DOI: 10.18721/JE.11208
UDC 658.5

MANAGEMENT OF ADDED VALUE IN ENGINEERING BUSINESS: PROCESS APPROACH AND TOOLS

A.N. Shichkov, N.A. Kremlyova, A.A. Borisov

Vologda State University, Vologda, Russian Federation

In this article engineering business is considered as the cycles of converting manufacturing capital and innovation capital of enterprises into monetary capital. The conversion cycles are implemented by organizing the production based on market relation within technological stages being the zones of financial responsibility (liability); by using the management accounting system forming the organization of production in monetary equivalent and the innovation activity ensuring the equality of product value and its market price. The relevance of the research topic is determined by the necessity to create motivating system of innovation activity in engineering enterprises. Our aim is to ensure a continuous growth of market innovation added value of products. The main task is to develop tools for managing a basic operation cycle converting manufacturing capital into monetary capital in the form of products whose consumer properties are competitive and for managing an innovation cycle converting an income producing idea into market added value. As the investigation method we used the process approach in the formation of operation and innovation cycles parameters. As a result, the integrated mathematical model has been created that allows designing operation and innovation cycles; developing a management accounting system and on this basis to implement product and technological innovations. Studying conversion operation cycles of several engineering business enterprises allows us to formulate necessary requirements to the organization of production. Consumer properties and technological costs of final products should be formed by being transferred within technological stages being at the same time the zones of financial liability. Management accounting should ensure the equilibrium of operation basic and innovation cycles converting manufacturing and innovation capital into monetary capital and market added value of products respectively. To motivate innovative activity it is necessary to personalize intangible assets that guarantee market added value. Subsequent research will focus on the design, development and implementation of management accounting systems for manufacturing-technological systems to manage innovation processes ensuring market added value of each technological stage and final products.

Keywords: basic operation cycle of converting manufacturing capital into competitive products; innovation cycle of converting innovation capital into market added value; management accounting system; transferring technological costs and market value within technological stages, zones of financial liability

Citation: A.N. Shichkov, N.A. Kremlyova, A.A. Borisov, Management of added value in engineering business: process approach and tools, St. Petersburg State Polytechnical University Journal. Economics, 11 (2) (2018) 81–91. DOI: 10.18721/JE.11208

УПРАВЛЕНИЕ ДОБАВЛЕННОЙ СТОИМОСТЬЮ В ИНЖЕНЕРНОМ БИЗНЕСЕ: ПРОЦЕССНЫЙ ПОДХОД И ИНСТРУМЕНТЫ

А.Н. Шичков, Н.А. Кремлёва, А.А. Борисов

Вологодский государственный университет, г. Вологда, Российская Федерация

Инженерный бизнес определён в исследовании как циклы конверсии производственного и инновационного капитала предприятия в денежный капитал. Операционный цикл реализуется путём организации производства на основе рыночного уклада

между технологическими переделами, являющимися зонами финансовой ответственности, использования системы управленческого учёта, формирующей организацию производства в денежном эквиваленте, и инновационной деятельности, обеспечивающей равенство стоимости продукта и его рыночной цены. Актуальность темы исследования определяется необходимостью разработки мотивированной системы инновационной деятельности в инженерном предприятии. Целью исследования является обеспечение непрерывного роста рыночной добавленной стоимости продуктов производства. Основная задача при этом – создание инструментов управления базовым операционным циклом конверсии производственного капитала в денежный капитал в форме продуктов, потребительские свойства которых являются конкурентоспособными и для управления циклом конверсии доходной идеи в рыночную добавленную стоимость. Использован процессный подход в формировании параметров операционного и инновационного циклов. Создана интегрированная математическая модель, позволяющая проектировать операционный и инновационный циклы, разрабатывать системы управленческого учёта и осваивать на их основе продуктовые и технологические инновации. Исследование операционных циклов конверсии различных предприятий инженерного бизнеса позволило сформулировать необходимые требования к организации производства. Потребительские свойства и технологические затраты конечного продукта должны быть сформированы путём трансферта по технологическим переделам, являющимся в то же время зонами финансовой ответственности. Управленческий учёт должен обеспечить равновесие операционного базового и инновационного циклов конверсии производственного и инновационного капитала в денежный капитал и рыночную добавленную стоимость продукции соответственно. Чтобы мотивировать инновационную деятельность, необходимо персонализировать нематериальные активы, которые гарантировали рыночную добавленную стоимость. Последующие исследования будут сфокусированы на проектировании, создании и освоении систем управленческого учёта производственно-технологических систем для управления инновационными процессами, обеспечивающими рыночную добавленную стоимость каждого технологического передела и конечного продукта.

Ключевые слова: базовый операционный цикл конверсии производственного капитала в конкурентоспособную продукцию; инновационный цикл конверсии инновационного капитала в рыночную добавленную стоимость; система управленческого учёта; трансферт технологических затрат и рыночной стоимости по технологическим переделам, являющихся одновременно зонами финансовой ответственности

Ссылка при цитировании: Шичков А.Н., Кремлёва Н.А., Борисов А.А. Управление добавленной стоимостью в инженерном бизнесе: процессный подход и инструменты // Научно-технические ведомости СПбГПУ. Экономические науки. 2018. Т. 11, № 2. С. 81–91. DOI: 10.18721/JE.11208

Introduction. By definition engineering business is a manufacturing technological and marketing activity in which engineering creativity based on scientific theoretical and practical knowledge in the field of organization of production, management accounting and innovation allows business to continuously manufacture and sell goods [1–8].

The performance of a manufacturing technological system increases by improving assets. Basic assets of engineering business enterprises are manual assets. Mechanical drive attached to technological equipment in the form of James Watt's steam engine (1769) added tangible assets to manual assets and allowed increasing business performance. In the 1960s intangible assets were added to engineering business. The use of three assets in the organization of production added management accounting and innovation activity. In this case, the organization of production is an integrated set of controlling tools. It means that if the integrated set of tools includes the organization of production, management accounting and innovation activity, this complex is the controlling system of engineering business enterprises.

At present there is no clear understanding of the concept «controlling». To formulate the concept of controlling, we have studied the definitions of this term by different authors. According to Ivashkevich, «controlling is the system of managing the process of achieving final goals and outcomes of the company's activity» [9, 10]. Karminsky defines controlling as «a new management concept generated by the practice of joint management» [11, 12]. At the heart of this new concept of system management of the organization there is the desire to ensure the successful functioning of an enterprise in the long term.

According to the modern approach (Han [13]), controlling can be interpreted as information support focused on the results of enterprise management. Orekhovsky regards controlling as the achievement of goals of the organizational system. Smirnov C.A. believes that controlling is a system of managing the achievement of goals of an enterprise. According to Utkin and Myrynyuk [14], controlling is the concept of effective management of the enterprise ensuring its stable existence on the market. Maier [15] considers controlling as a leadership concept for effective management of the enterprise and ensuring its long-term existence. Gradov and Kusin define controlling in a broad sense as a system of ensuring the survival of an enterprise at the stages of strategic and tactical management.

Definitions of the concept «controlling» are the following: management system of the process of achieving final goals; practice of joint management; system management of the organization; information support focused on the results of enterprise management; organizational system; stable existence on the market; effective management; survival of an enterprise at the stages of strategic and tactical management.

As a result, the definition of this concept is the following: **controlling** is an integrated set of management systems and information support of organization focused on survival and stable existence on the market at the stages of strategic and tactical management and on achieving the final goals of an enterprise.

In Russia, the interest in controlling appeared at the beginning of the 1990s, when the economy finally consolidated both legal and market principles of economic management. The evolution of views on controlling in Russia can be presented as follows [16–19]:

– 1991–1995, controlling is similar to cost accounting;

– 1996–1997, controlling is understood as accounting of costs and benefits;

– 1998–2000, controlling of budgeting, operational planning and costs management;

– since 2000, there has been a predominant understanding of controlling as a provider and interpreter of information for management, as well as the coordinator of operational activities of an enterprise.

The Union of controllers was established in 2000 as a unifying form of interaction between theorists and practitioners involved in controlling. Since 2001, the Union has been publishing the journal «Controlling».

Controlling is a philosophy and a way of thinking of managers focused on the efficient use of resources and development of enterprises in the long term. Thus, the task of controlling as a science is to develop the theory, methods and instruments of management from different perspectives.

Our subsequent research will aim at the creation of a mathematical model [20, 21] integrating three components of controlling: organization of production management; management accounting system and innovation management where operation of production management balances demand and supply of products; innovation management balances product cost and its demand and market value; management accounting system implements organization of production, management and innovation management in monetary equivalent.

Designing the market parameters of engineering business. The main condition of successful engineering business is to manufacture only products that will be sold well. Each manufacturing technological system of any engineering business has its characteristic in the form of function $f(GW)$, where G is the production volume and W is the unit costs. Therefore, the first stage of designing an engineering business is designing the business characteristic.

1. Parametrical equation of business characteristic.

Demand and supply of engineering business are described by multiplying two variables: production volume G, product units/time units, and units costs W, rub/product units. The graphical interpretation of function $f(GW)$ is the parabola in rectangular coordinates. Fig. 1 presents the algorithm of designing the business characteristic $f(GW)$.

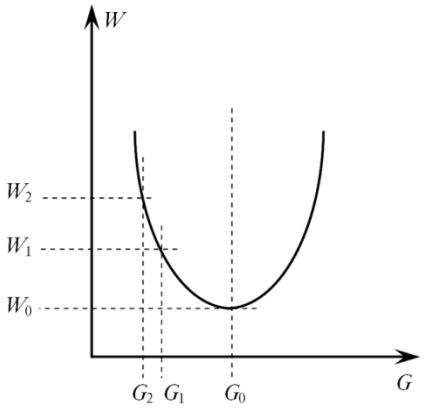

Fig. 1. Designing the algorithm of the business characteristic $f(GW)$

The field of changing parameters of demand and supply is $\min G_2$, G_1, $\max G_0$ and W_2, W_1, W_0, respectively, where:

$$W_0 = \frac{(4ac - b^2)}{4a}; \quad (1)$$

$$G_0 = -\frac{b}{2a}. \quad (2)$$

The system of equations describing the constant coefficients a, b, c in the equation of the parabola is the following:

$$\begin{cases} W_1 = aG_1^2 + bG_1 + c, \\ W_2 = aG_2^2 + bG_2 + c, \\ W_0 = aG_0^2 + bG_0 + c. \end{cases} \quad (3)$$

The solution of the equation results in obtaining the controlling equation by changing the variables $W_0 \div W_2$ and $G_0 \div G_2$,

$$W = aG^2 + bG + c. \quad (4)$$

The basic parameters of business G_0 and W_0 are obtained from dependences (1) and (2). Business performance T_0, rub/hour is determined by the dependences,

$$\begin{cases} T_0 = \frac{G_0 W_0}{R_0}, \\ R_0 = \frac{G_0 W_0}{T_0}, \\ R_0 T_0 = G_0 W_0, \end{cases} \quad (5)$$

where R_0, hour/year is the annual resource of working time. Constant R_G, hour/year is the annual resource of useful life of fixed assets and intangible assets. In this case, manufacturing technological processes will be balanced and all kinds of wear (technological, functional and economic) will be planned.

2. The structure of 'novelty' of products and technologies consists of two parts. In the first part of the novelty, parameters and properties of products and technologies are described as close to their prototypes. In the second part of the novelty, after the phrase «differing in ...», additions and changes determining the novelty are given. It means that the structure of innovation activity and the structure of engineering business consist of two parts: basic and innovation. Basic operation cycle manufactures products in a manufacturing technological system and innovation cycle converts income-generating ideas into market added value.

Mathematical model of operation and innovation cycles in vector form. The structural model of engineering business is considered in the form of two cycles:

2.1. Operation cycle of converting the manufacturing capital of a manufacturing technological system into monetary capital in the form of a competitive product.

2.2. Innovation cycle of converting the innovation capital into monetary capital in the form of products having competitive advantages.

The mathematical model of each cycle is a system of two balance equations.

The first equation of an operation cycle is a balance equation of basic manufacturing capital Q_{bmc} including technological costs C_{tc} and the main funds in the form of depreciable and taxable fixed assets U_{fa}. In turn, technological costs C_{tc} is an integrated set of direct manufacturing costs C_{dmc}, and manufacturing (business) waste costs C_{mwc}. As for C_{dmc}, it is the sum of material costs C_{mc}, other costs C_{oc}, and minimal labor payment costs $\min C_{lpc}$.

Normalization of direct costs during manufacturing of products leads to simultaneously developing and increasing manufacturing waste. The fact is that the initial material comes to the manufacturing technological system in the wholesale form; therefore, manufacturing waste arises in the manufacturing process. In this case, innovation activity of production personnel is excluded. If a manufacturing technological system is a technological stage with market cost and at the same time is a zone of financial liability, the reduction of manufacturing waste is motivating.

$$Q_{bmc} = C_{dmc} + C_{mwc} + \min C_{lp} + U_{fa}. \quad (6)$$

The second equation of an operation cycle is the balance equation of monetary capital in the form of competitive products manufactured in the technological system of the enterprise. Monetary capital (market basic cost) V_{bsv} is equal to the sum of direct manufacturing costs in products C_{dmc}, manufacturing waste C_{mwc} and net income D_0.

Net income D_0 of a basic operation cycle includes: value added tax $N_{vat} = 0.18 V_{sv}$, where V_{sv} is the sum of the basic sales value V_{bsv} and the

added value V_{asv}; fixed assets tax $N_{fat} = 0.02U_{bfa}$, where U_{bfa} is the balance cost of fixed assets; capitalization for business owners C_{cbo}. As a rule, the capitalization rate of business is more than the bank capitalization and it equals 10 %; depreciation of fixed assets is, for example, $0{,}03U_{bfa}$ and manufacturing waste is C_{mwc}. The efficiency of technological innovations is estimated by decreasing the rate of manufacturing waste in net income.

$$V_{bSV} = C_{dtc} + D_0 = C_{dmc} + C_{mwc} + \\ + N_{vat} + N_{fat} + C_{cbo} + C_{dfa}. \quad (7)$$

The first equation of an innovation cycle is the manufacturing capital including the costs in the form of the labor payment C_{lp} with all payments that are related to labor payment and the main funds in the form of intangible assets amortization U_{ia}. The value of intangible assets is determined only by the market added value, therefore, intangible assets are the objective reality and do not depend on whether they are on the balance sheet of the company or not.

Balance equation of manufacturing capital in an innovation cycle has the form:

$$Q_{imc} = C_{lp} + U_{ia}. \quad (8)$$

The second equation of the monetary capital of an innovation cycle is equal to the sum of added value V_{mav}, net profit P_0 with tax on the operation profit N_{opt} and the amortization of intangible assets C_{aia}.

Balance equation of monetary capital in a conversion operation cycle has the form:

$$V_{mav} = C_{lp} + P_0 + N_{opt} + C_{aia}. \quad (9)$$

Parameters of an operation cycle and an innovation cycle are the monetary flows vectors. Dependences (6,7) and (8,9) are presented in the form of two vector equation systems.

The system of vector equations describing a conversion operation cycle has the form:

$$\begin{cases} \vec{Q}_{bmc} = \vec{C}_{tc} + \vec{U}_{fa}, & (10) \\ \vec{V}_{bmc} = \vec{C}_{dmc} + \vec{C}_{mwc} + \vec{D}_0. & (11) \end{cases}$$

The system of vector equations describing a conversion innovation cycle has the form:

$$\begin{cases} \vec{Q}_{ic} = \vec{C}_{lp} + \vec{U}_{ia}, & (12) \\ \vec{V}_{isv} = \vec{V}_{amv} + \vec{P}_0 + \vec{C}_{aia} + \vec{N}_{opt}. & (13) \end{cases}$$

Only equilibrium processes can be graphically interpreted in any coordinate system. Therefore, the graphical interpretation of equilibrium conversion operation and innovation cycles in vector form can be presented in Fig. 2. In this case the vector triangle 1-2-3 performs as a coordinate system.

The sum of collinear vectors 1-5 and 5-2 is, respectively, the sum of innovation Q_{imc} (8) and basic Q_{bmc} (6) manufacturing capital. Similarly, the sum of collinear vectors 1-6 and 6-3 are added V_{asv} (9) and basic sales value V_{bsv} (7). Each of these vectors is a sum of two orthogonal vectors.

Vector Q_{imc} is equal to the sum of vectors 1-4 (labor payment costs C_{lp}) and vectors 4-5 (intangible assets U_{ia}).

Vector Q_{bmc} is equal to the sum of vectors 5-7 (technological costs C_{tc}) and vectors 7-2 (fixed assets U_{fa}).

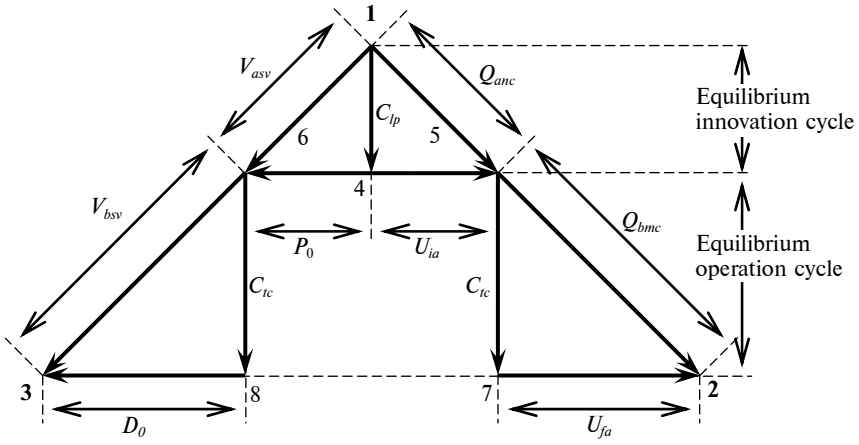

Fig. 2. Equilibrium conversion operation and innovation cycles in vector form

Vector V_{asv} is equal to the sum of vectors 1-4 (labor payment costs C_{lp}) and vectors 4-6 (net profit P_0).

Vector V_{bsv} is equal to the sum of vectors 6-8 (technological costs C_{tc}) and vectors 8-3 (net income D_0).

Management accounting and innovation activities support the equilibrium parameter of basic and innovation cycles.

It should be borne in mind that operation and innovation cycles are closed; therefore, all the parameters of cycles in innovation projects change at the same time.

The efficiency of engineering business is determined by the ratio of innovation and operational (basic) cycles.

The ratio of operation (basic) and innovation cycles should be equal to unity. A ratio exceeding unity is only possible in excise business. The enterprises that do not use management accounting have only the operation cycle. In this case market labor payment is compensated by not paying taxes. The fact is that the current manufacturing technological system cannot ensure these processes' metrology and, therefore, cannot implement management accounting.

Mathematical model of the operation and innovation cycles in variables: performance *T* and entropy *S*. The graphical interpretation of operation and innovation cycles in a vector coordinate system does not allow evaluating the changes of business performance. To fulfill this task, we describe the equation systems (10-13) in other parameters such as performance T, rub/hour and entropy S, hour/year.

$$\begin{cases} Q_{bmc} = T_{tc}R_0 + T_{fa}R_G, & (14) \\ V_{bmc} = T_{tc}R_0 + T_{fa}R_0, & (15) \end{cases}$$

$$\begin{cases} Q_{ic} = T_{sv}R_0 + T_{tc}R_G, & (16) \\ V_{isv} = T_{sv}R_0 + T_{tc}R_0. & (17) \end{cases}$$

Fig. 3 presents equilibrium operation and innovation cycles converting manufacturing and innovation capital into monetary capital in the form of the sum of basic sales value V_{bsv} and added market value V_{amv}. The abscissa axis presents the change of entropy S, hour/year and the ordinate axis presents the process of performance T, rub/hour. The field of rectangle 1-2-3-4 is the equilibrium conversion of operation (9-2-6-8) and innovation (8-5-4-7) cycles. Business efficiency is determined by the ratio of these cycles.

The processes and parameters of conversion operation cycles in engineering business are the following:

1. The process of forming the manufacturing capital of a basic conversion operation cycle. The process of forming the basic manufacturing capital Q_{bmc} of a basic conversion operation cycle consists of two processes: forming fixed assets 9-2 and forming technological costs 2-6.

The first process is the process of forming fixed assets U_{fa}. This is the process of setting up technological machines and equipment (tangible assets). Fixed assets are a taxable and depreciable part of main funds.

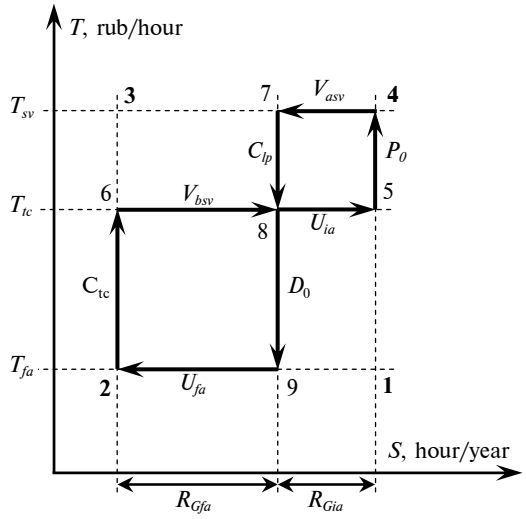

Fig. 3. Equilibrium conversion operation and innovation cycles in the coordinate system of performance T and entropy S

The second process is the process of forming technological costs 2-6 which in a basic cycle are equal to the sum of material costs C_{mtc}, other costs C_{otc} and minimal labor payment costs $minC_{lpc}$.

2. The process of forming basic monetary capital V_{bsv} of a basic operation cycle consists of two processes: manufacturing products in a manufacturing technological system 6-8 and selling products by the marketing division of an enterprise.

Market added value of a basic operation cycle is the depreciation of intangible assets during their useful life. Therefore, the value of

depreciable intangible assets is included in the value of fixed assets and is not the result of innovation activity.

This process of forming basic monetary capital consists of a manufacturing technological process converting technological costs C_{tc} into products whose the consumer properties allow receiving monetary capital equal to C_{tc} and the process of selling goods which allows forming net income D_0.

In the basic monetary capital net income 8-9 includes: value added tax N_{vat}, with the tax rate ψ_{vat}, fixed assets tax N_{fat}, with the tax rate ψ_{fat}; fixed assets depreciation C_{dfa}, where the fixed assets depreciation rate is minimal α_{dfa}=0.03. As a rule, the depreciation rate of fixed assets should be more than the tax rate of fixed assets. Net income of a basic operation cycle includes net profit with the operation profit tax P_{bo} for business owners. The net income of a basic operating cycle includes all business waste C_{bw}.

3. The process of forming the manufacturing capital of an innovative operation cycle.

As in the first case, the process of forming the manufacturing capital in an innovative operation cycle Q_{imc} consists of two processes: the process of forming intangible assets U_{ia} whose cost is equal to market added value and the process of forming manufacturing costs C_{ilp} in the form of personalized labor payment with all payments attributable to labor payment.

4. The process of forming monetary capital in an innovation operation cycle. This process consists of two processes: forming added value and forming net profit with all payments related to personalized labor payment.

Dynamic mathematical model of operation and innovation cycles. All the processes in operation and innovation cycles are dynamic processes. To study these processes, we suggest a mathematical model in the form of differential equations system.

$$\begin{cases} dQ_{mc} = dQ_{bmc} + \sum_{n=1}^{m} dQ_{amcn}, & (18) \\ dV_{sv} = dV_{bsv} + \sum_{n=1}^{m} dV_{asvn}, & (19) \end{cases}$$

where dQ_{bmc} is the basic manufacturing capital converted into the basic monetary capital dV_{bsv} as produced and sold goods with a market cost;

$\sum_{n=1}^{m} dQ_{amcn}$ is the sum of added innovative manufacturing capital in different technological stages converted into monetary capital in the form of the sum of added market value $\sum_{n=1}^{m} dV_{asvn}$.

We may write the equations (18) and (19) in the full form, where:

1) the process of forming basic manufacturing capital dQ_{bmc} consists of the process of forming tangible assets in the form of fixed assets differential dU_{fa} and the process of forming technological costs in the form of the constant of production volume multiplied by units costs differential $G_0dW=dC_{btc}$;

2) the process of forming added value of the manufacturing capital in each technological stage (m) is presented in the form of the sum of the processes of forming intangible assets in the form of dU_{ia} and the process of forming labor payment in the form of the constant of production volume multiplied by unit costs differential $G_0dW=dC_{alp}$;

3) the process of forming basic monetary capital dV_{bmc} consists of the manufacturing technological process equal to the constant of production volume multiplied by unit costs differential G_0dW and the process of forming sold goods and net income. This process is presented in the following mathematical form: $W_0dG=dD_{b0}$;

4) the process of forming added monetary capital in each technological stage (m) is based on implementing productive and technological innovations. Similar to basic monetary capital, added monetary capital consists of added value and net profit including all payments related to labor payment. This process is presented in the following mathematical form:

$$\begin{cases} dQ_{mc} = (dU_{fa} + G_0dW)_{bmc} + \\ + \sum_{n=1}^{m} (dU_{ia} + G_0dW)_{amcn}, & (20) \\ dV_{sv} = (G_0dW + W_0dG)_{bsv} + \\ + \sum_{n=1}^{m} (G_0dW + W_0dG)_{asvn}. & (21) \end{cases}$$

The system of equations (20) and (21) describes the operation cycle of converting manufacturing capital into monetary capital in the form of produced and sold goods with a market cost. We multiply and divide all members of the equations by the corresponding performance.

Each conversion operation cycle consists of four processes:

$$\begin{cases} T_{mc}\dfrac{dQ_{mc}}{T_{nc}} = \left(T_{fa}\dfrac{dU_{fa}}{T_{fa}} + G_0 T_{tc}\dfrac{dW}{T_{tc}}\right)_{bmc} + \\ + \sum\limits_{n=1}^{m}\left(T_{ia}\dfrac{dU_{ia}}{T_{ia}} + G_0 T_{lp}\dfrac{dW}{T_{lp}}\right)_{amcn}, \end{cases} \quad (22)$$

$$\begin{cases} T_{sv}\dfrac{dV_{sv}}{T_{sv}} = \left(T_{tc}G_0\dfrac{dW}{T_{tc}} + T_{D_0}W_0\dfrac{dG}{T_{D_0}}\right)_{bsn} + \\ + \sum\limits_{n=1}^{m}\left(T_{ia}G_0\dfrac{dW}{T_{ia}} + T_{np}W_0\dfrac{dG}{T_{np}}\right)_{asvn}. \end{cases} \quad (23)$$

As a result, we obtain the systems of equations in variables such as performance T and entropy S:

$$\begin{cases} T_{mc}dS(Q_{mc}) = (T_{fa}dS(R_{U_{fa}}) + T_{tc}dS(R_W))_{bmc} + \\ + \sum\limits_{n=1}^{m}(T_{ia}dS(R_{U_{ia}}) + T_{lp}dS(R_W))_{amcn}, \end{cases} \quad (24)$$

$$\begin{cases} T_{sv}dS(V_{sv}) = (T_{tc}dS(R_W) + T_{D_0}dS(R_G))_{bsn} + \\ + \sum\limits_{n=1}^{m}(T_{ia}dS(R_W) + T_{np}dS(R_G))_{asvn} \end{cases} \quad (25)$$

or

$$\begin{cases} T_{mc}dS(Q_{mc}) = (T_{fa}dR_{U_{fa}} + T_{tc}dR_W)_{bmc} + \\ + \sum\limits_{n=1}^{m}(T_{ia}dR_{U_{ia}} + T_{lp}dR_W)_{amcn}, \end{cases} \quad (26)$$

$$\begin{cases} T_{sv}dS(V_{sv}) = (T_{tc}dR_W + T_{D_0}dR_G)_{bsn} + \\ + \sum\limits_{n=1}^{m}(T_{ia}dR_W + T_{np}dR_G)_{asvn}. \end{cases} \quad (27)$$

We integrate the parameters in a closed cycle. An integral over a closed contour is equal to zero according to the property of parameters.

$$\begin{cases} T_{mc}\oint dS(Q_{nc}) = \left(T_{fa}\int\limits_0^{R_G} dR_{U_{fa}} + T_{tc}\int\limits_0^{R_0} dR_W\right)_{bmc} + \\ + \sum\limits_{n=1}^{m}\left(T_{ia}\int\limits_0^{R_{ia}} dR_{U_{ia}} + T_{lp}\int\limits_0^{R_{ia}} dR_W\right)_{amcn} = 0, \end{cases} \quad (28)$$

$$\begin{cases} T_{sv}\oint dS(V_{sv}) = \left(T_{tc}\int\limits_0^{R_0} dR_W + T_{D_0}\int\limits_0^{R_0} dR_G\right)_{bsn} + \\ + \sum\limits_{n=1}^{m}\left(T_{ia}\int\limits_0^{R_{ia}} dR_W + T_{np}\int\limits_0^{R_{ia}} dR_G\right)_{asvn} = 0. \end{cases} \quad (29)$$

As a result, we obtain the equilibrium property of operation and innovation cycles.

$$\begin{cases} \left(T_{fa}R_G + T_{tc}R_0\right)_{bmc} + \sum\limits_{n=1}^{m}\left(T_{ia}R_{ia} + T_{lp}R_{ia}\right)_{amcn} = 0, \quad (30) \\ \left(T_{tc}R_0 + T_{D_0}R_0\right)_{bsn} + \sum\limits_{n=1}^{m}\left(T_{ia}R_{ia} + T_{np}R_{ia}\right)_{asvn} = 0. \quad (31) \end{cases}$$

The systems of dependences and equations describe the equilibrium of the processes in manufacturing and innovation cycles:

$$\begin{cases} dQ_{amc} = dU_{ia} + (G_0 dW)_{lp}, & (32) \\ T_{amc}\dfrac{dQ_{amc}}{T_{amc}} = T_{ia}\dfrac{dU_{ia}}{T_{ia}} + T_{lp}\dfrac{G_0 dW}{T_{lp}}, & (33) \\ T_{amc}dS_{amc} = T_{ia}dS_{ia} + T_{lp}dS_{lp}, & (34) \\ S_{amc} = \dfrac{Q_{amc}}{T_{amc}} = \dfrac{U_{ia}}{T_{ia}} + \dfrac{G_0 W}{T_{lp}} = R_{Gi} + R_{0i}, & (35) \\ dS_{amc} = dR_{Gi} + 0, & (36) \\ Q_{mc} = (T_{fa}R_G + T_{ia}R_{Gi}) + (T_{tc}R_0 + T_{lp}R_{0i}), & (37) \\ Q_{mc} = U_{mf} + C_{tc}. & (38) \end{cases}$$

Organization of production and management accounting in engineering business. Fig. 4 presents a flowchart of the production organized based on transferring technological costs and consumer properties in the form of market value within technological stages that are also zones of financial liability.

Basic manufacturing capital Q_{bmc} is converted into monetary capital in the form of products being the first technological stage. Monetary capital in each technological stage is equal to the sum of basic sales value V_{bsv} and market added sales value V_{asv}. Finally, the product market value is equal to the sum of the basic sales value and the added market sales value from all technological stages.

This production organization in the form of monetary equivalent is the management accounting system.

Conclusions

1. The integrated set of added value tools in engineering business controlling includes:

– production organization by transferring technological costs and the products' consumer properties (market value) within technological stages that are at the same time the zones of financial liability;

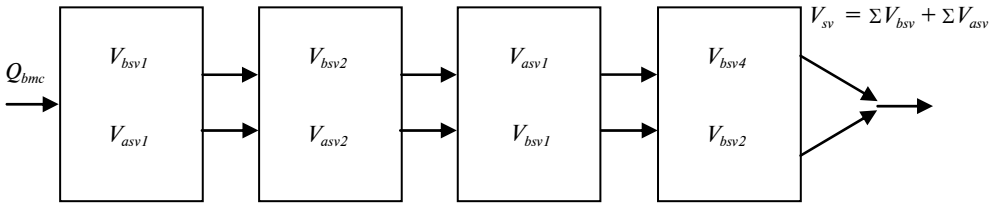

Fig. 4. Production organization and management accounting within the technological stages that are zones of financial liability

– management accounting system controlling the production organization in monetary equivalent;

– innovation activity by implementing product, technological and allocation innovations ensuring that the cost of manufactured products is equal to the market price.

2. Studies of the conversion operation cycles in engineering business allow us to formulate the following main properties:

2.1. Each technological stage should have market value. Only in this case the final product will have market cost.

2.2. Labor payment, net profit for dividends, amortization of intangible assets are in added value.

2.3. Added value of engineering business is a tendency to be equal to the basic cost of products manufactured in the operation cycle of an enterprise.

2.4. Management accounting system is the intellectual property of an enterprise.

2.5. Innovation can only be motivated by personalization of intangible assets.

The use of this integrated set of tools will ensure a continuous increase of the products' added value.

REFERENCES

[1] **A.V. Brizhan', S.G. Fal'ko,** Problemy kontrollinga na predpriiatiiakh po okazaniiu uslug v oblasti energoobespecheniia, Strategicheskoe planirovanie i razvitie predpriiatii: mater. XVI Vseros. simp. Ed. G.B. Kleiner, Moscow, TSEMI RAN, (2015) 25–27.

[2] **T.I. Glushko, S.G. Fal'ko,** Instrumenty kontrollinga v elektroenergeticheskoi kompanii: podkhody k formirovaniiu Toolset of Controlling, Sovremennye vyzovy kontrollingu i trebovaniia k kontrolleram: sb. nauch. tr., Moscow, Ob"edinenie kontrollerov, (2015) 54–62.

[3] **T.I. Glushko, S.G. Fal'ko,** Strategicheskii i operativnyi kontrolling na predpriiatiiakh elektroenergetiki, Strategicheskoe planirovanie i razvitie predpriiatii: mater. XVI Vseros. simp. Ed. G.B. Kleiner, Moscow,TSEMI RAN, (2015) 32–34.

[4] **S.V. Grishunin, S.B. Suloeva,** Organizatsiia protsessa soprovozhdeniia kreditnykh reitingov v kompanii na osnove kontseptsii kontrollinga, Kontrolling, 59 (2016) 42–51.

[5] **D.S. Emelyanova, S.B. Suloeva,** The role of controlling the system of environmental management, St. Petersburg State Polytechnical University Journal. Economics, 2-1 (144) (2012) 73–76.

[6] **S.G. Fal'ko,** Kontrolling v protsesse vnedreniia i optimizatsii proizvodstvennykh system, Kontrolling, 1 (63) (2017) 2–5.

[7] **S.G. Fal'ko,** Sistematizatsiia kontseptsii kontrollinga i faktorov, opredeliaiushchikh vybor instrumentov kontrollinga, Ekonomika znanii: strategicheskie problemy i resheniia: mater. VII Mezhdunar. nauch.-prakt. konf. Otv. red. V.V. Ermolenko, M.R. Zakarian, Krasnodar, Kubanskii gos. un-t, (2015) 18–25.

[8] **S.G. Fal'ko, V.S. Chugunov,** Kontrolling: predstavlenie i ispol'zovanie znanii v upravlenii organizatsiei, Vestnik Iuzhno-Rossiiskogo gosudarstvennogo tekhnicheskogo universiteta (Novocherkasskogo politekhnicheskogo instituta). Seriia: Sotsial'no-ekonomicheskie nauki, 3 (2017) 4–11.

[9] **V.B. Ivashkevich,** Problemy teorii upravlencheskogo ucheta i kontrollinga, Mezhdunarodnyi bukhgalterskii uchet, 14 (404) (2016) 32–46.

[10] **V.B. Ivashkevich,** Strategicheskii kontrolling biznes-protsessov proizvodstva i prodazh, Upravlencheskii uchet, 1 (2013) 31–36.

[11] **A.M. Karminskii, A.A. Zhevaga, S.A. Zubov,** Kontrolling i informatsionnykh tekhnologii v banke (chast' 1), Kontrolling, 1 (51) (2014) 74–77.

[12] **A.M. Karminskii, A.A. Zhevaga, S.A. Zubov,** Kontrolling i informatsionnykh tekhnologii v banke (chast' 2), Kontrolling, 2 (52) (2014) 56–65.

[13] **D. Khan,** Planirovanie i kontrol': kontseptsiia kontrollinga: per. s nem. Ed. A.A. Turchak, L.G. Golovach, M.L. Lukashevich, Moscow, Finansy i statistika, 1977.

[14] **E.A. Utkin, I.V. Myryniuk,** Kontrolling: rossiiskaia praktika. M.: Finansy i statistika, 1999. 269 s.

[15] **E. Maier,** Kontrolling kak sistema myshleniia i upravleniia. Per. s nem. Iu.G. Zhukova, S.N. Zaitseva, Moscow, Finansy i statistika, 1993.

[16] **S.A. Zubov, A.A. Zhevaga, A.M. Karminskii,** Novye podkhody k kontrollingu biznes-protsessov i informatsionnykh tekhnologii, Kontrolling, 1 (2014) 60.

[17] **V.G. Larionov, M.N. Pavlenkov, S.G. Fal'ko,** Kontseptsiia kontrollinga upravleniia sbytom predpriiatiia tekstil'noi promyshlennosti, Izvestiia vysshikh uchebnykh zavedenii. Tekhnologiia tekstil'noi promyshlennosti, 4 (358) (2015) 66–69.

[18] **Ju.Ju. Luzhenskaja, S.B. Suloeva,** Mechanism for determining the main financial goals of the industrial enterprise in the controlling system, St. Petersburg State Polytechnical University Journal. Economics, 4 (175) (2013) 95–104.

[19] **S. Grishunin, S. Suloeva,** Project Controlling in Telecommunication Industry, Lecture Notes in Computer Science, 9247 (2015) 573–584.

[20] **A.N. Shichkov, N.A. Kremleva, A.N. Shichkov,** Proektirovanie operatsionnogo tsikla konversii proizvodstvennogo kapitala v denezhnyi kapital v inzhenernom biznese, Ekonomika i menedzhment v usloviiakh tsifrovizatsii: sostoianie, problemy, forsait: tr. nauch.-prakt. konf. s mezhdunar. uchastiem, St. Petersburg, Izd-vo Politekhn. un-ta, (2017) 483–511.

[21] **A.N. Shichkov, N.A. Kremlyova, A.A. Borisov, A.N. Shichkov,** Contradictions in Innovative Development of Engineering Business ering Business, Tendentsii razvitiia ekonomiki i promyshlennosti v usloviiakh tsifrovizatsii: monogr. Ed. A.V. Babkin, St. Petersburg, Izd-vo Politekhn. un-ta, (2017) 468–503.

SHICHKOV Aleksandr N. E-mail: shichkov-an@yandex.ru
KREMLYOVA Nataliia A. E-mail: kremleva-n@yandex.ru
BORISOV Aleksandr A. E-mail: uiiop@mh.vstu.edu.ru

СПИСОК ЛИТЕРАТУРЫ

[1] **Брижань А. В., Фалько С. Г.** Проблемы контроллинга на предприятиях по оказанию услуг в области энергообеспечения // Стратегическое планирование и развитие предприятий: матер. XVI Всерос. симп. / под ред. Г.Б. Клейнера. М.: ЦЭМИ РАН, 2015. С. 25–27.

[2] **Глушко Т.И., Фалько С.Г. И**нструменты контроллинга в электроэнергетической компании: подходы к формированию Toolset of Controlling // Современные вызовы контроллингу и требования к контроллерам: сб. науч. тр. М.: Объединение контроллеров, 2015. С. 54–62.

[3] **Глушко Т.И., Фалько С.Г.** Стратегический и оперативный контроллинг на предприятиях электроэнергетики // Стратегическое планирование и развитие предприятий: матер. XVI Всерос. симп. / под ред. Г.Б. Клейнера. М.: ЦЕМИ РАН, 2015. С. 32–34.

[4] **Гришунин С.В., Сулоева С.Б.** Организация процесса сопровождения кредитных рейтингов в компании на основе концепции контроллинга // Контроллинг. 2016. № 59. С. 42–51.

[5] **Емельянова Д.С., Сулоева С.Б.** Роль экологического контроллинга в системе управления предприятием // Научно-технические ведомости СПбГПУ. Экономические науки. 2012. № 2-1 (144). С. 73–76.

[6] **Фалько С.Г.** Контроллинг в процессе внедрения и оптимизации производственных систем // Контроллинг. 2017. № 1 (63). С. 2–5.

[7] **Фалько С.Г.** Систематизация концепций контроллинга и факторов, определяющих выбор инструментов контроллинга // Экономика знаний: стратегические проблемы и решения: матер. VII Междунар. науч.-практ. конф. / отв. ред. В.В. Ермоленко, М.Р. Закарян. Краснодар: Кубанский гос. ун-т, 2015. С. 18–25.

[8] **Фалько С.Г., Чугунов В.С.** Контроллинг: представление и использование знаний в управлении организацией // Вестник Южно-Российского государственного технического университета (Новочеркасского политехнического института). Серия: Социально-экономические науки. 2017. № 3. С. 4–11.

[9] **Ивашкевич В.Б.** Проблемы теории управленческого учета и контроллинга // Международный бухгалтерский учет. 2016. № 14 (404). С. 32–46.

[10] **Ивашкевич В.Б.** Стратегический контроллинг бизнес-процессов производства и продаж // Управленческий учет. 2013. № 1. С. 31–36.

[11] **Карминский А.М., Жевага А.А., Зубов С.А.** Контроллинг и информационных технологий в банке (часть 1) // Контроллинг. 2014. № 1 (51). С. 74–77.

[12] **Карминский А.М., Жевага А.А., Зубов С.А.** Контроллинг и информационных технологий в банке (часть 2) // Контроллинг. 2014. № 2 (52). С. 56–65.

[13] **Хан Д.** Планирование и контроль: концепция контроллинга: пер. с нем. / под ред. и с пред. А.А. Турчака, Л.Г. Головача, М.Л. Лукашевича. М.: Финансы и статистика, 1977. 800 с.

[14] **Уткин Э.А., Мырынюк И.В.** Контроллинг: российская практика. М.: Финансы и статистика, 1999. 269 с.

[15] **Майер Э.** Контроллинг как система мышления и управления / пер. с нем. Ю.Г. Жукова, С.Н. Зайцева. М.: Финансы и статистика, 1993. 96 с.

[16] **Зубов С.А., Жевага А.А., Карминский А.М.** Новые подходы к контроллингу бизнес-процессов и информационных технологий // Контроллинг. 2014. № 1. С. 60.

[17] **Ларионов В.Г., Павленков М.Н., Фалько С.Г.** Концепция контроллинга управления сбытом предприятия текстильной промышленности // Известия высших учебных заведений. Технология текстильной промышленности. 2015. № 4 (358). С. 66–69.

[18] **Луженская Ю.Ю., Сулоева С.Б.** Механизм определения основных финансовых целей деятельности промышленного предприятия в системе контроллинга // Научно-технические ведомости Санкт-Петербургского государственного политехнического университета. Экономические науки. 2013. № 4 (175). С. 95–104.

[19] **Grishunin S., Suloeva S.** Project Controlling in Telecommunication Industry // Lecture Notes in Computer Science. 2015. Т. 9247. С. 573–584.

[20] **Шичков А.Н., Кремлева Н.А., Шичков А.Н.** Проектирование операционного цикла конверсии производственного капитала в денежный капитал в инженерном бизнесе // Экономика и менеджмент в условиях цифровизации: состояние, проблемы, форсайт: тр. науч.-практ. конф. с междунар. участием. СПб.: Изд-во Политехн. ун-та, 2017. С. 483–511.

[21] **Shichkov A.N.** Contradictions in Innovative Development of Engineering Business / А.Н. Шичков, Н.А. Кремлёва, А.А. Борисов, А.Н. Шичков // Тенденции развития экономики и промышленности в условиях цифровизации: моногр. / под ред. А.В. Бабкина. СПб.: Изд-во Политехн. ун-та, 2017. С. 468–503.

ШИЧКОВ Александр Николаевич. E-mail: shichkov-an@yandex.ru
КРЕМЛЁВА Наталия Анатольевна. E-mail: kremleva-n@yandex.ru
БОРИСОВ Александр Алексеевич. E-mail: uiiop@mh.vstu.edu.ru

Статья поступила в редакцию 04.02.18