MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE

National Aerospace University "Kharkiv Aviation Institute"

**Ya. Safronov, V. Kupriyanova, L. Kornilov,
T. Pavlenko, V. Voronko**

ECONOMICS OF ENTERPRISE

Tutorial

Kharkiv "KhAI" 2014

Розглянуто теоретичні відомості з найважливіших розділів курсу «Економіка підприємства». Основну увагу приділено розрахунку потреби в ресурсах та їх використанню, розрахунку кошторису витрат і собівартості продукції, оцінюванню конкурентоспроможності виробів, економічної ефективності капітальних вкладень та інвестицій у виробництво.

Для іноземних студентів, що вивчають курс «Економіка і менеджмент підприємства» англійською мовою.

Composite authors:
Ya. Safronov, V. Kupriyanova, L. Kornilov, T. Pavlenko, V. Voronko

Reviewers: PhD in Engineering, Prof. I. Y. Matyushenko,
PhD in Economics, associate professor N.I. Klimova

Tutorial covers the most important problems of economics of enterprise. Its authors focus on the ways to calculate resource requirements and their application, calculate cost estimates and production costs, evaluate the product competitiveness, economic effectiveness of capital and production investments.

The paper is intended for foreign students who study economics and management of enterprise in English.

Tabl. 4. Bibl.: 6 titles

CONTENTS

INTRODUCTION

Economic science covers all the aspects of human life related to their physiological and spiritual needs. People need food, clothing, and shelter if they want to live up to the standards and support their families. Life necessities are produced by agriculture, building, and manufacturing with the participation of communication and transport agencies. Thus, you should be familiar with business economics so that to understand current social and economic processes and solve commercial problems.

Real economics will not survive without production of goods. Economic mechanisms should follow from the requirements of material production and consider consumer demands. In order to avoid wrong business decisions, economists and managers should ground them on actual business mechanisms. Thus, they must know these mechanisms.

Market economy focuses economic activities upon an enterprise as the core of every economy. It is the enterprises that produce goods and deliver services. The enterprises accumulate qualified specialists, employ high-performance equipment and innovative technology, work out business plans, and apply both marketing and managing techniques. Market relations make enterprises study and determine market requirements properly, produce saleable goods, and support their staff's well-being. This requires deep knowledge of economics.

We created these lecture notes in order to help our students to comprehend business economics. Their units follow the established approach to teach and study this subject and include both theoretical data and problem-solving techniques that promote mastering of calculation and analysis methodology.

Unit 1.   MATERIAL RESOURCES FOR ENTERPRISES

1.1.   Fixed assets

All fixed assets, or fixed capital, have long life cycles of not less than a year which determines depreciation and low turnover rate.

Fixed assets include material values which keep their original form for a long period of time and lose their costs in parts.

Depending on how the fixed assets are involved in the expanded production, they can be divided into productive and non-productive ones.

Productive fixed assets take part in material production, wear out gradually, and transfer their cost in parts to the product manufactured. They are replenished through capital investment.

Non-productive fixed assets include houses, childcare centres and sports institutions as well as other enterprise-owned facilities providing employees with cultural and community services.

Fixed production assets incorporate different work equipment owned by enterprises which differ in purpose and lifetime though are economically homogeneous.

According to the existing classification, fixed production assets are divided into the following groups:

1) land plots and natural resources (water, mineral, etc.) belonging to the enterprise;

2) buildings (including industrial, technical, service buildings, etc.);

3) premises (civil engineering facilities employed in manufacturing);

4) transfer devices (power lines and heat supply systems);

5) machinery and equipment;

6) measuring and control instruments, devices, and laboratory equipment;

7) computers;

8) vehicles;

9) tools and accessories;

10) production implements and household equipment;

11) intraeconomic roads.

Monetary funds of the enterprises cover costs associated with the upgrading of fixed assets. These funds accumulate as depreciation charges during the lifetime of the fixed capital.

Depreciation is a money compensation for the ageing of the fixed assets which is obtained by including their value in production costs. Consequently, depreciation is the monetary value of the physical and moral ageing of the fixed capital. Depreciation is spent to replace fixed assets when they retire. The amount of depreciation charges depends on the value of fixed assets, their operation time and modernization costs. Annual depreciation charges included in the production costs are calculated as

$$A_{depreciation} = \frac{(C_{original} + C_{modernization} + C_{displacement} - C_{liquidation})}{P_{depreciation}}, \quad (1.1)$$

where

$C_{original}$ is the original cost of fixed assets, UAH;

$C_{modernization}$ are modernization costs and expenses spent on major repairs of fixed assets, UAH;

$C_{displacement}$ are dismantlement costs, UAH;

$C_{liquidation}$ are costs spent on liquidation of fixed assets, UAH;

$P_{depreciation}$ is the standard life (depreciation period) of fixed assets, years.

Depreciation coefficient is the ratio of the annual depreciation charges to the original value of fixed assets. It is calculated as

$$C_{depreciation} = \frac{A_{depreciation}}{C_{original}}. \quad (1.2)$$

Depreciation ratio reveals the share of original costs that the fixed assets transfer annually to the products.

Depreciation rate is the ratio of the annual depreciation charges to the cost of fixed assets, in %:

$$R_{depreciation} = C_{depreciation} \cdot 100. \quad (1.3)$$

According to the established norms, depreciation charges are included in the cost of the final product. Depreciation rates determine the amount of resources needed to restore worn parts and equipment as well as regulate turnover of the fixed assets and intensify their reproduction.

Today in Ukraine annual depreciation charges of fixed assets are included in the cost of manufactured products and determined by the residual value of fixed assets:

$$A_{depreciation} = \frac{R_{depresiation} \cdot C_{residual}}{100},$$ (1.4)

where

$C_{residual}$ are residual costs of the fixed asset at the beginning of the year for which annual depreciation charges are calculated, UAH.

1.2. Indicators for use of fixed assets

Based on their technological development and structure, fixed production assets regulate the output growth, cost reduction, and increased savings for enterprises.

Indicators for use of fixed production assets can be divided into three groups:

1) indicators of extensive use which reflect time of application;

2) indicators of intensive use which reflect power (performance) of application;

3) indicators of integral use which take into account cumulative effect of all factors (both extensive and intensive).

Appropriate application of fixed assets increases the output. Therefore, a general index showing application efficiency of fixed assets should be based on the principle of comparing goods manufactured with the whole amount of fixed assets.

In this case, it will reveal the ratio of the output to every one UAH of fixed assets that is the capital productivity of fixed assets. The value of capital productivity is calculated as

$$C_{productivity} = \frac{V_{sold\ goods}}{C_{averege\ annual}},$$ (1.5)

where

$V_{sold\ goods}$ is annual value of sold goods, UAH;

$C_{average\ annual}$ is average annual cost of fixed production assets owned by the enterprise, UAH.

The average annual cost of fixed production assets is given by

$$C_{average\ annual} = C_{begin.\ y} + C_{inflow} \cdot \frac{m_1}{12} - C_{outflow} \cdot \frac{m_2}{12},\qquad (1.6)$$

where

$C_{begin.y}$ is the cost of fixed assets owned by the enterprise at the beginning of the year, UAH;

C_{inflow} is the cost of inflowing fixed assets, UAH;

$C_{outflow}$ is the cost of outflowing fixed assets, UAH;

m_1 is the number of full months which passed since the inflow of fixed assets to the end of the year;

m_2 is the number of full months which passed since the inflow of fixed assets to the end of the year.

Capital output ratio is the value inverse to capital productivity. It shows the value of fixed assets included into every one UAH of the cost of output goods. If capital productivity tends to increase, then capital intensity tends to decrease.

1.3. Circulating (current) assets

Besides fixed assets, every enterprise owns circulating assets that is circulating production assets and monetary funds.

Enterprise-owned circulating production assets cover production assets (production materials) which are used in every production cycle so that their price is in its totality included into the final cost of a manufactured product. Material circulating assets change their original form, physical and chemical properties at the very production process. They lose their customer value due to their industrial use, with the new customer value coming from the manufactured products.

Enterprise-owned circulating production assets include:
1) inventories;
2) semi-finished domestic products;
3) future expenses.

Circulating assets constantly move from the sphere of distribution to the sphere of production and back again. Money circulates from the moment an enterprise pays for necessary materials and other resources to the moment it

receives sales proceeds. Then this money is again used to buy resources and produce goods.

Current assets turnover period is a period of time during which circulating assets make one full cycle of production and distribution. It characterizes the average speed of the asset flow within an industry or enterprise.

Adequate management of circulating assets secures the necessary cycle of production and distribution at the smallest possible amount of available circulating assets. It means that enterprise-owned circulating assets should be properly donated to all turnover stages. At every moment of production, circulating assets should be available for turnover in the form of money, resources, semi-finished and finished products.

Current assets measurement lies in finding economically appropriate amounts of circulating (current) assets which would secure regular functioning of the enterprise. It results in determining necessary monetary and non-monetary funds, minimum balances for production in process, etc. Measurable circulating assets cover inventories as well as semi-finished and finished products including those stored in enterprise warehouses. Other circulating assets are called immeasurable. Current assets measurement determines standards and quotas for circulating (current) assets.

Standard for circulating assets identifies minimal enterprise inventory and is calculated in inventory days, standards for storing spare parts, UAH per a unit of account, etc.

Quota for current assets is a UAH product obtained by multiplying the standard for circulating assets by the indicator for which the standard is determined that.

Current assets measurement means

$$Q_{current\ assets} = Q_{inventory} + Q_{semi-finished\ prod} + Q_{finished\ prod} , \qquad (1.7)$$

where

$Q_{inventory}$ is an inventory quota;

$Q_{semi-finished\ prod}$ is a quota for semi-finished products;

$Q_{finished\ prod}$ is a quota for finished products.

Efficient use of circulating assets is shown by:
1) turnover rate for circulating assets;
2) utilization rate for circulating assets;
3) one turnover cycle of circulating assets.

Turnover rate for circulating assets is determined through dividing the volume of sales at wholesale prices by the average balance of enterprise-owned circulating assets:

$$C_{turnover\,rate} = \frac{V_{prod.\,sold}}{AB_{circulat.\,assets}}, \tag{1.8}$$

where

$C_{turnover\,rate}$ is the turnover rate for circulating assets, turnover cycles;

$V_{prod.\,sold}$ is the value of products sold, UAH;

$AB_{circulat.\,assets}$ is the average balance of circulating assets, UAH.

Turnover rate for circulating assets shows the number of turnover cycles completed by circulating assets within a given period of three months, a year, etc. The formula shows that more turnover cycles result in either output growth at the cost of the same current assets or decrease of current assets spent on manufacturing the same output.

Utilization rate for circulating assets determines current assets spent per one UAH of a product sold. It is a value inverse to turnover rate:

$$C_{utilization\,rate} = \frac{AB_{circulat.\,assets}}{V_{prod.\,sold}}. \tag{1.9}$$

One turnover cycle of circulating assets is calculated through dividing the number of days in a cycle by the turnover rate:

$$T_{turnover} = \frac{N_{days}}{C_{turnover\,rate}} = N_{days} \cdot \frac{AB_{circulat.\,assets}}{V_{prod.\,sold}}, \tag{1.10}$$

where

N_{days} is the number of days in a cycle.

The shorter turnover cycle or the more cycles current assets complete for the same output, the smaller amount of circulating assets is necessary and the more efficient is their use.

1.4. Consumption measurement and calculation of stock demand

When using materials efficiently, enterprises spent less in order to obtain

certain output and thus have resources to increase the production.

We understand material consumption as their industrial use for providing the necessary output. Material consumption can be general and specific.

General consumption of material resources is the use of all materials or their different types for providing the necessary output within a certain period of time. General consumption of materials is calculated in kind, whereas, consumption of different kinds of materials is found out in cost.

Specific consumption of a certain kind of materials is their average amount consumed to manufacture a valid product. It is determined though dividing the total amount of material consumed to manufacture a valid product within a certain period of time to the number of valid products:

$$q_i = \frac{m_i}{N},$$ (1.11)

where

q_i is a specific consumption of a certain material i used to manufacture the product, kg/pr;

m_i is an amount of the material consumed, kg;

N is a number of products, items.

Material consumption is characterised by the product's material intensity of use, which estimates the actual amount of material consumed to manufacture a product item (expressed in kind).

We understand material intensity of use as an amount of a certain kind of material consumed (expressed in kind) per every one UAH of a gross, net or sold product:

$$Q_{ij} = \frac{m_{ij}}{N_j p_j},$$ (1.12)

where

Q_{ij} is an intensity of use for the material i-th consumed to manufacture the product j, kg /UAH;

N_j is a number of the products j manufactured within a certain period of time, items;

p_j is a price of the product j, UAH/item;

m_{ij} is an amount of the material "i" consumed to manufacture the product j, kg/item.

The demand in every material is calculated as:

$$m = m_{product} + m_{repair} + m_{incomplete} + SS_{end} + SS_{begin} \,,\qquad (1.13)$$

where

$m_{product}$ are materials necessary for production;

m_{repair} are materials necessary for repair and maintenance;

$m_{incomplete}$ are materials necessary for incomplete production;

SS_{end} are stock quotas determined at the end of the year;

SS_{begin} are stock quotas determined at the beginning of the year.

When developing production programs and analysing the enterprise's production activity, economists employ different indicators in order to find out whether material resources were efficiently used for production.

Engineering economists usually prefer the material utilization ratio

$$R_{mat.\ utilizat} = \frac{\sum_{i=1}^{n} m_{net\ i} \cdot N_j}{m_i}\,,\qquad (1.14)$$

where

$m_{net\ i}$ is a net weight of the metal I consumed to manufacture one product j, kg;

N_j is an output of the products j, items;

m_i is a total consumption of the metal i consumed to manufacture the whole output of the products j, kg;

$j = \overline{1, n}$ are different products manufactured by an enterprise.

You can also evaluate whether materials are used efficiently by calculating manufacturing wastes. This indicator is directly related to the material utilization ratio: The smaller manufacturing wastes, the higher $R_{mat.\ utilizat}$.

Manufacturing wastes are calculated as the ratio of the amount of wastes obtained by manufacturing to the amount of consumed material. Calculation results show how much material has been wasted:

$$R_{wastes} = \frac{A_{wasted\ material}}{A} \cdot 100\ \%\,,\qquad (1.15)$$

where

R_{wastes} are material wastes, %;

A is a total amount of consumed material, kg;

$A_{wasted\ material}$ is an amount of wasted material, kg.

Unit 2.   PRODUCTION CAPACITY AND PRODUCTION VOLUMES OF AN ENTERPRISE

2.1.   Developing production programs

Production program of an enterprise is developed together with output plans. Production programs are characterised by the enterprise's volumes for production of the main manufactured goods expressed in kind together with other outputs planned for a certain period of time.

Product output in kind is set in units which take into account specific features of different industrial products. These units include items, sets, and packages as well as tons, meters, kilowatt-hours, and other measurement units. Production programs of enterprises and their subdivisions cover definite planning periods − years, months, etc.

Enterprise production programs are also characterised by the volume of manufactured goods arranged according to their nomenclature and range. Production nomenclature is planned based on the fact that the enterprise will manufacture new types and kinds of goods, and their range will better meet market needs and have a positive impact on technical progress.

Enterprise production programs fall under the influence of normative net output (NNO) which assesses the labour that the enterprise workers contributed to increase the output of competitive products and expresses the new value of a product created by them. NNO is incorporated into the wholesale price of the product (without material costs).

Based on the product costs, NNO volume is calculated as

$$Q_{NNO}=S_{work} + P_{plan.},\qquad\qquad (2.1)$$

where

$S_{work.\ salaries}$ is the sum of workers' salaries together with deductions for social events, UAH/item;

P_{plan} is a planned profit for the product, UAH/item.

The reality of production programs is confirmed by the calculation of market needs as well as by availability of the necessary production facilities and resources.

2.2. Calculating production capacity

Production capacity is the maximum possible output the enterprise can produce within a certain period of time in case of a full use of equipment and production areas employed for manufacturing the established nomenclature and range of goods.

Production capacity is determined in physical units for a limited nomenclature and range of goods and in cost for a wide nomenclature and range.

When planning production capacity, you determine:
a) necessary equipment and production areas;
b) application of the available equipment and areas;
c) necessary but unavailable equipment and areas in order to find out how to use available resources effectively.

For another thing, production capacity depends on the number and configuration of available equipment and production areas; operating hours; labour intensity of production process; workers qualification; fixed assets.

Then calculating production capacity, you consider the available equipment and production areas. However, usually they determine what kind and number of equipment is necessary to accomplish the annual production program.

The number of equipment equipment necessary to accomplish the annual production program is calculated as

$$n_{equipment} = \frac{t \cdot N}{F_{real} \cdot K_{simul.\ using} \cdot K_{s.p}} \,, \tag{2.2}$$

where
t is a labour intensity for one production item, labour-hours;
N is an annual program for manufacturing goods, items.
F_{real} is an annual real amount of equipment operating hours, h;
$K_{simul.\ using}$ is the coefficient of workers simultaneously using the

equipment;

$K_{s.p}$ is the coefficient of standards performance.

The amount of production areas depends on the type of production unit (line, or workshop) and the type of equipment located at this area.

For machine workshop, $S_{mach.\ workshop}$ is calculated as

$$S_{mach.\ workshop} = S_{unit} \cdot n_{equipment} , \qquad (2.3)$$

where

S_{unit} is the unit area calculated for a piece of equipment, m²;

$n_{equipment}$ is a number of equipment located in the workshop, pieces.

For assembly units and lines, $S_{ass.}$ is calculated as

$$S_{ass.} = \frac{N_{ass} \cdot S_{ass.i} \cdot C_{ass}}{F_{real} \cdot K_{s.p}} , \qquad (2.4)$$

where

N_{ass} is an annual program for goods assembled in the unit or by the line;

$S_{ass.i}$ is an area taken by one product, m2;

C_{ass} is a assembly cycle for one product, h;

F_{real} are actual operating hours of the assembly unit or line, h;

$K_{s.p}$ is the coefficient of standards performance.

Production capacities are calculated workshop sections based on their manufacturing tasks.

Production capacity of a machine workshop sections depends on their manufacturing tasks and a number of products manufactured:

If the section manufactures one product, its production capacity is calculated as

$$M = \frac{n \cdot F_{real} \cdot K_{s.p}}{t_i} , \qquad (2.5)$$

where

M is a section's production capacity, product items;

n is a number of equipment in the section, pieces;

F_{real} are actual annual operating hours of the equipment, h;

t_i is labour intensity calculated for manufacturing one product, standard-hours;

$K_{s.p}$ is the coefficient of standards performance.

If the section manufactures several different products (in conventional units), its production capacity is

$$M_{conv.} = \frac{n \cdot F_{real} \cdot K_{s.p}}{t_{conv}} ,\qquad (2.6)$$

where

M_{conv} is a section's production capacity in conventional units;

t_{conv} is a unit labour intensity based on the labour intensities for manufacturing certain products t_i as well as their unit weight y_i in general production program:

$$t_{conv} = \sum_{i=1}^{m} (t_i \cdot y_i),\qquad (2.7)$$

where

m is a number of products.

Production capacity in conventional units is used to find out production capacity for every manufactured product:

$$M = M_{conv} \cdot y_i.\qquad (2.8)$$

Production capacity of assembly sections is calculated with regard to production areas and the number of products assembled simultaneously.

If the section assembles one product, its production capacity is calculated as

$$M_{assembly} = \frac{S_{prod} \cdot F_{real} \cdot K_{s.p}}{S_i \cdot C_i} ,\qquad (2.9)$$

where

$M_{assembly}$ is a section's production capacity, assembled items;

S_{prod} is a section's production area, m²;

F_{real} are actual annual operating hours of the section, h;

S_i is an area of one product, m^2;

C_i is a assembly cycle for one product, h;

$K_{s.p}$ is the coefficient of standards performance.

If the section assembles different products, its production capacity is calculated as

$$M_{ass.conv} = \frac{S_{prod} \cdot F_{real} \cdot K_{s.p}}{\sum_{i=1}^{m} (S_i \cdot y_i \cdot C_i)} ,$$

(2.10)

where

y_i is a unit weight of every product in general production program;

m is a number of products.

Then production capacity for every kind of product is

$$M_{as} = M_{as.conv} \cdot y_i .$$

(2.11)

2.3. Calculating production volume

Production volumes and volumes of product sales are calculated so as to meet market needs. These calculations are based on such cost indicators as:

– enterprise's gross production of all types of operations and services including semi-finished products;

– volume of gross output at wholesale prices;

– volume of product sales in cost.

In order to plan production expenses; to determine necessary materials, fuels, and energy; to calculate the number of workers; to determine salary funds, labour productivity and other important indicators of the enterprise's operation, you calculate its gross production. Gross production characterizes production volumes and is determined as algebraic sum of commercial output and semi-finished products manufactured within a planned or reported period of time:

$$Q_{gross} = Q_{commercial} + (N_{end} - N_{begin}),$$

(2.12)

where

Q_{gross} is an enterprise's gross output;

17

$Q_{commercial}$ is a planned commercial output;

N_{end}, N_{begin} is a number of products semi-finished at the beginning of the planned period of time and at its end.

We understand semi-finished products as the products which are still being manufactured as well as premade products, remaining instruments, and technological equipment produced by the enterprise itself.

Coefficient of commercial output shows how many products are ready for sale. Commercial output includes the costs of

– finished products intended for sale, enterprise's capital building and its unprofitable units;

– premade products produced by the enterprise itself, output of its auxiliary and subsidiary units intended for sale;

– manufacturing operations performed on incoming orders or in order to fulfil the requirements of the enterprise's unprofitable units.

Commercial output is greater that product sales because it includes the costs of finished products stored at the enterprise's warehouses as well as finished product delivered to the customer but unpaid-for (at the beginning of the planned period of time and at its end).

Commercial output is calculated as

$$Q_{commercial} = Q_{prod.\ sales} + \left(Q_{fin.\ prod.\ end} - Q_{fin.\ prod.\ begin}\right) \\ + \left(Q_{prod.\ deliv.\ end} - Q_{prod.\ deliv.\ begin}\right),$$

(2.13)

where

$Q_{product\ sales}$ are product sales for a planning period, UAH/y;

$Q_{fin.\ prod.\ end}$, $Q_{fin.\ prod.\ begin}$ are finished products stored at the enterprise's warehouses (at the beginning of the planned period of time and at its end);

$Q_{prod.\ deliv.\ end}$, $Q_{prod.\ deliv.\ begin}$ are finished product delivered to the customer but unpaid-for (at the beginning of the planned period of time and at its end).

Commercial and gross outputs are calculated in the enterprise's wholesale and current market prices.

When planned in constant prises, gross output allows you to analyse the manufacturing dynamics of the enterprise. Commercial and gross outputs are determined by the enterprise method which means that the costs of finished

and premade products exclude the intrafactory turnover that is the cost of products used by the enterprise itself.

Production and economic activities of the enterprise are assessed by the product sales. Planned product sales are calculated as the costs of
– finished products intended for delivery and necessarily paid-for within the planned period of time;
– premade products produced by the enterprise itself;
– manufacturing operations performed on incoming orders;
– finished products manufactured and manufacturing operations performed in order to fulfil the enterprise's capital building and meet the requirements of its unprofitable units.

Product sales are calculated as

$$Q_{prod.\ sales} = Q_{commercial} + Q_{unsold\ begin} - Q_{unsold\ end},\qquad (2.14)$$

where $Q_{unsold\ begin}$, $Q_{unsold\ end}$ are unsold output remaining at the beginning of the planned period of time and at its end.

This means that product sales are products delivers to the customers, sales companies and organisations and paid-for by them.

The fact that the enterprise's output was sold means that it moved from manufacturing to consumption and was accepted by its customers.

As for the enterprise, product sales allow it to determine and secure the necessary economic encouragement of reproduction; financial rewards for workers; social measures and cultural events; house building; production development; progress in science and technology.

To assess their production efficiency, enterprises can also employ the net production coefficient.

Unit 3.   LABOUR FORCES OF AN ENTERPRISE

3.1. Enterprise personnel and labour productivity

Enterprise personnel include permanent workers who have got professional training and possess necessary experience and operating skills. Besides permanent workers, the other persons able to work can take a part in the enterprise operation on the contract basis.

Enterprise personnel consist of industrial personnel and non-industrial personnel. Industrial personnel include people engaged in principal and auxiliary departments, factory laboratories, and research units as well as enterprise managers and security workers. Non-industrial personnel include people occupied in non-manufacturing divisions.

Depending on their responsibilities and tasks performed, enterprise personnel can be divided into blue-collar workers (or simply workers), white-collar workers, experts, and managers. *Blue-collar workers* can be immediately engaged in product manufacturing or provide service and maintenance support. *White-collar workers* prepare technical and business documentation, provide utility services, audit and carry out record-keeping. *Experts* perform complex engineering, economic, and other tasks. *Managers* govern, control, and administer enterprises and their subdivisions.

Enterprise personnel cover people of different professions, specific job preparations, and qualifications. Profession determines what kind of work a person can perform. Specific job preparation limits responsibilities of a worker to a relatively narrow scope of professional tasks. Qualification shows how complex and sophisticated these professional tasks can be. Qualification includes expert knowledge and professional skills which determine whether a worker is ready to accept certain responsibilities.

Depending on their qualification, blue- and white-collar workers, experts, and managers can be divided into certain groups and categories, with their level of expertise specified by wage-rates and skills handbook. Blue-collar workers are usually divided into grades.

In order to determine the necessary enterprise personnel (i.e. number of employees), you perform certain calculations:

1. You calculate the real number of industrial personnel for a planned period:

$$N_{i.p}^{real} = \frac{N_{i.p}^{base} \cdot K_{volum}}{100\,\%},$$

(3.1)

where

$N_{i.p}^{real}$ is the real number of industrial personnel for a planned period;

$N_{i.p}^{base}$ is the base number of industrial personnel for a planned period;

K_{volum} indicates the growth rate of production volumes in the planned period, %.

2. You calculate the planned number of industrial personnel by finding a difference between their real number $N_{i.p}^{real}$ in the planned period and the amount of their reduction E_{total}.

Third, you determine the economy of labour forces due to:
1) raising the technical level of production;
2) growing level of production technology;
3) structural and technological changes in manufacturing process;
4) improved production and labour management and administration;
5) changed production volumes;
6) new products introduced into manufacturing process, etc.

Change in the number of labour forces is calculated as a difference between a number of workers planned for a new enterprise and a number of workers the new enterprise would need to produce goods at the basic level of labour productivity determined for a certain branch of industry.

Total economy of labour forces is a sum of the values of economy determined for every factor mentioned above.

Labour productivity characterizes the labour efficiency and shows whether workers are able to manufacture a certain output within a definite period of time. Labour productivity can express the amount of direct labour (individual labour productivity) or the aggregate amount of direct and embodied labour (social labour productivity).

Labour productivity is determined by the production rate which shows the number of products manufactured within a unit of time. Production rate is inverse to labour intensity.

3. Production rate can be determined in three ways:

1) by kind method through dividing a product output by a time spent for manufacturing, expressed in labour-hours;

2) by cost method through dividing a product output cost in UAH by a time spent for manufacturing, expressed in man-days or man-hours);

3) by labour method through dividing a product output, expressed in labour-hours (i.e. in the expenses of operating time) by a number of workers.

Labour productivity is planned by means of direct or factor calculation.

Direct calculation determines planned labour productivity P_{plan} through dividing planned output expressed in cost Q_{cost}^{pl} or Q_{number}^{pl} in kind by the planned number of industrial personnel $N_{i.p}^{pl}$.

$$P_{plan.} = \frac{Q_{cost}^{pl}}{N_{i.p}^{pl}} \ \ or \ \ \frac{Q_{number}^{pl}}{N_{i.p}^{pl}}.$$ (3.2)

Factor calculation determines the increase of labour productivity due to economy of labour forces.

You calculate planned labour productivity in several steps.

4. You find out the increment of labour productivity for the planned period:

$$\Delta P_{increment\ plan.} = \frac{E_{total}}{N_{i.p}^{real} - E_{total}} \cdot 100.$$ (3.3)

If you know the enterprise dynamics for labour intensity of the production program, you can calculate possible change in enterprise productivity in a planned year as:

$$\Delta P_{increment} = \frac{\Delta t_{program}}{100 - \Delta t_{program}} \cdot 100,$$ (3.4)

where

$\Delta P_{increment}$ is a change of labour productivity in the planned year, %;

$\Delta t_{program}$ is a change of the labour intensity of the production program in the planned year, %:

$$\Delta t_{program} = \frac{E_{operating\ hours}}{t_{program\ base}} \cdot 100,$$ (3.5)

where

$E_{operating\ hours}$ is an economy (or growth) of operating hours spent to accomplish production program in the planned year, labour-hours;

$t_{program\ base}$ is a labour intensity of the production program in the reference year, labour-hours.

Economic analysis of enterprise operation includes estimation of possible increment of production output due to the growth of labour productivity:

$$\Delta Q_{increment\ of\ prod} = 100 - \frac{\Delta N_{i.p}}{\Delta Q} \cdot 100,$$ (3.6)

where

$\Delta Q_{increment\ of\ prod}$ is an increment of product output due to the growth of labour productivity, %;

$\Delta N_{i.p}$ is an increment of the number of workers, %;

ΔQ is an increment of the production volume, %.

Profitable enterprise operation welcomes scientific management of labour. It means that labour management incorporates all the achievements of science and technology as well as advanced research and manufacturing experience in order to provide best cooperation of labour forces and production equipment, secure efficient resource exploitation, and preserve people's health.

Enterprise operation is regulated by time and by space. Regulation by time occurs through labour standards including standard piece time, standard production rate, standard number of personnel, and standard machine servicing rate.

In case of mass production, standard piece time becomes the time for piece:

$$T_{piece} = T_{base\ cycle} + T_{servicing} + T_{rest},\tag{3.7}$$

where

$T_{base\ cycle}$ stands for base cycle time, labour-hours;

$T_{servicing}$ stands for time spent on workplace servicing, labour-hours;

T_{rest} stands for time spent on personal needs and rest, labour-hours;

$$T_{base\ cycle} = T_{direct} + T_{auxiliary},\tag{3.8}$$

where

T_{direct} is a direct manufacture time spent on one product item, labour-hours;

$T_{auxiliary}$ is an auxiliary time spent on one product item, labour-hours

$$T_{servicing} = T_{technical} + T_{management},\tag{3.9}$$

where

$T_{technical}$ is time spent on workplace technical servicing, labour-hours;

$T_{management}$ is time spent on workplace management, labour-hours.

In case of small-scale and single-piece production, standard piece time becomes the calculated time for piece:

$$T_{calculat.\ piece} = T_{piece} + \left(T_{set-up\ time} \big/ n \right),$$
(3.10)

where

$T_{set-up\ time}$ is a set-up time spent on a production batch, labour-hours;

n is a number of products in a batch, items.

Standard production rate is a product output which must be manufactured within a certain period of time:

$$S_{product} = \frac{1}{T_{piece}}.$$
(3.11)

Standard production rate for a shift is calculated as

$$S_{product.\ shift} = \frac{T_{shift}}{T_{piece}},$$
(3.12)

where T_{shift} is a shift duration, h.

If standard production rate increases by a %, standard piece time decreases by

$$\frac{100 \cdot a}{100 + a},$$

and if standard production rate decreases by a %, standard piece time increases by

$$\frac{100 \cdot a}{100 - a}.$$

Average fulfilment of the standard production rate $S_{product}$ is calculated through dividing labour-hours spent on manufacturing products t_{labour} by actual operating time t_{actual} :

$$S_{product} = \frac{t_{labour}}{t_{actual}} \cdot 100.$$
(3.13)

Standard number of personnel determines how many workers can perform a certain amount of work or manufacture a certain product output.

Standard machine servicing rate determines how many pieces of equipment, workplaces, or square meters of production area can be served by a worker or a working team within a shift.

As a whole, labour standards determine the number of workers employed by the enterprise.

Planned number of industrial personnel is calculated as

$$N_{i.p}^{pl} = N_{i.p}^{base} \cdot \frac{I_q}{I_p},$$
(3.14)

where

$N_{i.p}^{base}$ is a reference number of industrial personnel, persons;

I_q is a growth coefficient for production volume in a planned year;

I_p is a planned growth coefficient for labour productivity.

Planned number of permanent workers $N_{p.w}$ can be determined by three methods:

1) by labour intensity of the production program:

$$N_{p.w} = \frac{t_{total}}{F_{real} \cdot K_{s.p}},$$
(3.15)

where

t_{total} stands for total labour intensity of the production program, labour-hours;

F_{real} stands for actual operating time of an average worker, hours (is determined by balance of operating time for an average worker);

$K_{s.p}$ stands for average coefficient of standards performance.

2) by standard machine servicing rate:

$$N_{permanent\,w} = \frac{n \cdot N_{shift} \cdot K_{payroll}}{S_{servicing}},$$
(3.16)

where

n is a total amount of serviceable equipment, items;

N_{shift} is a number of the shift equipment's operating;

$K_{payroll}$ is a payroll coefficient calculated through dividing real number of workers to their payroll number;

$S_{servicing}$ is a standard machine servicing rate calculated for one worker.

You can also calculate the number of permanent workers by standard machine servicing rate as

$$N_{permanent\,w} = n \cdot N_{shift} \cdot K_{payroll} \cdot S_{permanent\,w} , \qquad (3.17)$$

where N_{shift} is a number of permanent workers who serve one piece of equipment at the same time, persons.

3) by standard production rate:

$$N_{permanent\,w} = \frac{N}{F_{real} \cdot K_{s.\,p} \cdot S_{product}}, \qquad (3.18)$$

where

N stands for a planned product output, in kind.

$S_{product}$ stands for a standard hourly production rate of one worker, in kind.

Planned number of auxiliary workers $N_{auxiliary\,w}$ is calculated in the same way as the number of permanent workers if they have their own standard production rates or standard machine servicing rates. Otherwise, the number of auxiliary workers is calculated as

$$N_{auxiliary\,w} = n_{auxiliary} \cdot N_{shift} \cdot K_{payroll}, \qquad (3.19)$$

where $n_{auxiliary}$ is a number of workplaces for auxiliary workers.

Number of white-collar workers, experts, and managers is determined by the enterprise's staffing tables which set the number of these employees based on the existing quotas.

Calculations of enterprise personnel also involve calculations of actual operation time for an average worker based on setting a balance of his or her operating time.

In this balance, real number of working days is calculated as a difference between the nominal number of working days (365 or 366 days in a year minus

holidays and weekends) and the number of days when the worker was absent. Actual duration of a working shift is calculated as a difference between the nominal duration of an ordinary shift (in hours) and the duration of a reduced shift (in hours).

Real annual number of operating time is equal to the product of the real number of working days and the actual duration of a working shift.

3.2. Salaries and emoluments

Enterprises derive system of salaries and emoluments from the tariff system that includes:
- salary (wage) distribution schemes;
- salaries (wages) assigned to grades and responsibilities;
- wage-rates and skills handbooks.

Salary distribution schemes include qualification categories (grades) and corresponding salary coefficients.

Salaries assigned to grades and responsibilities determine absolute value of salaries and emoluments which are paid to workers belonging to a certain qualification category (grade) for a unit of their operating time.

Salaries assigned to a first (the lowest) grade are established by the government. Salaries assigned to other categories (grades) L_i are calculated by multiplying the salary assigned to a first grade L_1 by the corresponding salary coefficient K_i:

$$L_i = L_1 \cdot K_i \,.$$ (3.20)

Wage-rates and skills handbooks provide qualifying characteristics for various working tasks and responsibilities and determine qualification categories (grades) of employees and tasks performed.

Qualification categories of the tasks performed depend on their complexity and sophistication whereas qualification categories of employees determine their ability to perform these tasks as well as professional competence and necessary experience.

Enterprises are allowed to choose forms and systems of paying salaries and emoluments independently though they refer to corresponding recommendations from the government.

Enterprises generally use time-wage and piece-rate systems of paying salaries and emoluments.

Time-wage system means that salaries (wages) are paid for real operating time based on the employee's qualification. It includes:

1. *Direct hourly wage system* at which actual salary $W_{direct\ hourly}$ is

$$W_{direct\ hourly} = F_{month} \cdot L,$$
(3.21)

where

F_{month} stands for real operating time worked per month, h,

L is hourly wage rate for the qualification category (grade) of an employee, UAH.

2. *Time-plus-bonus wage system* at which actual salary is calculated as

$$W_{time-plus-bonus} = W_{direct\ hourly} + WB,$$
(3.22)

where

$W_{direct\ hourly}$ is an income paid at the direct hourly wage system, UAH;

WB is an amount of money bonuses paid for certain qualitative or quantitative achievements, UAH.

Money bonuses are calculated as

$$W_{bonus} = \frac{W_{direct\ hourly} \cdot \%_{bonus}}{100}.$$
(3.23)

3. *System of salaries (wages) assigned to responsibilities* is a variation of the time-plus-bonus wage system which can be applied only to permanent employees (workers). In this case, wages and salaries depend on the payment system existing at the enterprise.

Piece-rate system means that salaries (wages) depend on the product output of a worker (employee) or the professional tasks performed within a certain period of time. It includes:

1. *Direct piece rate system* at which actual salary $W_{direct\ piece\ rate}$ is

$$W_{direct\ piece\ rate} = \sum_{i=1}^{n} P_i \cdot N_i,$$
(3.24)

where

P_i is a piece-rate for manufacturing one product item, UAH;

N_i is a number of product items i manufactured by a worker (employee) within a certain period of time (shift, month), pcs.;

n is a number of kinds of products

$$P_i = t \cdot L, \qquad (3.25)$$

where

t is a labour intensity for one production item i, labour-hours;

L is hourly wage rate depending on the category of a professional task, UAH.

2. *Piece rate plus bonus system* at which actual salary is

$$W_{piece\ rate\ plus\ bonus} = W_{direct\ piece\ rate} + B_{piece}, \qquad (3.26)$$

where

$W_{direct\ piece\ rate}$ is a worker's salary at the clean piece rate system, UAH;

B_{piece} is an amount of money bonuses determined as

$$B_{piece} = W_{direct\ piece\ rate} \cdot \frac{P_1 + P_2 + P_{overful}}{100}, \qquad (3.27)$$

where

P_1 is a bonus for manufacturing planned output, %;

P_2 is a bonus for every extra-manufactured product, %;

$P_{overful}$ is the overfulfilment of the plan, %;

$$P_{overful} = \frac{N_f - N_{plan}}{N_{plan}} \cdot 100\ \%, \qquad (3.28)$$

where N_f and N_{plan} are actual and planned production volumes per month correspondingly, items/month.

3. *Progressive piece rate system* at which actual salary $W_{progres.\ piece\ rate}$ is

$$W_{progres.\ piece\ rate} = N_{base} \cdot P + (N_f - N_{base}) \cdot P_{increas}, \qquad (3.29)$$

where

$N_{standard}$ is a part of planned production volumes after manufacturing which the prise for every manufactured product item increases (usually 100…110 % N_{plan}), items/month.

P is a usual rate for every manufactured product item, UAH/items.

$P_{increas}$ is an increased rate for every manufactured product item, UAH/items:

$$P_{increas.} = P \cdot \left(1 + \frac{\% \ increase \ depends}{100}\right).$$
(3.30)

Rate increase depends on how great was the overfulfillment of the planned production volume and is approved by enterprise owners themselves.

4. *Indirect piece rate system* is used to pay auxiliary and unskilled workers. The salary paid to unskilled workers is calculated as

$$W_{unskilled \ worker} = N_{f.i} \cdot P_{ind. \ piece \ i},$$
(3.31)

where

$N_{f.i}$ is an actual product output of a worker i within a shift, items/shift;

$P_{ind. \ piece \ i}$ is an indirect piece rate paid for during servicing a permanent worker i, UAH/items;

$$P_{ind. \ piece \ i} = \frac{L_{shift \ rate}}{n \cdot N_{plan}},$$
(3.32)

where

$L_{shift \ rate}$ is a shift rate for unskilled workers, UAH/shift;

N_{plan} is a planned product output for a permanent worker (employee) i, items/shift;

n is a number of permanent workers (employees) served by the same unskilled worker.

The salary paid to auxiliary workers $W_{auxiliary}$ is calculated as

$$W_{auxiliary} = T_{f.i} \cdot l_i \cdot K,$$
(3.33)

where

$T_{f.i}$ is real operating time of every worker;

l_i is an hourly rate for auxiliary workers depending on their category;

K is a coefficient of standards performance at the manufacturing area served by the auxiliary worker.

5. *Joint piece rate system* is used to pay for team work. Actual salary of every worker in a team is determined as a part of team rate (calculated as if at direct piece rate system based on team prices) distributed throughout team workers taking into account:

− the coefficient of standards performance $K_{s.p}$;

− the index of labour distribution (ILD).

Based on the coefficient of standards performance, actual salary of a team worker is calculated by the following steps.

First, you determine actual salary of a working team $W_{f.\ team}$ as well as team prices as

$$W_{f.\ team} = l \cdot T, \qquad (3.34)$$

where

l is a piece-rate for one operating hour, based on the professional task qualification category, UAH;

T is a labour intensity of the task, labour-hours.

Second, you calculate team rate salary as a sum of rate salaries of all team workers:

$$W_{rate\ team} = \sum_{i=1}^{n} l_i \cdot t_i, \qquad (3.35)$$

where

l_i is an hourly rate based on a worker's qualification category (grade), UAH;

t_i is real operating time of every worker, h;

n is a number of team workers, persons.

Third, you calculate $K_{s.p}$

$$K_{s.p} = \frac{W_{f.\ team}}{W_{rate\ team}} ; \qquad (3.36)$$

Finally, you calculate actual salary paid to every team worker as

$$W_{f.\ i} = l_i \cdot t_i \cdot K_{s.p} .$$ (3.37)

Based on the index of labour distribution, actual salary of a team worker is calculated by the following steps.

First, you calculate a monthly team rate salary as

$$W_{rate\ team} = \sum_{i=1}^{n} l_i \cdot t_i ,$$ (3.38)

where

l_i is an hourly rate based on a worker's qualification category (grade), UAH;

t_i is real operating time of every worker, h;

n is a number of team workers, persons.

Second, you determine a monthly team rate salary based on the index of labour distribution:

$$W_{r.t\ ild} = \sum l_i \cdot t_i \cdot ILD_i ,$$ (3.39)

where ILD_i is the index of labour distribution of a worker i determined by the leaders of a working team according to his or her personal labour input.

A monthly rate salary of every worker based on the index of labour distribution equals

$$W_{r.i} = l_i \cdot t_i \cdot ILD_i .$$ (3.40)

Third, you determine extra money earned by a working team:

$$W_{extra} = W_{f.\ team} - W_{rate\ team} ,$$ (3.41)

where

$W_{f.\ team}$ stands for actual salary of a working team, UAH, calculated as if based on the coefficient of standards performance.

Fourth, you calculate extra money earned by every team worker as

$$W_{extra\ i} = l_i \cdot t_{i.} \cdot ILD_i \cdot K_{extra} ,$$ (3.42)

where K_{extra} is a coefficient of extra money earned,

$$K_{extra} = \frac{W_{extra}}{W_{r.t\ ILD}}.$$ (3.43)

Then, you find out how team bonuses are distributed among team workers using the coefficient K_{bonus},

$$K_{bonus} = \frac{S_{bonus}}{W_{r.t\ ILD}}.$$ (3.44)

Every team worker get his or her bonus equal to

$$W_{bonus} = l_i \cdot t_i \cdot ILD_i \cdot K_{bonus}.$$ (3.45)

Finally, you calculate actual salary of every team worker by summing his or her monthly rate salary, extra money, and bonuses:

$$W_{f.\ i} = W_{r.i} + W_{extra\ i} + W_{bonus}.$$ (3.46)

Besides time-wage and piece-rate systems, enterprises can pay salaries and emoluments using accord-wage system, contract wage system, or profit sharing system.

Accord-wage system means that salary rates are established not for a product item to-be-manufactured or a service to-be-provided but for the whole professional task to-be-performed (operating time is usually established and limited by the customer).

Contract wage system means employers (customers) and employees (workers) sign a contract which specifies working mode and conditions, rights and obligations of the contract parties, salaries and emoluments, etc. At this system, salary (wages) can be paid for actual operating time (hourly wages) or actual professional tasks performed (piece wages).

Profit sharing system means that an enterprise shares a certain part of its profit with its employees (workers). This profit can be paid in cash or distributed in a form of shares (share certificates). Enterprises frequently turn to profit sharing system in cases when their employees have no interest in the enterprise's efficiency because they are not satisfied with the current payment

system. Plain and fair distribution of business profits among the owners, managers, experts, blue- and white-collar workers usually provides for the necessary working atmosphere and financial success of the enterprise.

Payment rates are set by an agreement signed by all the parties (enterprise and its employees) and depend on manufacturing expenses, product costs and values, company's financial standing, as well as personal achievements, labour productivity, bonuses already paid, etc.

3.3. Planning salaries and emoluments

Total wage and salary budget (payroll) includes money funds intended for paying regular and extra wages (salaries). These funds are planned for every separate qualification category of employees (workers).

Money fund intended for paying permanent employees (workers) their regular wages (salaries) is determined as

$$F_{d.\ perm} = F_{total} \cdot \bar{l} , \qquad (3.47)$$

where

F_{total} is a total labour intensity of a production unit (line, or workshop) within an annual production program, labour-hours;

$\bar{l}$ is an average hourly rate for a production unit (line, or workshop) corresponding to an average qualification category $\bar{R}$ of products manufactured and tasks performed.

Average rates and average qualification categories are determined as

$$\bar{l} = \frac{\sum ln}{\sum n} , \qquad \bar{R} = \frac{\sum Rn}{\sum n} , \qquad (3.48)$$

where

$l,\ R$ are both average hourly wage rates and corresponding average qualification categories;

n is a number of employees (workers) of these average qualification categories.

Money fund intended for paying auxiliary employees (workers) their regular wages (salaries) is determined as

$$F_{d.\,aux} = \sum_{i=1}^{m} l_i \cdot F \cdot n_i , \qquad (3.49)$$

where

l_i is an hourly rate for auxiliary employees (workers), UAH;

F is actual annual operating time, h;

n_i is a payroll number of auxiliary employees (workers).

Money fund intended for paying salaries (wages) assigned to certain grades and responsibilities is determined as

$$F_d = \sum W_i \cdot m_i \cdot n_i , \qquad (3.50)$$

where

W_i is a salary (wages) assigned to a certain grade or responsibility i;

m_i is a number of working months in a year;

n_i is a number of employees (workers) of a certain grade or responsibility i.

Money funds intended for paying extra wages (salaries) are determined as a part of regular salaries fund for every separate qualification category of employees (workers) (usually 20 to 40 %).

To calculate total wage and salary budget (payroll), you sum regular and extra salaries funds for every separate qualification category of employees (workers). To calculate hourly, daily, monthly, and yearly wage and salary budgets (payrolls), you add additional (hourly, daily, etc.) payments to the total wage and salary budget (payroll).

Unit 4. MANUFACTURING EXPENSES, COST AND MARKET PRICES OF PRODUCTS

4.1. Basic terms and concepts

Cost price of a product is a sum of money an enterprise spent to manufacture and sell this product.

As an economic parameter, cost prices are used to assess the enterprise efficiency in using labour forces, material resources, and financial assets.

For product manufacturing, mechanical engineering uses a lot of different materials, premade products, spare parts, and accessories; apply different tools and equipment; employ workers, experts, and managers. To plan, recognise, and analyse cost prices, these components are converted into monetary form.

Depending on manufacturing purposes, expenses can be divided into economic members and calculation items. Economic members include uniform expenses such as material expenditures, salaries and emoluments, depreciation charges, etc. Calculation items cover manufactured products and are used to estimate production costing.

All manufacturing expenses can be classified into

– direct and indirect expenses based on whether they are spent to produce one or many goods;

– permanent and variable expenses based on whether they depend on production volumes;

– simple and complex expenses based on their structure.

Direct expenses (material resources, salaries and emoluments) are spent to produce certain kinds of products; therefore, you can calculate them for every one product item and include them into its cost price based on current standards and direct charging. *Indirect expenses* (equipment operation, service, and repair; workshop expenses; whole-plant expenses; non-manufacturing expenses) are spent simultaneously on different technological processes or production lines (units, workshops) that is why they cannot (or there is no such need) be calculated for every one product item. You determine them in % of indirect expenses.

Variable expenses (materials, salaries and emoluments of permanent workers, fuels and energy necessary for technological procedures) depend on what exactly is manufactured because they are spent on every one product item. *Permanent expenses* (managers' salaries and emoluments, artificial lighting, space heating) do not depend on production volumes, and their changes are usually nominal or unessential.

Simple expenses (material resources, salaries and emoluments, fuels and energy necessary for technological procedures) are spent on one economic member; *complex expenses* (equipment operation, service, and repair; workshop expenses) are spent on several economic members contain some economic elements.

4.2. Production costing

When planning cost prices, you determine annual production costing and calculate cost prices of products and technological procedures. Annual production costing for a production line, unit, or workshop is calculated twice – separately for calculation items and economic members.

4.2.1. Production costing by calculation items

Table 4.1 covers calculation items used to calculate production costing.

Table 4.1

N	Calculation items	Expenses
1	Material resources	
2	Purchased premade products, spare parts, and accessories	
3	Material wastes *(subtracted)*	
4	Regular wages (salaries) of industrial personnel	
5	Extra wages (salaries) of industrial personnel	
6	Social measures and cultural events	
7	Equipment operation, service, and repair	
8	Workshop expenses	
9	Compensation for ageing of specific tools and equipment	
10	Assimilation of new products	
	Production costing for a production line, unit, workshop	
11	Whole-plant manufacturing expenses	
	Production costing for a whole plant or factory	
12	Non-manufacturing expenses	
	Total production costing	

Remember that production costing can cover other calculation items such as compulsory insurance of business property, road maintenance, ground lease, industrial conversion, upgrading and innovation, etc.

Production costing for a production line, unit, or workshop includes all expenses covered by lines 1-10 of Table 4.1.

Material resources are used for product manufacturing and are transformed into product items by means of direct labour:

$$C_{material} = H_{amount} \cdot C_1 \cdot N_{year},$$ (4.1)

where

H_{amount} is a standard amount of materials consumed to manufacture one product item, kg;

C_1 is a cost of one kilo of material, UAH;

N_{year} is an annual production program, items.

Purchased premade products, spare parts, and accessories.

Spare parts and accessories are finished products received from other enterprises and given to them at the assembly stage of product manufacturing. Premade products are work objects which were preliminary processed but need the application of direct labour to be transformed into finished products. These calculation items are determined in the same way as material resources. Spare parts and accessories are purchased at agreed prices.

Material wastes are calculated as a difference between a standard amount of materials consumed to manufacture one product item and its final mass:

$$C_{m.w} = \left(H_{amount} - B_{f.p}\right) \cdot C_{m.w.1} \cdot N_{year},$$ (4.2)

where

$C_{m.w}$ is a cost of material wastes on the annual production program, UAH;

$B_{f.p}$ is a final mass of one product item, kg;

$C_{m.w.1}$ is a cost of one kilo of wasted material, UAH.

When determining product costing, subtract material waste.

Regular wages (salaries) of industrial personnel are calculated as

$$W_{main} = l \cdot t \cdot N_{year},$$ (4.3)

where

W_{main} is an annual sum of regular wages (salaries) obtained by industrial personnel, UAH;

l is an hourly rate for a certain qualification category (grade);

t is a labour intensity calculated for manufacturing one product, h/item.

Extra wages (salaries) of industrial personnel are calculated as a part of their regular wages (salaries), %.

Expenses on *social measures and cultural events* are calculated as a part of total, i.e. regular plus extra, wages (salaries) of industrial personnel, %.

Expenses on *equipment operation, service, and repair* include wages (salaries) paid to auxiliary workers (service engineers and technicians, repairmen, mechanics) who serve and repair tools and equipment, employed in maintenance and repair of equipment, cost of lubricants and cleaning materials, depreciation charges, etc. These expenses are calculated as a part of regular wages (salaries) of industrial personnel, %.

Workshop expenses include wages (salaries) paid to workshop chiefs and managers, cost of workshop building renovation, expenditure on providing occupational safety and health, etc. These expenses are calculated as a part of regular wages (salaries) of industrial personnel, %.

Compensation for ageing of specific tools and equipment include charges for stamping tools, dies, and punches; forms, templates, and sweeps; assembly tools; press-moulds and moulding tools (retire within two years). For integrated calculations, these expenses are calculated as a part of regular wages (salaries) of industrial personnel, %, or a part of regular wages (salaries) of industrial personnel plus expenditures on material resources, %.

Expenses on *assimilation of new products* include

a) raised charges for manufacturing new products during their assimilation as well as for assimilation of new products, not intended for mass production;

b) expenses on assimilation of new technologies, workshops, and equipment together with charges for pilot production and equipment setting.

For integrated calculations, these expenses are calculated as a part of regular wages (salaries) of industrial personnel plus expenditures on material resources, %.

Production costing for a whole plant or factory includes production costing for a production line, unit, or workshop (lines 1-10 of Table 4.1) plus whole-plant manufacturing expenses (line 11 of Table 4.1).

Whole-plant manufacturing expenses include charges for maintenance of buildings, constructions, and manufacturing stocks; salaries (wages) of non-industrial personnel, expenditures on business consulting and auditing, etc. These expenses are calculated as a part of regular wages (salaries) of industrial personnel, %.

Total production costing includes production costing for a whole plant or factory (lines 1-11 of Table 4.1) plus non-manufacturing expenses (line 12 of Table 4.1).

Non-manufacturing expenses are spent to sell the production output and include charges for maintenance of warehouses, product transportation across the territory of the enterprise, advertising costs, etc. These expenses are calculated as a part of production costing, %.

4.2.2. Production costing by economic members

Table 4.2 covers economic members used to calculate production costing.

Table 4.2

N	Economic members	Expenses
1	Material resources	
2	Purchased premade products, spare parts, and accessories	
3	Auxiliary resources	
4	Recyclable wastes *(subtracted)*	
5	Purchased fuels	
6	Purchased energy	
7	Regular and extra wages (salaries) of all personnel	
8	Social measures and cultural events	
9	Depreciation of fixed assets	
10	Other expenses	
	Total	

Production costing by calculation items is equal to production costing by economic members (these are the same expenses). Production costing by economic members coordinates production costing for production lines (units, workshops) with total production costing, and total production costing with local and state budgets.

4.3. Calculating market prices

Table 4.3 covers calculation items used to calculate market price.

Table 4.3

N	Calculation items	Expenses
1	Material resources	
2	Purchased premade products, spare parts, and accessories	
3	Recyclable wastes *(subtracted)*	
4	Regular wages (salaries) of industrial personnel	
5	Extra wages (salaries) of industrial personnel	
6	Social measures and cultural events	
7	Equipment operation, service, and repair	
8	Workshop expenses	
9	Compensation for ageing of specific tools and equipment	
10	Assimilation of new products	
	Workshop price	
11	Whole-plant manufacturing expenses	
	Factory price	
12	Non-manufacturing expenses	
	Cost price	
13	Profit	
	Wholesale price	
14	Value added tax (VAT)	
	Market price	

Calculation items are determined in the same way as for production costing but for a product item instead of an annual production program (lines 1-12 of Table 4.3).

Wholesale price is a sum of cost price (lines 1-12 of Table 4.3) and profit (line 13 of Table 4.3).

Profit is calculated as a part of cost price of a product, %

Market price is a sum of wholesale price (lines 1-13 of Table 4.3) and value added tax (line 14 of Table 4.3).

Value added tax (VAT) is a net income of the state which goes completely to the state budget. It is calculated as a part of wholesale price minus expenses on material resources. When training economists, it can be considered (and thus calculated) as a part of wholesale price.

Unit 5.   PRODUCT QUALITY AND COMPETITIVENESS

To evaluate product quality, you compare the quality parameters to the corresponding parameters of their reference, actual, or hypothetical variants. For this, you take for basic such domestic or foreign analogues which have structure, operating principles, purpose and functionality, design units and principle of action, common functional purpose, production scales, and application conditions.

To analyse the quality of considered variants, you employ such comparison criteria as:

– complex quality factor showing current (obtained) quality level of a hypothetical variant, aims for 1 (one);

– arithmetic mean value of the complex quality factor showing the lowest quality limit.

Complex quality assessment is provided in cases then all particular values lie within accepted limits.

Under conditions of saturated market and tough competition, product variants should be chosen so that to meet the same requirements and satisfy the same wants at a lower level of expenditure on their structural and operational parameters. Moreover, product features which allow meeting certain requirements to the fullest possible extent (100 %) are considered hypothetical; and particular values are summed up and form an integrated factor based on their ranking or specific contribution to wants satisfaction.

According to the production concept of marketing, competing products are compared their technical and economic performance: If it exceeds 1 $(J_{competition} \geq 1)$, the product will have the advantage over competing products at the market. To give an opportunity for selecting marketing strategies, this value must reach at least 30 ... 50 %, and to stay competitive, the product needs 50 ... 70 % of advantage over the analogues.

To evaluate the product competitiveness, you gather information about competing products, their purpose and functionality; fill in the tables of business rival, and compare the product's quality to the quality of competing products. Then you employ certain assessment criteria to analyse obtained data and think over the ways to increase your competitiveness.

To calculate complex quality factors and indices of competitiveness, you:

1. Determine absolute values of particular quality factors (for compared products):

– number of factors *I = 1, 2, ..., n*;

– number of compared products *j = 1, 2, ..., m*.

2. Divide quality factors into two groups depending on their ability to improve the product quality:

– maximizing factors include accuracy, speed, range, etc.;

– minimizing factors include weight, size, expenses, etc.

3. Find out a hypothetical product which provides the highest quality (for compared products and their variants).

4. Use the expert evaluation method to calculate weight coefficients for particular quality factors provided that they (factors) have a positive weight, and their weights add up to one:

$$b_i > 0, \qquad \sum_{i=1}^{n} b_i = 1 \,. \tag{5.1}$$

5. Calculate relative values of particular quality factors (for compared products):

$$K_{ij} = \frac{q_{ij}}{q_{ir}} \,; \; i = const, \tag{5.2}$$

where

q_{ij} is a value of the i-th particular quality factor for the j-th product;

q_{ir} is a value of the i-th particular quality factor for the hypothetical product.

6. Sum up complex quality factors for every compared product:

$$K_j^o = \sum_{i=1}^{n} K_{ij} b_i \,. \tag{5.3}$$

7. Calculate relative indices of competitiveness for every compared product taking into account its manufacturing costs:

$$K_{kc}^j = \frac{K_j^o}{C_j} \,, \tag{5.4}$$

where C_j is a value of manufacturing costs.

8. Select the best possible variant which has the highest achievable index of competitiveness:

$$K_{kc}^{optim} \Rightarrow max. \tag{5.5}$$

You can use this procedure to assess product competitiveness under conditions of market economy provided that you take into account market prices and the product's share of the market.

Unit 6.   PROFITABILITY

Profit is a general indicator which shows the efficiency of product manufacturing, capital investment, and enterprise's financial standing.

Balance sheet profit incorporates all results of product manufacturing and includes profit gained by product sales, subsidiary production, and non-selling activities.

Balance sheet profit mainly consists of profit on sales. Profit on sales is equal to the difference between the cash revenue gained by product sales at wholesale prices and their actual cost prices.

By the direct calculation method, profit is calculated as

$$P = \sum_{i=1}^{n} N_s \cdot P_r - \sum_{i=1}^{n} N_p \cdot C, \tag{6.1}$$

where

n is a product nomenclature, items;

N_s is an amount of product sales in kind;

P_r is a wholesale price of a product item;

C is a cost price of a product item.

Profit gained from subsidiary production is calculated based on its cost.

Profit on non-selling activities includes only permanent incomes and expenses attributed to profits and losses and related to the normal enterprise operation (e.g., expenditure on housing and utilities or cultural and educational facilities).

Unit 7.   ECONOMIC EFFICIENCY OF COMPANY RESOURCES

7.1. Economic efficiency of capital investments

Economic efficiency is measured by comparing the cost of final results to the cost or amount of applied resources. This parameter is used for planning, analysing business activities, and making decisions.

For the quantitative evaluation of economic efficiency to meet the application tasks, you should employ a number of different analysis criteria:

– factors showing economic efficiency of public production;

– factors showing effective (or not effective) use of material resources and labour forces;

– factors showing efficiency of capital investments (reproduction of fixed assets), progress in science and technology.

To assess economic efficiency of capital investments, you employ absolute and relative efficiency factors. Absolute efficiency factors evaluate how recurrent (capital) and current expenditures contribute to the efficiency of the enterprise. They allow you to choose where to apply available resources, what to produce. Relative efficiency factors justify manufacturing decisions in terms of economy, i.e. answer the questions how to produce.

Main factors used to evaluate absolute efficiency of capital investments include total commercial effect, coefficient of absolute efficiency, and capital investments return period.

Total commercial effect is an annual increase of an enterprise profit ΔP.

Coefficient of absolute efficiency is

$$E = \Delta P / K ,\qquad\qquad(7.1)$$

where K is an amount of capital investments that provides additional profits ΔP.

Absolute efficiency E must exceed standard efficiency E_s $(E > E_s)$. Otherwise, investments are impractical (ineffective).

As a coefficient of standard efficiency E_s, you can use interest rates for long-term loans, average or threshold return on equity, the latter taking into account possible investment risks.

Capital investments return period T is a period of time (years) during which the accumulated profit becomes equal to capital investment K:

$$K = \sum_{t=1}^{T} P_t ,$$ (7.2)

where P_t is a profit gained in the t-th year.

Main factors used to evaluate relative efficiency of capital investments include reduced costs, coefficient of relative efficiency, and additional investments return period.

Reduced costs C_r for every possible variant of product manufacturing which is provide the same production volumes and quality of products is calculated as a sum of current annual cost C_i (production costings) and capital costs K, calculated for a current year according to standard efficiency E_s, i. e.

$$C_i = C_i + E_s \cdot K_i.$$ (7.3)

The amount of expenses indicates the most acceptable variant of product manufacturing. This variant can be the best of the best as well as the best of the worst: Therefore, economic efficiency of product manufacturing means that the coefficient of absolute efficiency E is greater that the coefficient of standard efficiency E_s.

Coefficient of relative effectiveness E is

$$E = \frac{C^c - C^n}{K^n - K^c} = \frac{\Delta C}{\Delta K} ,$$ (7.4)

where

C^c, C^n stand for annual cost prices of a current and new variant, correspondingly;

K^n, K^c stand for capital investments in these variants;

ΔC stands for annual savings (additional profit) gain in case an enterprise accepts the new variant (compared to the current one);

ΔK stands for additional investment in the new variant.

If there are no savings or capital investments, relative effectiveness is negative, and $C^n < C^c$, then there is no sense in adopting the new variant of the product manufacturing.

Additional investments return period P_{return} is reverse to the coefficient of relative efficiency E:

$$P_{return} = \frac{1}{E} = \frac{\Delta K}{\Delta C}. \tag{7.5}$$

When assessing efficiency, you should remember that additional profits are taxed so that their part H_{tax} goes to state budget according to income tax. Therefore, (7.1) and (7.4) should be modified.

Coefficient of absolute efficiency becomes

$$E = \frac{\Delta P(1 - H_{tax}/100)}{K}, \tag{7.6}$$

and coefficient of relative efficiency becomes

$$E = \frac{\Delta C(1 - H_{tax}/100)}{\Delta K}. \tag{7.7}$$

Moreover, you should modify return period calculations ((7.2) and (7.5)) to account for current taxation.

To determine annual production program for different variants of capital investments, you can employ a critical program N_{cr}. It is used for compromise case, e.g. when a new version secures lower current costs but requires greater capital investments. Then

$$N_{cr} = \frac{E_s \cdot \Delta K}{C^c - C^n}, \tag{7.8}$$

where C^c, C^n stand for current and new cost prices of a product item, correspondingly.

If an annual production programs is relatively small $(N < N_{cr})$, you should prefer the variant of product manufacturing which requires less capital investments though needs greater current **costs**.

7.2. Economic efficiency of investment projects

To evaluate economic efficiency of investment projects, you employ such factors as net cash flow (complex commercial effect for the assessment

period); investments return period; coefficient of project efficiency; project profitability (return on equity); maximum cash outflow; break-even point.

Net cash flow is calculated as total (cumulative) discounted cash in hand:

$$NVP = \sum_{t=1}^{T} (P_t - Z_t) \cdot \alpha_t , \qquad (7.9)$$

where

P_t is a cash inflow of the t-th year, UAH;

Z_t is a cash outflow of the t-th year, UAH;

T is an assessment period, years;

α_t is a time reduction coefficient for the t-th year:

$$\alpha_t = (1 + E_{dp})^{t_p - t} , \qquad (7.10)$$

where

E_{dp} is a discounting standard (threshold of profitability);

t_p is an assessment year (the first investment year);

t is a the year which results and expenses are reduced to the assessment year.

Investments return period is a period of time (years) during which the accumulated profit becomes equal to investments:

$$K = \sum_{t=1}^{T} (P_t - Z_t). \qquad (7.11)$$

In case of inflation, investments return period is

$$K = \sum_{t=1}^{T} (P_t - Z_t) \cdot (1 + \frac{i}{100})^{1-t} , \qquad (7.12)$$

where i is the expected inflation rate, %.

Coefficient of project efficiency is determined by trial-and-error method. It is equal to such a discounting standard (7.10) which guarantees zero net cash flow within the assessment period. Coefficient of project efficiency shows at

what maximum annual inflation the investment project saves its efficiency and has enough cash to ensure current payments.

Project profitability (return on equity) in the t-th year is calculated as a ratio of the profit P_t gained in the t-th year to the value of investments K. Average profitability is equal to the ratio of average annual profit P to the value of investments K.

Maximum cash outflow is the most negative value of the cumulative net cash flow calculated from Table 7.1 (usually it is a total of general investments).

Table 7.1

Factor	Building, modernization		Adaptation	Manufacturing	
	t = 1	t =2	…	t = t -1	t = T
Cash inflow P_t, including – product sales – disposal value Cash outflow Z_t, including – investments – administrative costs – taxes					
Net current costs $P_t - Z_t$ Cumulative net current costs Discounted net cash flow $\quad (P_t - Z_t) \cdot \alpha_t$ Cumulative discounted net cash flow					

Break-even point (a critical program) is a minimal production program for which product sales refund total expenses:

$$N_{br.ev} = \frac{E_{perm}}{P_m - E_{var}},$$
(7.13)

where

E_{perm} stands for permanent expenses according to annual production costing;

49

P_m stands for a product's market price (without VAT);

E_{var} stands for specific variable expenses according to a product's cost price.

Unit 8.   MANAGEMENT DECISIONS FOR SHORT-TERM TIME INTERVALS

Short-term time interval is a time interval any enterprise needs to create or assimilate new production methods, manufacturing technologies, equipment.

Since at short-term time intervals, enterprises still use previous production methods, manufacturing technologies, or equipment, permanent expenses remain constant:

$$E_{perm} = const. \tag{8.1}$$

That is why we can define short-term time interval as a time interval at which enterprises keep their permanent expenses constant.

Since permanent expenses are constant, short-term time intervals require optimal management decisions to be based on the difference between earnings (revenue) R and variable expenses E_{var} (marginal or increment cost price), i.e. expenses cover

$$V_0 = R - E_{var}. \tag{8.2}$$

This yields basic rule for making management decisions: At short-term time intervals, choose the product manufacturing variant which maximally covers the expenses (or with a maximum expenses cover):

$$V_0 \rightarrow max. \tag{8.3}$$

If there are factors or circumstances which limit expenses cover, basic rule is modified: At short-term time intervals, choose the product manufacturing variant with a maximum expenses cover for a unit of the limiting factor.

Possible limiting factors include product sales, monetary funds, material resources, labour forces, time, space, etc. These factors change with time and thus change criteria for optimal management decisions. For example, if at the beginning an enterprise lacks orders, the limiting factor is revenue R which can be overcome by developing dealer network. Then this enterprise can lack

production capacities F_{real} (real operating time of equipment). Expansion of production capacity can cause a lack of production areas S, etc.

All these limiting factors call for different criteria for optimal management decisions:

$$k_{cover} = \frac{V_0}{R}, \qquad \frac{V_0}{F_{real}}, \qquad \frac{V_0}{S}, \tag{8.4}$$

where k_{cover} is a coefficient of expenses cover.

Standard short-term management decisions include acceptation of special orders at prices lower that the cost price; developing of an optimal production program to overcome a limiting factor; decision to continue or stop manufacturing; decision to manufacture or buy spare parts and accessories, etc.

When making standard short-term management decisions, *remember*:

1. If you accept a special order at a price lower that the cost price, you should consider whether it makes economic sense based on potential dynamics of expenses cover.

2. In case then changed market prices influence cost prices of a manufactured product, you can stop manufacturing if it reduces the loss burden. If you stop the manufacturing and this reduces expenses cover, you can decide to continue.

3. Whether you can develop an optimal production program to overcome a limiting factor depends on the limiting factor itself. Before making a decision:

   – determine permanent expenses and assume them constant;

   – calculate earnings (revenue) and marginal variable expenses for every variant of product manufacturing;

   – find out the main limiting factor and calculate expenses cover for a unit of the limiting factor;

   – choose the variant which provide maximum expenses cover for a unit of the limiting factor.

4. When you decide whether to manufacture spare parts and accessories or buy them, you compare possible expenses. If $\overline{E_{var}} < P$, then you start their manufacturing. If this spare part or accessory displaces any other manufactured product, then you add the possible loss of expenses cover variable expenses. If (8.5) is true, then you still start manufacturing this spare part or accessory:

$$\overline{E_{var}} + \Delta \overline{V_0} < P, \tag{8.5}$$

where

$\Delta \overline{V_0}$ is a value of expenses cover possibly lost by manufacturing one spare part (accessory) under consideration;

P is a price of one spare part (accessory) under consideration.

REFERENCES

1. Короткий українсько-російсько-англо-німецький словник з економіки та менеджменту / Уклад. О. І. Лесюк та ін. – К. : Спалах ЛТД, 1996. – 312 с.

2. Сафронов Я. В. Экономическое обоснование бизнес-проектов в машиностроении / Я. В. Сафронов, В. Н. Гавва, В. А. Пильщиков – Х. : Нац. аэрокосм. ун-т им. Н. Е. Жуковского «Харьк. авиац. ин-т», 2002. – 114 с.

3. Экономика предприятия : сборник задач / А. И. Бабушкин, А. Н. Березюк, В. Н. Гавва и др. – Х. : Нац. аэрокосм. ун-т им. Н. Е. Жуковского «Харьк. авиац. ин-т», 2001. – 188 с.

4. Экономика предприятия : учеб. для вузов / под ред. В. Я. Горфинкеля, В. А. Швандара. – 3-е изд., перераб. и доп. – М. : ЮНИТИ-ДАНА, 2001. – 718 с.

5. Экономика предприятия : учеб. для вузов / Л. Я. Аврашков, В. В. Адамчук, О. В. Антонова и др. : / под ред. В. Я. Горфинкеля, В. А. Швандара. – 2-е изд., перераб. и доп. – М. : Банки и биржи, ЮНИТИ, 1998. – 742 с.

6. Экономика предприятия : учебник / [под ред. проф. О. И. Волкова. – М. : ИНФРА-М, 2001. – 520 с.