Software Design for Integrated Computerized Management Systems

Adalat Muradov[1], Nazim Hajiyev[2,3], Safwan Al Salaimeh[4], Salim Istyaq[5]

[1] Prof. Dr. rector of Azerbaijan State University of Economics (UNEC)
[2] Associate prof., Dr., Department of Economics and Business management in UNEC Business School in Azerbaijan State University of Economics (UNEC), Baku, Republic of Azerbaijan, n.hajiyev@unec.edu.az
[3] Visiting Scholar, Davis Center for Russian and Eurasian Studies, Harvard University (01.11.2017- 31.08.2018), Boston, USA
[4] Prof. Software Engineering Department, Information Technology Faculty, Aqaba University of Technology, Aqaba, Jordan. Safwan670@yahoo.com, ssalaimeh@aut.edu.jo
[5] Computer Engineering, University Polytechnic, A.M.U. Aligarh, India, salimistyaq@gmail.com

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Abstract

Design software consists of design features of the software and design algorithmic support. In the algorithmic software includes algorithms for solving functional problems in integrated computerized management system ICMS. Design of software ICMS generally passes through a series of stages for most among which is:

1. Analysis of the object by mathematical methods and its assignment to a particular class;
2. Analysis of control problems and determining the type of task;
3. The mathematical formation of the problem (formulation of a mathematical model of the problems, election decision criteria and etc.);
4. Choice of the mathematical method of solving the problem;
5. Develop an algorithm for solving the problem;
6. Evaluation of the quality of the algorithm.

In this paper was developed models and methods which used in ICMS to solve economic problems, realizing the function of computerized enterprise management system.

Keywords*:* Mathematical model, Computerized system, Production process, Algorithm, System structure.

JEL Classification: C6, C8,

Introduction

Software- set of mathematical methods, and algorithms of information processing, which used in creating the integrated computerized control system (ICMS). Initial data for the design of ICMS software system is a list of functional task includes the task and function of computer aid design (CAD), computerized enterprise management system and etc. In this way, part of software of ICMS including mathematical methods, and means allows us to solve all given tasks. The structure of the software of ICMS shown in figure (1).

In the mathematical software of ICMS includes documentation, which used in designing set of methods, models, and algorithms, as well as personnel, production of tasks and algorithms to ICMS.

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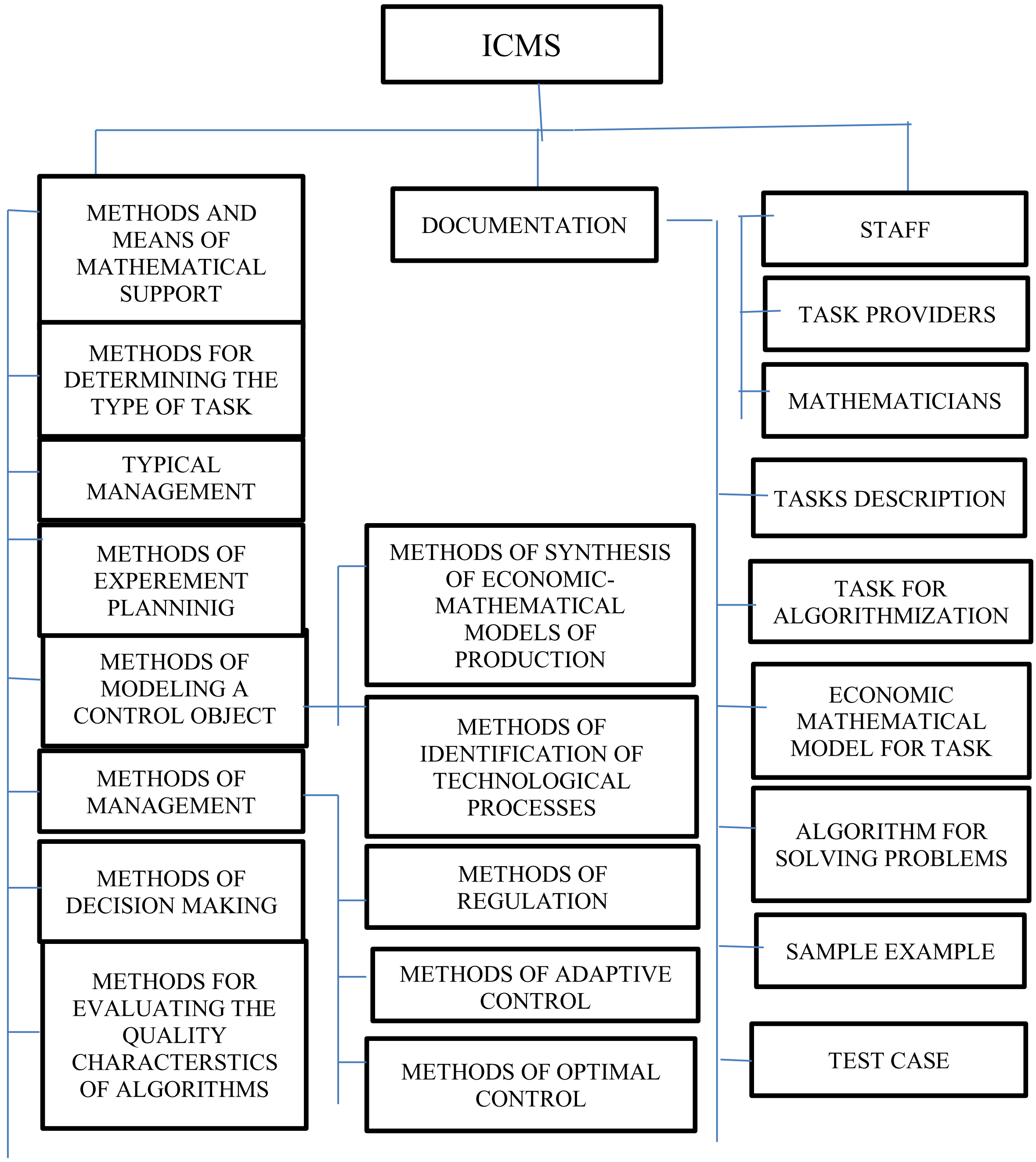

Figure (1) – Software structure of ICMS.

The Formulation of the Problem

The tasks of the computerized management system are understood as a part of the computerized functions of the computerized management system characterized by the outcomes and outputs in specific form.

Management function is: commutative action for computerized management system, aimed to achieve a criterion goal. Each task in computerized management system can be formulated at meaningful level but to solve it with the help of computational tools required mathematical description of the problem, i.e., formal presentation of its task Z may be defined as a set of raw data I and decision R:

$$Z \rightarrow \langle I, R \rangle \qquad (1)$$

Solution can be obtained by using method, which implemented in the form of the computation chart (algorithm A) or set of algorithms. Solution R can be obtained by the form:

$$R = M\,[I] \text{ or } R = A[I], \qquad (2)$$

Thus, formulation of the problem in computerized control system involves determining I, R, and selection of justification M. Description of the problem statement in computerized control system performed with accordance [Safwan Al Salaimeh (2003), Safwan Al Salaimeh (2003), Safwan Al Salaimeh, Zafer Makadmeh, Safwan Al Salaimeh, Khaled Batiha (2006)].

In the content of each task is: the purpose of the task, economic and mathematical model of the problem and method its solution, functional interconnectivity problems with information base of computerized control system and enterprise services, how to implement task for computer, reliable solution approximate of the efficiency objectives (expected performance, the cost of machine resources, cost of labor time and material resources for its development).
Content of the problem is included in documents (description of the problem statement) and description of the algorithms, who are working a document and design systems (Designers and programmers) and for employees of the enterprise management services.

Each document developed at the stage of technical design of ICMS and if necessary may be combined in one.

Realized of software and algorithmic support in ICMS is a software. A general description is made on the technical design stage and takes the form of a document (description of the software) of ICMS. A fully developed software is described in the detailed design stage and shall be in accordance with the requirements of the program document. The main section of the document (description of the problem statement):

1. Characterization of complex tasks;
2. Output information;
3. Input information.

In ICMS, engineering process is the main problem of mathematical models of technological process, are used to control the next tasks. Statement of the problem object control can be formulated follows:

Object is described input X; i.e. state of the environment, and output **γ,** i.e. state of the object

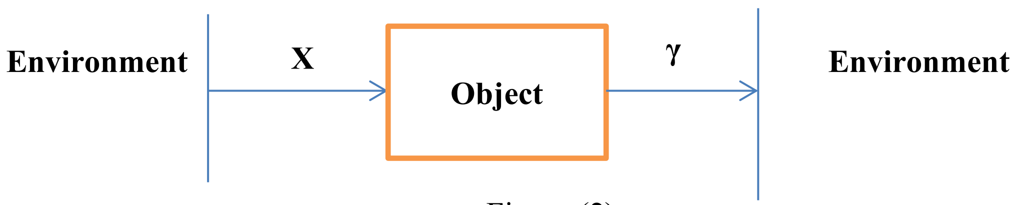

Figure (2)

State of the object γ depends on the environment X;

$\gamma = f^{o}(X)$;

where

f^{o} – characterizes the relationship between input and output object.

Source management purposes the system designer, which forms the purpose in accordance with their needs. If the state **γ** not satisfied with the developer recently formative influence on the object, i.e. implements management. If Z^{m} indicated the desired goal, then verify the objective Z^{m} the object can only be for the conditions γ. For this state y object should be expressed in the form Z= ψ (y). If Z= Z^{m} , you must create a control system, which is implemented to purpose Z^{m}.

For the implementation of control necessary to find the factors, they may be input object. If we denote management V, then state of an object depends on the X and V: $\boldsymbol{\gamma = f^{o}(X, V)}$**.** To formalize the description of their content management problem statement must identify input information I = <X, γ > and the desired result V: Z= Z^m. The next step after the formulation of the problem is the formulation of a mathematical models [Khaldoun Al Besoul, Safwan Al Salaimeh (2007), Safwan Al Salaimeh, Safwan Al Salaimeh, Amer Abu Zaher (2011)].

Economic and Mathematical Models and Their Construction

Economic and mathematical allows us to study the behavior of managed production facility under the control actions. Models differ in the degree of generality review of the manufacturing process, quantity and character analyzed factors. In each of the models generated local criteria, that is subject to the same criteria for the operations.

ICMS at the top level (long –term planning) enterprise considered as a single system without going into detail breakdown to subsystems functioning of subsystems of perspective planning subordinate to the global whole national economy. Model at this level essentially have a high degree and called production functions.

Mathematical products functions – this is algebraic relationship between performance and the factors of the production.

Production functions to determine the effective combination of resource. Expedient direction of their use within the constraints on resources and accepted performance criteria. Besides that, production functions used to predict the production of the company [Safwan Al Salaimeh, Amer Abu Zaher (2011), Safwan Al Salaimeh (2011), Safwan Al Salaimeh, Pushkarev A.N. (2011)].

At the level of technical and economic management uses balance models, which establish the balance between recourses and production plans. Mathematical balance model- this is system of linear control, combine various production factors, for example:- relationship between the number of products produced in consumed in another, the relationship between stored and sold products, between raw materials and energy.

The balance models are used to loading equipment; select the range of products, evaluation of productive assists, writing applications materials, forecast costs and profitability. The balance business model is specified as a production program. Production program describes a model of volume planning. Models associate the company's resources and the number of products, without revealing the release time, determining the overall performance of a certain time interval. These models differ from the model carrying the presence of criteria and restrictions.

These are a mathematical programming problem. At the next level of management are made agreement plans for all stages of the production process. This take into account the technological process, production cycle, adoption of performance planning system.

For economic and mathematical models of this level characterized by a large number of factors and limitations. For companies with serial and small- scale production, in which the duration of the production cycle considerable less scheduling period, exchange model used scheduling. For enterprise with unified character of production, on which the production cycle more planning period, used network models with limited recourses [Safwan Al Salaimeh, Zafer Makadmeh, Avramenko V. P. Shtangee S.V. (2012), Safwan Al Salaimeh, Mohammad Bani Younes (2014), Mohammad Bani Younes, Safwan Al Salaimeh (2015), Safwan al Salaimeh, Zeyad Al Saraireh, Jawad Hammad Al Rawashdeh (2015), Khaled Batiha, Safwan Al Salaimeh (2016)].

Final levels of management in the enterprise – operational management and regulation of production. Management process described by the models of scheduling (scheduling theory), that organize the work in time and models of operational control production flow. Depending on the nature of production can be deterministic or stochastic (probabilities).

Production functions – is the relationship between the system factors, which is not uniform in structure and the content and amount of expression does not give the characteristics of the production. However, you can get a high dependence, which links these factors.

In the simplest case the production function has form: Y = f(x). where y- dependent, x- independent factors. Increment the resulting factor

$\Delta y = \overline{f}(x)\Delta x$, if $\overline{f}(x) > 0$, then with growth x increase y, if $\overline{f}(x) < 0$, then return. This formulation used in solving problem of the form:

Find $max \sum_{j-1}^{m} \overline{f_j}(x)\Delta x_i$

Constraints: $\sum_{j=1}^{m} p_j \Delta x_i \leq c$, where p_j – price increment x_i , c – limit increase in recourses.

Production function takes into account the time factor, which is characteristics of dynamic models for static $\frac{dy}{dx_i}$ = const.

In most cases production functions is system static models; for their synthesis and analysis are accepted methods of mathematical statics, integral and differential calculus. Balance models using linearity and independent factors i.e. $f(\sum_i x_i) = \sum_i f(x_i)$;

Example of balance models are models binding qualified sources of resources and production capacity and loading equipment. They are given by a system of linear equation
$x_i - \sum_{j=1}^{m} a_{ij}x_j = y_i,\ i = \overline{1, n}\,.$ for example: inter branch balance can be described by this balance mode, here x_i – number of products, produced by branch; y_i – number of products reaching for domestic consumption; a_{ij} – number of products i-th branch; that goes for production in j-th branch; aij, x_j – the total number of products i-th branch.

This model is valid for many kinds of resources and production levels. Balance model can be transformed into a linear programming problem, for example- cost minimization for movement of goods from one branch to another. To solve these problems accepted theory of mathematical statics and linear algebra.
Model exchange plan formed as a optimization for example: the problem of formation of production program of the enterprise, known range of products $(i = \overline{I, n})$, the value of the party x_i; limit j-th recourse; A_j- profit per unit i-th product c_i.

Must maximize the total profits of the enterprise

$$\emptyset(x) = \sum_i c_i x_i \rightarrow max$$

under the constraints: resource $\sum_{i=1}^{n} T_i f x_i \leq B_f,\qquad f = \overline{I, F}$ on the technical and economic indicators $\sum_{i=1}^{n} C_{ip} X_i \geq Z_p$;

for the production of products $\underline{d_i} \leq x_i \leq \overline{d_\iota}$, where T_{if} – during operation time of equipment, f-th type, necessary for the production of one product i-th type, B_f – fund operating time of equipment f- th group; F- the number of groups of equipment; C_{if} –p-th technical and economic characteristics i-th type of products; Z_p – required level p-th of technical and economic indicators; $\underline{d_i}$ and $\overline{d_i}$ – number of products, determined in accordance with demand and the higher authority.

Mathematical apparatus synthesis models exchange planning is linear and integer programming. Exchange model used for an overall schedule planning, taking into account the load of each workplace impossible to implement of high – dimensional problems must be enlarged intermediate planning, which are designed to coordinate all services of the enterprise. Its purpose – distribution of the production program for the integrated planning period: quarter and month. In depending on the duration of the production cycle of two productions:

a) Formed by a linear programming problem must determine x_{it} –number of products i-th type, released into t-th month, under constraints: on the number of products by months $x_{it} \geq N_{it}$, $t = \overline{1,12}$ $i = \overline{I,n}$, bandwidth equipment $\sum_i T_{ij}.x_{it} < p_{jt}$, $t = \overline{1,2}$ $j = \overline{I,m}$, where N_{it} – minimum monthly volume of production output i-th type; T_{ij} – complexity of manufacturing i-th type of products into j-th type of the equipment's; P_{jt} – fund of working time j-th type of equipment into t-th month. As a creation can be act: uniform lo9ading equipment $Z_1 = \sum_{i=1}^{n} |T_t - \sum_{i=1}^{n} T_i x_{it}| \to min$, where T_t – the average complexity of manufacturing all products included to production program. t-th month, T_i –full complexity of manufacturing i-th type, deviation in value monthly production program from planned; at least the total number of files, produced in a month. Mathematical apparatus of the synthesis of such models is a mathematical programming.

b) Cycle of manufacturing products for more planning time, as a result of the solutions of sharing scheduling generalization of the areas assigned to certain discrete interval time. In this statement uses the following methods: network, calculation of timing the start of production in relation to output. Scheduling model used scheduling theory. An example of which model, is the model used for the Jonson problem: machined parts m, technical and technological route all the same parts (fig. 3)

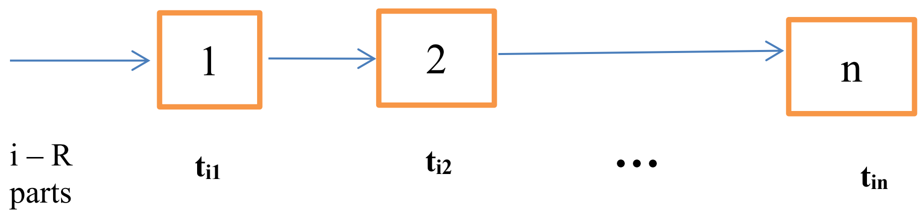

Figure (3) – route of parts

Restriction:

For each part processing on the j-m machine begins on earlier than it is over to (j-1)-m: $\underline{t}ij \geq t_{i,j-1}$, where t the beginning of operations, $\underline{t}$ – the end of operation; on each machine can process on piece; the beginner operation interrupted to completion $\overline{t_{ij}} = \underline{t_{ij}} + t_{ij}$ to describe the problem using brute force, although this inefficiently in the high dimensionality of the problem. Frequently used common task scheduling:

$i = \overline{1, n}$ - many parts which distinguish processing;

$s_i = \overline{1, m}$ – many equipment groups, si – i-th machining technology.

$J_i = \{J_{i1}, J_{i2}, \cdots, J_{ij}\}$ – sequence of groups of equipment, in which is processed kind of i-th parts, each types of parts many require different equipment or different sequence for its processing;
$j = \overline{1, k_i}$ –processing steps;

P_{ij}- the number of pieces of equipment $j - th$ groups, $J = \overline{1, m}$; $t_{ij} -$ duration of the operation J_{ij}, $t_{ij} > 0$; $s = \{J_{ij}\}$, $i = \overline{1, n}$, $j = \overline{1, maxk_i}$ - 3 matrix process, $T = \{t_{ij}\} -$ matrix duration.

Criteria problems:

$\tau = \min \max t_{ij}$, where τ – time completion of all work.

Restriction: on one piece is processed; reduction in the continuity and consistency of operations. For synthesis and analysis of these models used methods of discrete optimization.

Result

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