

# Determination of Economic Effect from the Implementation of Automated Designing Systems of Technological Processes

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**Abstract:** The authors have determined the economic effect of the introduction of computer-aided design systems for technological preparation processes in the machine-building industry. The research methodology is based on scientific heuristic methods and methods of functional analysis. The consolidated technical and economic indicators of the implementation of CAD TP were obtained, such as the average operating time of the system, the cost of CAD, capital investments, annual operating costs, the expected annual economic effect, the coefficient of economic efficiency, payback period. A methodology has been developed for calculating the economic effect from the introduction of CAD of technological processes, which differs from the methods by the lack of comparability of options for the identity of the results in the form of specific products. The author's vision of the terms of the economic effect from the introduction of CAD TP at mechanical engineering enterprises is proposed. The presented calculation method can be used in practice to determine the effectiveness of the creation and implementation of applied software products. The practical significance of the study lies in the adaptation of the software developed by the authors at machine-building enterprises. In the course of the research, the software was successfully tested and adapted, which is confirmed by the received certificates of implementation and title deeds. The duration of work during the technological preparation of those solved manually is 3.5 times longer than when working on a computer.

**Keywords:** computer-aided design systems; economic effect; labor input; salary

## 1 INTRODUCTION

Development and implementation of a software product for technological preparation of production based on the integration of means of a single information space technological design and management of production resources is a large-scale task for any machine-building enterprise.

The introduction of Cals-technologies [1, 2] has an effect in solving a number of socio-economic issues, such as: reducing the degree of dependence of the organization and the implementation of design results from changes in specialists; reduction in the share of design subjects with high professional qualifications; increasing intellectual resources, organizations implementing design processes; advanced training of design subjects; changes in the social and professional-qualification structure of the team.

A number of projects of integrated computerized production facilities operating on the basis of Cals-technologies have been carried out in Japan and the USA. One of the first was the project of an automated plant for the production of machine tool parts, implemented in Japan by the MAZAK company. The plant included: a complex of flexible production modules (FPM) and FMS, automated warehouses, a robotic transport system. It was provided for the use of local area networks (LAN) to perform the functions of service and technical support of branches, as well as interaction with enterprises - suppliers of components.

In the period 1985 - 1995 around twenty systems with different levels of automation were created in different countries of the world, of which eight automated factories produced metal-cutting equipment, four - products for the aerospace industry in the USA [3].

With the advent of universal software system in the early 90s, it became suitable for use in enterprises with various levels of automation.

Thus, the CAD/CAM/CAE and Material Requirements Planning (MRP) software complexes appeared.

CAD/CAM/CAE - a set of software for computer design, technical preparation of production and engineering calculations. The Russian-language analogue of this concept is CAD-K and CAD-T (design and technological computer-aided design systems).

MRP - has become a complex of tasks for managing the financial and economic activities of an enterprise: planning material resources, managing resources and others. During this period, a number of fundamental ideas, principles and technologies were developed:

1. Class of CAD / CAM / CAE automation systems for technical preparation of production. Automation tasks were solved by this class.

With the help of a CAD system, electronic drawings were created - a flat geometric model of the product.

The CAM system made it possible to develop technological processes and control programs for computer numerical control machines (CNC) based on the design models of the product.

2. The MRP class (MRP-II), which has a set of functions and interrelationships, has created the basis for the formation of a functional standard that describes the management technology implemented using computer systems. A distinctive feature of this technology is the use of automated systems using common databases and the absence of duplication of data entry, while maintaining their relevance and integrity.

3. Enterprise Resource Planning (ERP) class in systems laid the foundation for scientific research in the field of business and production management.

Before ERP systems, the MRP (Material Requirements Planning) standard was developed and was only able to perform functions such as planning material requirements in a closed loop. The methods were based on a calculation system using data from the current production plan, and the production plan was formed on the basis of:

- information about orders accepted for execution with approved delivery dates;
- the needs for replenishing the insurance stocks of raw materials (material resources and components);
- the provision of work centers (equipment) of the enterprise.

The ERP system included the capabilities of the MRP and MRP-II standards, as well as the ability to manage and analyze activities, DRP (Distribution Resource Planning) resource planning, FRP (Finance Requirements Planning) financial planning and SCM (Supply Chain Management) supply chain management capabilities [4].

Engineering enterprises implement ERP-systems based on Cals-technologies, if the feasibility is calculated and there are the necessary economic, technical and organizational conditions.

The generally accepted technological criteria for the use of Cals-systems in machine-building enterprises are:

- the openness of the system, the use of relational database management systems and CASE-technologies for the design and development of these systems;
- the presence of a two- or three-tier system architecture, including a database server, an application server and a client part, unified;
- graphical user interface of the system.

Machine-building enterprises introduce Cals technologies, if the feasibility is calculated and there are the necessary economic, technical and organizational conditions. The development of a methodology for calculating the economic effect of introducing Cals technologies is a rather difficult task.

## 2 ANALYSIS OF RESEARCH AND PUBLICATIONS

After analyzing projects using Cals technologies in automating the management of mechanical engineering production, it was revealed that industrial enterprises often use traditional ineffective approaches to access and work with data, which are associated with converting information from one database to another, which leads to significant economic losses and negatively affects the timing and quality of the final product.

The concepts of Cals technologies are implemented in foreign systems such as: R/3 (SAP), BAAN (BAAN), Oracle Applications (Oracle Corporation), MS Axapta (Microsoft Business Solutions-Axapta), MFG/PRO (QAD), People Soft (People Soft Inc.), One Word (JD Edwards), Syteline (Symix Systems), as well as Russian companies: Parus (Parus company), Galaktika (NovyAtlant corporation), IS-Pro ("Intellect Service"), [5-7].

In most of the implemented projects [8], the main reason for the difficulties in introducing Cals-technologies (for example, ERP-systems) at machine-building enterprises is a clear bias towards the automation and informatization of financial and accounting and economic business processes and postponing (or ignoring) the main tasks automation of technical preparation and operational management of production business processes.

Engineering enterprises risk huge sums of money buying ERP systems only for solving formalized financial management and accounting tasks, since the cost of a

license for software only and implementation averages about 6500 € per workplace [9]. This cost does not include investments in training and mastering new processes by the company's employees, amounting to 1500 € per week, and the purchase of hardware.

The cost of an ERP solution is not limited only by the price of a license and payment for training and implementation services. There are many hidden costs that an engineering company has to bear to operate and maintain an ERP system.

Analysis of previously existing methods for determining the economic efficiency of the introduction of new equipment, technology and organization of the production process [10-14] shows that these methods are based on the determination of the comparative economic efficiency of the implementation of various options for improvement, modernization, etc. advantages and disadvantages. A qualitative analysis without calculations comes down to an assessment: better or worse, more or less, cheaper or more expensive, etc. Quantitative analysis consists in calculating and comparing the costs associated with the production of the corresponding work. The annual economic effect from the introduction of options for organizational, technical or other solutions is defined as the savings on the reduced costs [15, 16]. These costs are calculated as the sum of current costs and capital investments, taking into account the standard ratio of their comparative efficiency. However, the lack of comparability of options and the identity of the useful result, as well as the probabilistic nature of the effect of the introduction of computer-aided design of technological processes (CADTP), necessitate the development of a comprehensive analysis of comparative organizational, economic, social feasibility. The results of the studies have shown that the existing methods for calculating the economic implementation of innovations [17-19], taking into account discounted income, are not always acceptable for the conditions of implementation in modern domestic engineering industries. Their main disadvantages are: description or explanation of many economic phenomena as a process of solving an imprecise problem based on subjective assessments.

Thus, the development of a methodology for calculating the economic effect from the introduction of a computer-aided design of technological and business processes at machine-building enterprises is an urgent task today and the feasibility and economic effect of its implementation in existing industries is beyond doubt.

## 3 EFFECTS OF CADTP IMPLEMENTATION

The enterprise implements CAD of technological processes (CAD TP) if expediency is confirmed and the necessary economic, technical and organizational conditions are provided. The effect of the introduction of CAD of technological processes can be economic, social and technical [20].

The full economic effect of the introduction of CAD of technological processes at the  $E_c$  enterprise consists of the following components:

$$E_e = E_c + E_{ep} + E_{dp} \quad (1)$$

where  $E_c$  is the economic effect obtained at the stage of consumption of products with improved consumer properties due to the fact that their properties are formulated by technologies designed by CAD of technological processes;  $E_{cp}$  is the economic effect obtained at the stage of using technologies in serial and pilot production, which, due to the fact that they are designed by means of CAD of technological processes, have improved production and technological indicators;  $E_{dp}$  is the economic effect obtained directly at the stage of product and technology design.

An accurate assessment of  $E_c$  for an enterprise implementing CAD of technological processes is problematic, since the effect is obtained from the consumer of the products. However, the manufacturer gets the opportunity to successfully promote products on the market, expand sales and maintain competitiveness.  $E_{cp}$  and  $E_{dp}$  are calculated according to standard methods.

The income generated by reducing operating costs and increasing sales must be sufficient to provide an acceptable return on capital costs for the implementation of CAD of technological processes. The coefficient of comparative economic efficiency for the entire industry is taken as 0.35. Consequently, the cost of implementing a CAD of technological processes system should be recouped within about 3 years. At the same time, if the CAD of technological processes system is the only opportunity for the survival of the enterprise, then the period can be significantly longer.

The introduction of CAD TP allows you to obtain a number of socio-economic effects, the most important of which are: reducing the degree of dependence (sensitivity) of the level of organization and implementation of design results from changes in the team of design subjects; reducing the share of non-creative, reproductive, routine work in the overall balance of working time of design subjects with high professional qualifications; increasing the productivity of intellectual resources, organizations implementing design processes; advanced training of design subjects and the prestige of their work; change in the social and professional-qualification structure of the team of design subjects [21].

There are a number of problems that cannot be solved by means of CAD TP. Although to some extent, CAD TP systems correct the careless work of performers, unscrupulous and low-skilled employees can make the system itself work incorrectly. The CAD TP system does not produce final products, and its operation in combination with low-performance equipment and outdated technologies will not lead to the expected effect. The implementation of the system is a strategic task and is unacceptable for enterprises balancing on the brink of bankruptcy or small enterprises focused on rapid capital turnover [22].

#### 4 CALCULATION OF THE ECONOMIC EFFECT FROM THE INTRODUCTION OF CAD TP

The cost price is the sum of development costs and the costs of maintaining and operating the equipment used in the implementation of the software product. The calculation of the cost of developing a program is made according to the formula:

$$C = S_d + C_e + C_o \quad (2)$$

$$C = 3506 + 514 + 1753 = 5773 \text{ \$}$$

where  $C$  is the cost of the program, \$;  $S_d = 3506$  \$ - developer's salary and social security contributions;  $C_e = 514$  \$ - equipment operating costs;  $C_o = 1753$  \$ - overhead costs (50% of the developer's basic salary).

The developer's salary consists of the programmer's basic salary during the development of the program, additional salary, social security contributions and is calculated using the formula:

$$S_d = S_b + S_a + O_{soc} \quad (3)$$

$$S_d = 218 + 26 + 63 = 307 \text{ \$}$$

where  $S_b = 218$  \$ - the basic salary of the programmer during the development of the program, \$;  $S_a = 26$  \$ - additional salary, \$ (12% of the main);  $O_{soc} = 63$  \$ - social security contributions, \$ (26% of the amount  $S_b$  and  $S_a$ ).

The calculation of the cost of 1 hour of the programmer's work is made according to the formula:

$$C_h = \frac{S_p}{N \cdot 8} \quad (4)$$

$$C_h = 307 / (22 \cdot 8) = 1.74 \text{ \$}$$

where  $S_p = 307$  \$ - programmer's salary for a month;  $N = 22$  days - the number of working days in a month; 8 - the duration of the working day, hour.

The programmer's salary for the period of program development is calculated by the formula:

$$S_p = S_s \cdot t_p \quad (5)$$

$$S_p = 1.74 \cdot 2000 = 3480 \text{ \$}$$

where  $S_s$  is the salary for one hour of work of a specialist, \$;  $t_p = 2000$  h is the time spent on creating the program;

The time spent on creating the program can be technically justified and determined on the basis of normative documents or experimentally - statistically.

The cost of electricity is calculated using the formula:

$$C_e = E_m \cdot t_m \cdot S_q \quad (6)$$

$$C_e = 0.3 \cdot 1000 \cdot 0.02 = 8.71 \text{ \$}$$

where  $E_m = 0.3$  kW/h is the electricity consumed by the computer;  $t_m = 1000$  h - machine time spent on creating the program, hour. (take 50% of  $t_p$ );  $S_q = 0.02$  \$ - the cost of one kW/h.

The amount of depreciation for the period of program development is calculated using the linear method [23] using the formula:

$$A_o = \frac{N_a \cdot C_e \cdot t_n}{100\% \cdot F_a} \quad (7)$$

$$A_o = \frac{10 \cdot 514 \cdot 1000}{100\% \cdot 2040} = 25.2 \text{ \$}$$

where  $N_a$  is the annual depreciation rate, % is calculated by the formula:

$$N_a = \frac{1}{t_n} 100\% \tag{8}$$

$$N_a = \frac{1}{1000} 100\% = 10\%$$

where  $C_e$  is the cost of equipment, \$;  $t_n$  is the standard service life, year;  $F_a$  is the annual fund of equipment working time, hour.

The  $F_a$  parameter is determined by the formula:

$$F_a = ((365 - S_{at} - S_{un} - H_{ol}) \times 8 - H_{ol} \times 1) \times S \times (1 - a / 100) \tag{9}$$

$$F_a = ((365 - 102) \cdot 8 - 1 \cdot 1) \cdot 1 \cdot (1 - 3 / 100) = 2040$$

where 365 - the number of calendar days in a year;  $S_{at}$ ,  $S_{un}$ ,  $H_{ol} = 254$  days - the number of non-working days in a year: Saturdays, Sundays and holidays; 8 is the duration of the shift, h;  $S$  is the number of shifts of equipment operation per day;  $a$  is the percentage of time lost for equipment repair ( $a = 3-5\%$ ).

The cost of repairing equipment for the period of program creation is determined by the formula:

$$C_{rep} = \frac{C_o \cdot C_e \cdot t_n}{100 \cdot F_a} \tag{10}$$

$$C_{rep} = (4 \cdot 514 \cdot 1000) / (100 \cdot 2040) = 10 \$$$

where  $C_o = 4\%$  is the amount of funds allocated for the repair of computer equipment relative to the cost of this equipment;  $C_e = \$ 200000$  is the cost of the equipment.

Equipment operating costs are calculated using the formula:

$$P_e = C_e + A_o + C_{rep} + S_{sp} \tag{11}$$

$$P_e = 8.71 + 25.2 + 10 + 232 = 275.9 \$$$

where  $C_e$  is the cost of electricity, \$;  $A_o$  is the amount of depreciation during the development of the program, \$;  $C_{rep}$  is the cost of equipment repair, \$;  $S_{sp}$  is the salary of service personnel during the development of the program, \$.

The salary of the service personnel during the development of the program is calculated by the formula:

$$S_{sp} = S_{sps} + S_{spa} + O_{soc} \tag{12}$$

$$S_{sp} = 164 + 20 + 48 = 232 \$$$

where  $S_{sps} = \$ 164$  is the basic salary of the service personnel for the work performed, \$;  $S_{spa} = \$ 20$  is the additional salary of service personnel, \$ (10% of the main);  $O_{soc} = 48 \$$  is the social security contributions, \$ (26% of basic and additional wages).

The basic salary of service personnel during the development of the program is determined by the formula:

$$S_{bsp} = \frac{\sum S_{ac} \cdot t_m}{n \cdot F_a} \tag{13}$$

$$S_{bsp} = \frac{232 \cdot 12 \cdot 1000}{10 \cdot 2040} = 136.4 \$$$

where  $n$  is the number of serviced computers, pcs;  $S_{ac}$  is the annual salary of service personnel by categories of workers, \$.

The complexity of the program can be determined either by standards or by expert estimates, that is, on the basis of experimental statistical data of programmers who give pessimistic, optimistic assessments [24]. The expected duration of work is calculated using the formula:

$$T_{cp} = \frac{2T_{pes} + 3T_{opt}}{5} \tag{14}$$

$$C_{cp} = \frac{2 \cdot 352 + 3 \cdot 182}{5} = 250 \text{ days}$$

where  $C_{cp}$  is the used for the calculation of the complexity of the program  $t_p$ , days;  $T_{opt}$  and  $T_{pes}$  - respectively optimistic and pessimistic assessment of this program, days.

The expected duration of work at the design stage is summarized in Tab. 1.

**Table 1** Expected duration of work at the design stage of the program

Name of works	Duration of work / days		
	Minimum ( $T_{opt}$ )	Maximum ( $T_{pes}$ )	Expected
1 Development of technical specification	30	60	42
2 Analysis of technical specifications and data collection	40	70	52
3 A set of programs on a PC*	52	92	68
4 Debugging a program on a PC*	40	70	52
5 Performing experiments*	20	60	36

Note: the asterisk marks the work performed with the help of a computer.

As a result of the calculation, 250 days were spent on the development of the program, of which 125 days using a computer. Considering that the number of hours of work per day is equal to 8, 2000 hours were spent on the development of the program, of which 1000 hours were the time of work on a computer.

The data for calculating the cost of CAD TP will be summarized in Tab. 2.

**Table 2** Data for calculating the cost of the automated system "HT Control"

Indicator	The values
The complexity of creating a program / h	2000
Labor intensity of work on a PC / h	1000
Monthly salary of a technician-programmer / \$	308
Energy consumption / kW/h	0,3
Annual depreciation rate / %	10
Equipment cost / \$	308
Annual fund of equipment working time minus downtime in repair / h	2040

The data on the service personnel are shown in Tab. 3.



**Table 3** Service staff

Categories of workers (service personnel)	Number of employees, people	Salary of one specialist per month / \$	Annual salary / \$
PC maintenance engineer	1	231	2776
Total: basic salary of maintenance personnel for the year	1	231	5552

The total savings for the developed system can be calculated using the formula:

$$E_{tot} = E_{sw} + E_{sm} \tag{15}$$

where  $E_{tot}$  is the total savings, \$;  $E_{sw}$  is the saving wages, \$;  $E_{sm}$  is the saving materials, \$.

Tab. 4 shows a comparison of the duration of work solved manually and on a computer.

**Table 4** Work execution time

Indicator	Basic variant / h	New variant / h
Annual labor intensity of the operation for entering and correcting data $t_{cc}$	920	332
Annual labor intensity of the operation for the search and processing of data $t_{search}$	1944	420
Annual labor intensity of the operation for registration and output of data $t_{of}$	1360	400
Total	4224	1152

Savings on wages are calculated using the formula:

$$E_{sw} = \Delta T \cdot C_{1he} \tag{16}$$

where  $\Delta T$  is saving labor intensity, h;  $C_{1he}$  is the cost of 1 hour of the contractor's work, and is calculated by the formula:

$$C_{1he} = \frac{S_e \cdot \alpha}{22.8}$$

$$C_{1he} = \frac{231.6 \cdot 1.26}{22.8} = 1.65 \text{ \$}$$

$$(17)$$

where  $S_e$  is the executor's salary, \$;  $\alpha$  is a coefficient that takes into account social payments.

Saving labor intensity is calculated by:

$$\Delta T = T_b - T_n \tag{18}$$

$$\Delta T = 4224 - 1152 = 3072 \text{ h}$$

where  $T_b = 4224 \text{ h}$  - the annual labor intensity of solving the problem is the basic version;  $T_n = 1152 \text{ h}$  - annual labor intensity of solving the problem - a new option.

The savings on wages (with a monthly salary of a process engineer of \$ 231.6 will be:

$$S_w = 3072 \cdot 1.65 = 5085.7 \text{ \$}$$

Consumable savings represent paper savings in printing processes. At a cost of one sheet of \$ 0.012, the

savings on paper for 300 printed technological processes per year will be (at the cost of ten sheets of paper per one technological process) 3.85 \$. The total savings for the developed system will be:

$$S_c = 5085.7 + 3.85 = 5089.6 \text{ \$}$$

The results of the calculations are summarized in Tab. 5.

**Table 5** Summary table of the calculated indicators in this paragraph

Indicators	The values
Machine time used to solve problems by the consumer using the developed program / h	1152
Saving working time / h	3072
Total savings / \$	5089

Capital investments in the system are calculated using the formula:

$$K = \frac{T_{mb} \cdot K_k}{F_a} + C \tag{19}$$

$$K = \frac{1152 \cdot 308.4}{2040} + 2974 = 3148 \text{ \$}$$

where  $K$  - capital investments in the system, \$;  $K_k = 308.4 \text{ \$}$  is the capital investments in the computer for which this program is intended;  $F_a = 2040 \text{ h}$  is the useful annual fund of operating time of this computer, minus downtime in repair, hour / year;  $T_{mb} = 1152 \text{ machine-hour/year}$  is a machine time used by the consumer for the tasks that he solves using the system (Tab. 5);  $C = 2974 \text{ \$}$  is the cost of the used system.

The salary of the service personnel during the operation of the program is calculated according to the Eq. (13):

$$S_{bsp} = \frac{231.3 \cdot 12 \cdot 1152}{10 \cdot 2040} = 156.7 \text{ \$}$$

where  $n$  is the number of serviced computers, pcs.

The cost of repairing equipment is calculated using the Eq. (10) and is:

$$C_{rep} = \frac{4 \cdot 308.4 \cdot 1152}{100 \cdot 2040} = 6.96 \text{ \$}$$

The cost of electricity is calculated using the Eq. (6) and is:

$$C_e = 0.3 \cdot 1152 \cdot 0.029 = 10.03 \text{ \$}$$

The amount of depreciation in computing, calculated by the Eq. (7), is:

$$A_o = \frac{10 \cdot 308.4 \cdot 1152}{100\% \cdot 2040} = 17.42 \text{ \$}$$

Depreciation deductions from the program are calculated using the formula:

$$A_p = \frac{C}{T_c} \quad (20)$$

where  $A_p$  is the depreciation deductions from the program, tg.;  $T_c$  is the service life of this program,  $T_c = 5$  years.

$$A_p = \frac{5774}{5} = 1154.7 \text{ \$}$$

Operating costs are:

$$O_c = 414 + 7 + 3905 + 17 + 1155 = 5498 \text{ \$}$$

Automation of the workplace is carried out, so additional costs for the maintenance of buildings and premises are not required. Total costs including other costs (2% of all operating costs) will be:

$$C_t = 0.02 \cdot 5498 = 110 \text{ \$}$$

Let's calculate the economic efficiency of using the program. The calculation is carried out according to the formula:

$$S_f = S_c - C_t \quad (21)$$

where  $S_f$  is the actual savings, \$.

The actual savings will be:

$$S_f = 5089 - 110 = 4979 \text{ \$}$$

The criterion for the effectiveness of the creation and implementation of applied software products is the expected annual economic effect received by the consumer of the program. The annual economic effect is calculated using the formula:

$$E_a = S_f - E_n K \quad (22)$$

where  $S_f$  is the annual savings, \$/system;  $E_n = 0.25$  is the standard coefficient of economic efficiency.

Thus, the expected annual economic effect is:

$$E_a = 4979 - 0.25 \cdot 3148 = 4192 \text{ \$}$$

The payback period for capital costs for the development and implementation of an automated system [25] is determined by the formula:

$$P_p = \frac{K}{E_a} \quad (23)$$

where  $P_p$  is the payback period of the product, year.

The payback period is:

$$P_p = \frac{2888.52}{3938.1} = 0.73 \text{ year}$$

The estimated coefficient of economic efficiency of capital costs for the development and implementation of an automated system is calculated by the formula:

$$E_p = \frac{E_a}{K} \quad (24)$$

The summary of technical and economic indicators of the introduction of CAD TP is given in Tab. 6.

**Table 6** Consolidated technical and economic indicators of development

Indicator	The value
Average operating time of the system / h	1152
System cost / \$	2974
Capital investments / \$	3148
Annual operating costs / \$/year	1603
Expected annual economic effect / \$/year	4192
Economic efficiency ratio	1,36
Payback period / year	0,73

## 5 CONCLUSION

During the research, the software developed by the authors was tested and adapted for the economic feasibility of CAD development [26]. For these purposes, by joint agreement, the Tomsk Electrotechnical Plant Joint Stock Company (JSC) was selected. A feature of the organization of production of JSC "Tomsk Electrotechnical Plant" is the focus on the production of complex, science-intensive products of single and small-scale production. Along with the traditional nomenclature, the plant is actively developing new promising types of products that are in demand on the market. The variety of products produced has become the primary factor for adapting the developed software.

An assessment of the implementation for the developed CAD system was carried out. The assessment included: an assessment of the financial feasibility of the project; assessment of the profitability of the project implementation or participation in it from the point of view of the project participants, the state and society; identification of the boundary conditions for the effective implementation of the project; assessment of the risk associated with the implementation of the project and the sustainability of the project (preserving its profitability and financial feasibility) in case of random fluctuations in the market situation and other changes in the external conditions of implementation. Based on the analysis carried out under the conditions of the situation of JSC "Tomsk Electrotechnical Plant", it was found that it is very profitable to introduce the developed automated design system of technological processes into production, since the payback period at a discount rate of  $i = 10\%$ ,  $PP = 0.9$  years. The net present value  $NPV > 0$  indicates that the profitability of the implementation of this project in the period under review (5 years) is very high. From the point of view of the IRR, the project is justified. The profitability index at the discount rate  $i = 10\%$  is  $PI = 2.34$ , and the project is considered effective if  $PI > 1$ . According to the calculations of economic indicators, it follows that the developed software implemented by JSC "Tomsk Electrotechnical Plant" is quite effective and the risk is low.

From the indicators of the economic assessment of investments, it can be concluded that the introduction of a new software product "Automated device for the preparation of machine-building production" [27] is beneficial, as evidenced by the act of introducing this computer-aided design system in the conditions of JSC "Tomsk Electrotechnical Plant".

Based on the research conducted, the following conclusions can be drawn:

1. The duration of work during the technological preparation, solved by hand, is 3.5 times longer than when working on a computer.
2. The introduction of computer-aided design (CAD) of technological processes is effective ( $E_p = 1.36 > E_n = 0.25$ ) and will pay off within 0.73 years, while the annual economic effect will be 4192 \$.

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