumption is in African countries. The index in African countries is a little more than 0.1 m^3 less than the average world consumption of 0.3 m^3 per capita. Imports and exports of wood and pulp and paper goods (in round wood recalculation) are on the whole approximately equal in the region.

In African countries in the torrid tropical zone, the area of wood exploited is 35 million hectares (20 per cent of the forested area) and the area of woods accessible for exploitation amounts to 120 million hectares (70 per cent). In tropical Africa, selective cuttings are most common; in such cuttings, only a certain number of trees per hectare of a specific (so-called commercial) species can be felled.

At present, large and easily processed wood, which is good for making ordinary wood materials, is preferred to these species, besides the valuable wood species used for finishing. In spite of this problem of exploitation, the huge potential of wood in central and western Africa remains untapped.

Usually 10-20 m^3 are logged from the approximately 400 m^3 of wood with more than 10 cm diameter that are available in each forested hectare in Africa. Almost half of the African wood exports consists of four species (Samba, ocume, sito, aka hzy) the logging of which exceeds the desgnated cutting area; another 20 per cent consist of six other species (sapelly limba, proko, macore, azobe macoretiama).

About 17 per cent of the world's industrial wood consumption is in Asia. Wood consumption per capita in African countries amounts to about 0.1 m^3 per capita. In Asia, selective cutting of tropical woods prevails when a limited number of commercial and marketable species are logged. All kinds of valuable finishing wood are considered marketable species. Recently, cheaper types of tropical wood, which do not differ much from the raw material of the temperate zones are being widely used.

A increase in the number of commercial species could make it possible to increase considerably export possibilities of the Asian countries, as well as to slow the growth of world prices for industrial wood.

The change-over to final or conditionally final cuttings would lessen current and capital expenditure for wood logging.

About 5 per cent of the world's industrial wood consumption, amounting to about 0.2 cubic metres of wood per capita, is in the Latin American countries.

The Latin American countries are generally importers of wood and especially of pulp and paper wood, despite the great resources of wood available.

Not more than 10-15 per cent of the Latin American countries have made an inventory, so this information about forested area and composition of wood species is based on different estimates.

The total forested area in Latin America amounts to 1.1 billion hectares. The major wood resources are concentrated in humid tropical forests. The area of newly planted forests in the region is less than 1 per cent of the total natural forest area.

In Latin America, more than in any other equatorial zone, there are hard heavy wood species that are difficult to process and cannot be floated. Selection cuttings prevail, of about 10-15 cubic metres of wood per hectare.

The above data on the state of wood resources show that the development of the wood and woodworking industry in developing countries may considerably increase the export potential and currency earnings of those countries. It may also serve as an important means of increasing the developing countries' share in world commercial goods trade to the 30 per cent envisaged for the year 2000 in the New Delhi Declaration and Plan of Action on Industrialization of Developing Countries and International Co-operation for their Industrial Development, adopted at the third General Conference of UNIDO.

It is worth noting that the realization of a number of measures concerning trade co-operation that are included in the New Delhi Declaration and Plan of Action will promote export potential, increasing the effectiveness and the foreign trade turnover of wood materials, as well as increasing currency earnings.

The expansion of the number of commercial and trade species logged in tropical forests, the addition of new species hitherto unknown in the world markets, and the introduction of ordinary tropical wood that is widely used in construction work and in the manufacture of boxes, matches and other articles and as raw material for the pulp and paper industry all foster the export possibilities of the developing countries. Besides setting up such measures, it is expedient to expand in every possible way research on the qualities for consumption purposes of tropical wood species not known before in world trade. It is also possible to organize joint research on wood quality by both supplier and consumer developing countries.

Valuable species of tropical wood used in the furniture industry for the manufacture of parquet, sport facilities, low-tonnage ships and finishing material are in great demand in the world market. Lately, however, the importance of these wood materials is slowly but steadily decreasing in the world market because of the limited amount of wood resources, despite consumers' and exporters' efforts to find ways to introduce the new type of finishing wood in the world market.

Ordinary tropical wood used in the construction industry for joinery work and in the manufacture of boxes, matches and other articles also figure in the wood exports of developing countries. The expansion of the use of tropical species, mainly at the expense of the cheaper types used for manufacturing a number of ordinary wood materials increased the exports of developing countries.

This type of wood, when used as a construction material, has a number of positive qualities and successfully competes with wood from temperate climates. In recent years, the use of cheap species of tropical wood in the pulp and paper industry has expanded and further increases its export possibilities.

Some species of tropical wood with special qualities (chemical stability, abrasion resistance etc.) that are used for specific purposes (machine bearings, chemical equipment, thermal-insulation) have a comparatively narrow sphere of application, in which they can be successfully replaced by non-wood materials. It is therefore necessary to find other ways of using them.

The experience gained from co-operation between the USSR and Cuba, the Lao People's Democratic Republic, Viet Nam, and other countries has shown that the research referred to above is an effective means of determining the most expedient structure for tropical wood exports by finding out the field of application of different species of tropical wood in importing countries, as well as the volume of world imports. On the basis of the research findings, technical requirements for wood supply are drawn up and co-ordinated between the suppliers and the consumers, and recommendations are made on mechanical treatment and on surface treatment with lacquer and dye-stuffs and other materials. The improvement of the structure of tropical wood imports and the increase in the share of ready-made products or semi-finished products which are the result of deep wood processing, primarily by chemical and mechanical-chemical methods, are comparatively new directions for increasing export supplies to the developing countries. The use of the co-operation experience of the USSR with other socialist countries in this field may contribute to the solution of this problem, both by the joint establishment of new woodworking and pulp and paper enterprises and the rebuilding of existing ones, and by transfer of technology, technical documentation, experience, know-how and the training of national personnel.

CONCLUSION

The wood and woodworking industry in the USSR is of a multi-product nature, covering logging and sawmilling, particle-board and fibre-board production, and the manufacture of plywood, furniture, packaging material, matches, prefabricated housing etc. It plays and important role in the economy. The products of various branches of the forest-related industrial complex have a wide application in construction, industry and agriculture.

The development of the USSR wood and woodworking industry is inseparable from the development of the national economy. Within a short period of history, the wood and woodworking industry has become a highly developed industrial branch of the economy, in which up-to-date, efficient machines and advanced technology are used.

Within the period 1913-1981 the volume of timber output increased more than seven times and plywood output more than eight times. New branches of the woodworking industry - particle-board and fibreboard production - have been created, in which the Soviet Union holds a leading position. Large-scale industrial enterprises (logging camps and plants), working all year round and applying progressive technology and efficient national equipment, are the basis of the country's wood and woodworking industry.

The availability of considerable stocks of mature stands provides for stable and systematic development of all branches of the forest complex, aimed at meeting the ever-growing requirments of the national economy for timber and its products.

As regards importance for the national economy, location and functions, all forests of the USSR are divided into three groups, in which differential forest management is established. Inexhaustibility and sustained yield are the main principles of forest utilization.

Forest regeneration is carried out both naturally and artificially.

The most characteristic feature of modern scientific and technical progress in logging and woodworking industries is the introduction of new machines and equipment, thus eliminating manual labour completely in both basic and auxiliary operations. The specific feature of new machinery and technology is a fuller use of forest biomass, as well as better environmental protection.

At the present time, the main logging operations - felling, skidding, loading, transportation, unloading, cross-cutting and stacking - are carried out by machines and other mechanisms.

For the first time, a tree-length system (for harvesting and transportation) was developed as a more efficient technology and introduced throughout the entire country. This technology provides smaller capital costs per cubic metre of harvested timber compared with that of a short-wood harvesting and transportation system (in assortments).

Timber harvesting and transportation in tree-lengths provides more favourable conditions for mechanization, since it enables the minimum number of operations to be performed at a felling site. This, in turn, makes it

possible to mechanize all operations at a felling site, by means of single or double operational machines (fellers, feller-bunchers, feller-skidders, delimbers).

Technical progress in the timber and woodworking industries facilitates the solution of important social problems connected with the substitution of machines for manual labour, changes in the professional skill structure and the elimination of professional traumatism and diseases.

The complex utilization of timber resources, including logging residues and woodworking waste is the most important means of increasing the efficiency of the wood and woodworking industry, other vital factors being concentration, specialization, co-operation and vocational training of personnel.

Taking into account the ever-increasing demand for timber, the volume of waste wood utilization is being constantly increased in the Soviet Union. Waste wood is mainly used in the pulp and paper industry, the production of wood-based boards (wood panels), in hydrolisis, and in the manufacture of pharmaceutical products.

As a rule wastes are only used as fuel wood when their use for technological processes is not economically feasible. The processing of 1,000 m^3 of wood waste reduces the cut areas by 6-10 hectares, provides and additional 0.2 tons of pulp or 600-700 m^3 of particle board or 100,000-120,000 m^2 of fibreboard etc.

Increased concentration and specialization in sawmilling, wood panel and plywood enterprises results in a reduction of capital investment and exploitation expenditure per unit of production, and labour productivity increases.

The development of the wood and woodworking industry in the USSR is carried out on a planned basis. Planning and forecasting are the main tools of socialist economic management. The main target of planning is the feasibility of State plans and the fulfilment of production output in planned volumes, assortments and quality by fixed dates at a minimum cost. In terms of time, the planning function covers long-term, current and operative planning. Perspective planning is made up of a system of plan forecasts, long-term and five-year plans.

Mathematical models are used for forecasting the development of the wood and woodworking industry in order to seek out the most efficient variants.

The forests of the USSR are State-owned and play an important role in environmental protection. Therefore, in the USSR a complex of measures is adopted to make possible the rational utilization of natural resources, to regenerate and multiply forest stands and to protect the latter from fires and diseases.

The forest, as an element of the biosphere, is necessary to maintain ecological equilibrium on a level that will guarantee the existence of the human being as a biological species. Therefore, the forest problem becomes an international one.

Soviet foreign trade in forest products is one form of economic co-operation with other nations.

The export of products of the mechanical, chemico-mechanical and chemical processing of timber (plywood, wood panels, pulp, paper and cardboard) is developing most rapidly.

Economic and scientific and technical co-operation methods of the USSR with CMEA countries include international specialization and co-operation, joint construction and joint running of logging and woodworking enterprises, mutual deliveries of forest and pulp and paper products on the basis of long-term trade agreements and contracts; delivery of machinery and spare parts from the USSR for the wood and woodworking industry; co-ordination, co-operation, joint scientific and industrial tests, development and introduction of new logging machines and equipment; co-operation in the unification and standardization of paper products on a multilateral basis, and co-operation in the vocational training of local personnel.

The Soviet Union renders assistance and develops economic relations with developing countries on a democratic and just basis, with respect for sovereignty, equality and mutual benefits.

At the present time, the main forms of co-operation are technical assistance in the construction of industrial enterprises, trade in forest products, industrial co-operation and assistance in skill training.

The above shows that the experience gained by such well-developed countries in forestry as the USSR is of great importance for developing nations that are just beginning to extend the harvesting and processing of timber.

The problems described in the present survey in connection with the analysis of USSR forest resources, stages of development of the wood and woodworking industry, the present state of the industry, methods of planning and forecasting the development of the wood and woodworking industry, wood-waste utilization, use of timber as fuel wood, environmental protection and experiences in international co-operation are undoubtedly of interest for the economy of developing countries possessing substantial timber resources.

Problems encountered in the development of the wood and woodworking industry in developing countries include deficits in their own capital investments, the need to increase the employment level of the population, lack of specialized forest machinery and equipment, ever-increasing domestic demands for timber and its products; these problems require the comprehensive solution of organizational, technical and economic questions.

Bearing in mind the experience gained in the Soviet Union, these questions may be summarized as follows:

(a) Organization of forest resource inventories;

(b) Mechanization and automation of all technological processes;

(c) Improvement of the structure of all branches of the complex of forest-related industries;

(d) Comprehensive utilization of all timber resources;

(e) Organization of the wood and woodworking industry on principles allowing for domestic national peculiarities as well as the general standards typical for developed countries;

(f) Increased export volume and extension of the export structure of forest products;

(g) Application of modern scientifically proved methods for planning and forecasting the development of the wood and woodworking industry;

(h) Organization of logging operations and forest management on sustained yield utilization principles;

(i) Timely training of personnel.

The need for improvements in the forest industry structure is shown by the fact that at the present time the production of sawnwood, wood-based panels, plywood and construction elements in developing countries is poorly developed. In 1980, according to FAO data, the African and Latin American countries produced respectively 1.8 and 4.9 per cent of the world production of sawnwood, 0.4 and 3.8 percent of the fibreboard, 0.9 and 2.3 per cent of the particle board and 0.9 and 2.5 per cent of the plywood.3/

It is clear that timber is mainly consumed as roundwood which is not efficient from the economic point of view.

Judging from the experience gained by the USSR, the economic efficiency of timber utilization in different branches of the national economy increases with a rise in the production of timber substitutes. At the present level of the development of woodworking industry, the substitution factors for different forest products evaluated in commercial timber are as follows: sawnwood, 1.5 m^3 per cubic metre; plywood, 5.0 m^3 per cubic meter; particle board, 3.7 m^3 per cubic metre; fibreboard, 20 m^3 per thousand square metres; cardboard - 14 m^3 per ton. Improvement of the production structure is an important factor in increasing the influx of foreign currency as well.

Comprehensive utilization of timber resources, including wood waste, not only effects savings in commercial wood but also increases the profitability of the wood and woodworking industry, creates a better employment climate, reduces the cost of transporting unprocessed timber and decreases the amount of capital investment per unit of output.

Utilization of wood-waste as fuelwood makes it possible to cover part of the domestic demand for energy and to reduce imports of solid and liquid fuels.

3/ Yearbook of Forest Products, 1969-1980 (Rome, Food and Agriculture Organization of the United Nations, 1982).

Concentration, specialization and co-operation of production, especially for sawmilling, board and furniture plants are an important means of reducing capital expenditure per unit of forest products in developing countries.

A study of the experience gained by countries with a developed forest industry will make it possible for the developing nations to choose the most efficient machines and equipment and the most advanced technological processes.

In organizing technological processes in wood and woodworking industry, besides taking account of specific forest-growing conditions and the natural and other peculiarities of a given country, the general principles of specialization, proportionality, continuity and cyclical production should be taken into consideration as well.

Bearing in mind the ever-increasing volumes of timber cut, it is of key importance for developing countries to carry out measures to improve the forest management system: a complete and accurate forest inventory, justified felling methods, selection of the most efficient technique of forest regeneration; fire protection; and protection of stands from diseases and insects.

To run the machinery and equipment are becoming more and more expensive, and in order to operate them as efficiently as possible, it is important for developing countries to oganize regular technical maintenance and repair of machinery, as well as to organize systems of vocational training of personnel in the proper time (operators, tractor-operators, drivers, mechanics, adjusters etc.).

Rational use of the whole biomass of a tree, forest regeneration, increase of forest productivity and of the protective sanitary, hygienic and recreational function of forests - all are vital measures for as regards environmental protection in developing countries.

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