Simulation of difficult industrial systems in the form of the probable automatic machine

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Abstract
The complex spatial distributed multistage production systems by the nature are the discrete; they consist of a set of processing stages, aggregates and operations. They have distribution in space and difficult non-linear structure of communications on inputs, statuses and outputs. Simulation of these objects requires application of models with adequate structure. Generally production has some inputs, technology factors divided on processing stages or aggregates and outputs.
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The complex system is presented in the form of the final automatic machine. The set of all elementary symbols, possible for this automatic machine, from which information is formed, is called as the structural alphabet of this automatic machine, and final sequences of symbols of the alphabet vectors in this alphabet. The number a component of a vector is a dimension of a vector. Structural alphabets of entrances, states and exits of automatic machine are final. Definitely both entrance, and output knots of the automatic machine are described, and entrance and output signals are set by final sets of elementary symbols. Alphabets of entrances, states and exits can have a different dimension, and their components are represented (are coded) as follows:
$k=1,...,K$ – number of a stage of processing (unit), $a_{kl_k j_{l_k}}$ – component of alphabets of entrances, where $j_{l_k}=1,...,J_{l_k}$, where J_{l_k} – alphabet dimension l inputs on k unit, $l_k=1,...,L_k$ – number of an entrance (elements of raw materials, semi-finished products) on k-om the unit, – an alphabet dimension entrance l on k the unit – a component of alphabets of states (technology factors) for unit k-go, $j_{m_k}=1,...,J_{m_k}$, where J_{m_k} – a dimension of

the alphabet of m-go of technology factor on k-ohm the unit, $m_k = 1,...,M_k$ – numbers of factors on processing stage k.

C_{rj_r} – a component of alphabets of r of an exit, $j_r = 1,...,J_r$ – a dimension of the alphabet of p-go of an exit, $r = 1,...,R$ – number of an exit. Thus, final entrance alphabet:

$$V = \{a_{111},...,a_{11J_1}\} \times ... \times \{a_{1L_1 1},...,a_{1L_1 J_{L1}}\} \times ... \times \{a_{k11},...,a_{k1J_1}\} \times ...$$
$$... \times \{a_{kL_k 1},...,a_{kL_k J_{L_k}}\} = \{\sigma_{\alpha_k}, \alpha_k = 1,..., A_k;\ A_k = \prod_{i=1}^{L_k} J_i\},$$

where σ_α - option of combinations of alphabets of entrances $V[t]$, A_k – the maximum quantity of combinations of alphabets of entrances on k-om the unit.

Final internal alphabet (alphabet of technology factors)

$$X = \{b_{111},...,b_{11J_1}\} \times ... \times \{b_{1M_1 1},...,b_{1M_1 J_{M_1}}\} \times ... \times \{b_{k11},...,b_{k1J_1}\} \times ...$$
$$... \times \{b_{kM_k 1},...,b_{kM_k J_{Mk}}\} = \{\xi_{\beta k}, \beta_k = 1,...B; B = \prod_{i=1}^{M_k} J_i\},$$

ξ_{β_k} – option of a combination of alphabets on k-ohm the unit, K – number of units, m_k – number of factors on k-ohm the unit.

Option of a combination of alphabets on the l unit:

$$\xi_{\beta_1} = \{b_{111},...,b_{11J_1}\} \times ... \times \{b_{1M_1 1},...,b_{1M_1 J_1}\} = \{\xi_{\beta_1}, \beta_1 = 1,..., B_1; B_1 = \prod_{i=1}^{M_1} J_i\}$$

Option of a combination of alphabets on k-om the unit:

$$\xi_{\beta_k} = \{b_{k11},...,b_{k1J_1}\} \times ... \times \{b_{kM_k 1},...,b_{kM_k J_{M_k}}\} = \{\xi_{\beta_k}, \beta_k = 1,..., B_k; B_k = \prod_{i=1}^{M_k} J_i\}$$

Option of a combination of alphabets on the last unit:

$$\xi_{\beta_K} = \{b_{K11},...,b_{K1J_1}\} \times ... \times \{b_{KM_k 1},...,b_{KM_k J_{M_k}}\} =$$
$$= \{\xi_{\beta_K}, \beta_K = 1,..., B_K; B_K = \prod_{i=1}^{M_K} J_i\},$$

σ_α – option of a combination of alphabets $V[t]$ on all units:

$$\sigma_\alpha, \alpha = 1,..., A; A = \prod_{i=1}^{K} A_i$$

ξ_β – option of a combination of alphabets $x[t]$ on all units:

$$\xi_\beta, \beta = 1,..., B; B = \prod_{i=1}^{K} B_i$$

Final output alphabet:

$$Y = \{c_{11},...,c_{1J_1}\} \times ... \times \{c_{R1},...,c_{RJ_R}\} = \{\tau_\gamma, \gamma = 1,..., \Gamma; \Gamma = \prod_{i=1}^{R} J_i\}$$

τ_γ - option of a combination of alphabets of entrances $y[t]$.

Preliminary probe of the difficult spatial distributed production systems allows to analyse laws of distribution of random variables of technological processes and to define unconditional probabilities, which each of states $\xi_{\beta k}$ $(k = 1,..., K)$ meets in real production, and, therefore, it is usually used.

Realization of concrete technology doesn't provide strict obtaining final properties of a certain quality (doesn't allow to receive the only combination of alphabets of exits), it is necessary for each technological chain to describe the probabilistic machine gun. The description of functioning of the probabilistic final machine gun can be treated so that on any k of a stage of processing for each couple $\left(\xi_{\beta(k-1)}, \sigma_{\alpha(k)}\right)$ joint conditional distribution of probabilities of new states and exits is set. the internal alphabet (the alphabet of technological random variables) and the output alphabet terminating , we have couple of discrete random variables which has to be set by the joint law of distribution. The number of the analyzed distributions on each unit is equal to number of possible couples $\left(\xi_{\beta(k-1)}, \sigma_{\alpha(k)}\right)$

The law of joint distribution it is possible to present tables in the table1.

Table 1. Joint law of distribution of states and exits to processing stage k.

	P_γ	$P_{1_k}^{<\xi\beta(k-1),\sigma\alpha_k>}$	...	$P_{\gamma_k}^{<\xi\beta(k-1),\sigma\alpha_k>}$	...	$P_{\Gamma_k}^{<\xi\beta(k-1),\sigma\alpha_k>}$
P_β	y_k / x_k	τ_{1_k}	...	τ_{γ_k}	...	τ_{Γ_k}
$P_{1_k}^{<\xi\beta(k-1),\sigma\alpha_k>}$	ξ_{1k}	$P_{11(k)}^{<\xi\beta(k-1),\sigma\alpha_k>}$	...	$P_{1\gamma(k)}^{<\xi\beta(k-1),\sigma\alpha_k>}$	...	$P_{1\Gamma(k)}^{<\xi\beta(k-1),\sigma\alpha_k>}$
$\vdots$	$\vdots$					
$P_{\beta_k}^{<\xi\beta(k-1),\sigma\alpha_k>}$	$\xi_{\beta k}$	$P_{\beta 1(k)}^{<\xi\beta(k-1),\sigma\alpha_k>}$	...	$P_{\beta\gamma(k)}^{<\xi\beta(k-1),\sigma\alpha_k>}$	...	$P_{\beta\Gamma(k)}^{<\xi\beta(k-1),\sigma\alpha_k>}$
$\vdots$	$\vdots$					
$P_{B_k}^{<\xi\beta(k-1),\sigma\alpha_k>}$	ξ_{Bk}	$P_{B1(k)}^{<\xi\beta(k-1),\sigma\alpha_k>}$	...	$P_{B\gamma(k)}^{<\xi\beta(k-1),\sigma\alpha_k>}$	...	$P_{B\Gamma(k)}^{<\xi\beta(k-1),\sigma\alpha_k>}$

Thus requirements have to be fulfilled:

$$0 \le P_{\beta\gamma_{(k)}}^{<\xi_{\beta(k-1)},\sigma_{\alpha_k}>} \le 1$$

$$\sum_{\xi_{\beta k}\in X_k}\sum_{\tau_{\gamma_k}\in Y_k} P_{\beta\gamma_{(k)}}^{<\xi_{\beta(k-1)},\sigma_{\alpha_k}>} = 1$$

For states and exits the following ratios are right:

1. $P_{\beta_{(k)}}^{<\xi_{\beta(k-1)},\sigma_{\alpha_k}>} = \sum_{\tau_{\gamma_k}\in Y_k} P_{\beta\gamma_{(k)}}^{<\xi_{\beta(k-1)},\sigma_{\alpha_k}>}$

2. $0 \le P_{\beta_{(k)}}^{<\xi_{\beta(k-1)},\sigma_{\alpha_k}>} \le 1$

3. $\sum_{\xi_{\beta k}\in X_k} P_{\beta_{(k)}}^{<\xi_{\beta(k-1)},\sigma_{\alpha_k}>} = 1$

As a result information can be presented in table 2.

Table 2. The table of exits of the probabilistic final machine gun, describing the multistage spatial distributed system

$V_{11}...V_{1L_1}$	$V_{21}...V_{2L_2}$	...	$V_{(k+1)_1}..V_{(k+1)_{(k+1}}$	$x_{11}..x_{1M_1}$	...	$x_{k1}..x_{kM_k}$	$P_{1_{(k+1)}} \dots P_{\gamma_{(k+1)}} \dots P_{\Gamma_{(k+1)}}$
$\sigma_{1_{(1)}}$.	$\sigma_{1_{(2)}}$		$\sigma_{1_{(k+1)}}$.	$\xi_{1_{(1)}}$.		$\xi_{1_{(k)}}$.	$P_{\tau_{1_{(k+1)}}} \dots P_{\tau_{\gamma_{(k+1)}}} \dots P_{\tau_{\Gamma_{(k+1)}}}$
	.			.			

. . $\sigma_{A_{(1)}}$	. $\sigma_{A_{(2)}}$		. . $\sigma_{A_{(k+1)}}$	. $\xi_{B_{(1)}}$		. . $\xi_{B_{(k)}}$	$\langle P_{(c_{(k+1)_{11}},..,c_{(k+1)rk+1}1,...}$ $_{...,c_{(k+1)R_{(k+1)}}1)}$ … $P_{(c_{(k+1)j_{1(k+1)}},..,c_{(k+1)r_{k+1}jr_{k+1}}}$ $_{...,c_{(k+1)R_{k+1}JR_{k+1}})}$ … $P_{(c_{(k+1)1J_{1(k+1)}},..,c_{(k+1)r_{k+1}jr_{k+}}}$ $_{...,c_{(k+1)R_{k+1}JR_{k+1}})}$

Every line of the table 2. $\xi_{\beta_1},..,\xi_{\beta_\kappa},..,\xi_{\beta_K}$ represents separate realization of technology (a technological chain). Knowing distribution of probabilities of output properties, it is possible to allocate such combinations of alphabets of entrance sizes and states (technological parameters) which provide a maximum level of the demanded properties. For this purpose the combination of alphabets of the output sizes meeting the requirements of standards gets out. For example, after realization of technology of processing on k+1 units, there is a combination

$$\tau_\gamma^+ = c^*_{(k+1)1j_1} \ldots c^*_{(k+1)r_{(k+1)}j_{r_{k+1}}} \ldots c^*_{(k+1)R_{k+1}j_{R_{k+1}}}$$

It is necessary to pick up the technological chain (a set of combinations of alphabets of entrance sizes and states) providing the maximum probability of hit in τ_γ^+. For this purpose it is possible to use criteria of an assessment of efficiency of the modes of functioning of difficult systems. The technological chain having the maximum value of criterion of communication can be chosen as optimum technology. If the maximum value of criterion is reached at combination of several technological chains described in table 2, their combination can be used as optimum technological space.

Theorem 1

The probabilistic final automatic machine corresponding to the multistage spatial distributed system consisting of k of cages distinguishes any option of combinations of alphabets of entrances σ_{α_1}, if there is a way $\xi_{\beta_1},..,\xi_{\beta_\kappa},..,\xi_{\beta_K}$ from entrance combinations of alphabets entrances σ_{α_1}, in one of output combinations of alphabets τ_{γ_k}.

Proof

If the table of exits of the probabilistic final automatic machine contains option of combinations of alphabets entrances σ_{α_1}, for it there are one or several lines of the table containing combinations of alphabets of conditions of each cage of a chain $\xi_{\beta_1},..,\xi_{\beta_\kappa},..,\xi_{\beta_K}$ and frequencies of hits in combinations of output alphabets τ_{γ_k}. Therefore, the probabilistic final automatic machine distinguishes such option of combinations of alphabets of entrances σ_{α_1}.

Theorem 2

The probabilistic final automatic machine, distinguishes the multistage spatial distributed system consisting of *k* of cages if he distinguishes all final set of ways $\xi_{\beta_1},..,\xi_{\beta_\kappa},..,\xi_{\beta_K}$ from entrance combinations of alphabets of entrances σ_{α_1},in one of output combinations of alphabets τ_{γ_k}.

Proof

As alphabets of entrances and conditions of cages of a chain is terminating, the table of exits of the probabilistic final automatic machine terminating also contains all possible options of combinations of alphabets of entrances σ_{α_1} and alphabets of conditions of each cage of a chain $\xi_{\beta_1},..,\xi_{\beta_\kappa},..,\xi_{\beta_K}$, that is confirmed by table 2. Thus, all final set of combinations (ways) $\xi_{\beta_1},..,\xi_{\beta_\kappa},..,\xi_{\beta_K}$ from entrance combinations of alphabets of entrances σ_{α_1}, describing the multistage spatial distributed system, gets to one of output combinations of alphabets τ_{γ_k} . Therefore, the probabilistic final automatic machine, distinguishes the multistage spatial distributed system consisting of *k* of cages.

Conclusions

The analysis of functions of transitions and exits of probabilistic final automatic machines allows to choose optimum alphabets of the studied random variables and their dimension that allows to create final machine guns of separate stages of processing and to describe their functioning. Functioning or behavior of the final automatic machine is completely determined and is defined by its functions of transitions and exits. Function of transitions establishes dependence of current states of the automatic machine on the previous and entrance influences. Thus states (technological parameters) realized on the previous unit are considered as the previous. Function of exits reflects influence of entrance influences and technological parameters (conditions) for the weekend of the characteristic.

References

1. Korneev A.M., Abdullah L.S., Smetannikova T.A. Structural cell-hierarchical identification of complex spatially distributed production systems. Proceedings of the 3rd International Academic Conference. 2013, St. Louis, Missouri, USA. p. 75-79.
2. Korneev A.M., Lavrukhina T.V., Smetannikova T.A. Description of the technological process with a finite state machine. [Text]. Proceedings of the Workshop on Computer Science and Information Technogies CSIT'2013, Volume 1. – Vienna-Budapest-Bratislava, 2013. P.155–159.
3. Blyumin, S.L., Korneev A.M. Discrete modeling automation and control systems [Text]: Monograph; Lipetsk eco-Humanitarian Institute. Lipetsk, LEGI, 2005, p. 124
4. Korneev A.M., Ziyautdinov V.S., Zolotareva T.A., Smetannikova T.A. The description of a technology with using iterative networks. "Science, Technology and Higher Education" 2nd international scientific conference, Vol. II, Westwood, Canada, 2013, p.159 -163.
5. Abdullah Lutfi.S. Design Complex Production Systems and the determination. Questions of Education and Science in the XXI century: Sat. scientific. tr. by mat-lam Intern. scientific and practical. Conf. April 29, 2013 Mr. .: Part 1. Tambov, 2013. p. 6 - 9.
6. Korneev A.M., Abdullah L.S. (2013). AUTOMATED SYSTEM FOR THE DESIGN PROCESS AND THE GENERATION OF TECHNOLOGICAL INFORMATION. *International Scientific Journal, Theoretical & Applied Science.«Advances in techniques & technologies»*, Milan, Italy, No 10, p.p. 41-44.
7. Patel, V., J. Ashby, and J. Ma. 2002. Discrete event simulation in automotive Final Process System, Proceedings of the 2002 Winter Simulation Conference, ed. E. Yücesan, C.-H. Chen, J. L. Snowdon, and J. M. Charnes, p. p. 1030-1034, San Diego, California.