Logistic Approach of Building and Development of Production Systems

Logistički pristup građenju i razvoju sustava proizvodnje

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Summary

The paper presents a complex of information aimed at automated production systems structures and simulation. For production systems intergrated structures formation it uses logistic principles for making the internal material flow among various logistic nodes more precise and effective, including respective information flow, here e. g. with use of integrable and compatibile handling and technological systems, as well.

KEY WORDS

modular and multifunctional production system
structure formation
production logistic chain

Sažetak

Članak prezentira kompleksnu informaciju koja ima za cilj strukture automatiziranih proizvodnih sustava i simulaciju. Za integrirano oblikovanje proizvodnih sustava koristi logističke principe da bi učinila interni tijek među različitim logističkim čvorovima preciznijim i djelotvornijim uključujući pripadajući protok t.j. korištenje i integrabilnog i kompatibilnog rukovanja tehnoloških sustava

KLJUČNE RIJEČI

modularni i višefunkcionalni sustav proizvodnje
formiranje struktura
lanac logističke proizvodnje

1. INTRODUCTION

Recent trends aimed at development and using basic resources lead to looking for new and higher effects solutions. These are mostly connected with an effort to fully and intensively solve functions in the framework of machine ensemble, assembly and system, i.e. with extending mutually interconnected links leading to growth and transformation of construction moduls and machine systems integrated assemblies function. The creation of satisfying solutions is in accordance to industrial practice requirements to innovate strategic change and restructuralization of company systems with respect to market adaptability, manufacturing efficiency, competitiveness and provided services level growth.

2. STARTING POINTS OF PRODUCTION SYSTEM CONSTRUCTION AND DEVELOPMENT

Machine-controlled manufacturing systems have undergone considerably development and have been installed at many production places effectively running in various configurations and within a wide spectrum. However, after their evolutionary development, a sufficient and exact description of installed and designed systems defining realtions and boundaries inside systems and among them is missing so that their further development could be defined [1].

Problems with building of machine-controlled manufacturing systems have to answer several questions, especially a question of technical and working base and its integration, company preparation manufacturing level, competitive manufacturing position, development forecast, company culture, but neither they always answer to aptness of appropriate structure. In future, structures with a certain degree of flexibility, ranking, investment utilizability and reconfigurability. A manufacturing systems new types structures development thus requires answers to other questions supporting integrity, equivalency and synergy of functions and activity. They become determining factors for simple and unambiguous integrating into production-logistic chain Fig 1 [4,5], i.e. ability to create appropriate logistic infrastructure of information and material flow and thus make process-value chains more real also for purposes considerably different from an original intention [4,5].

3. SOLUTION LOGISTIC PRINCIPLES IMPORTANCE

To reach market production and all company adaptability and efficiency is not able without logistic principles applying and logistic solutions creating. Thus, particular production activities and its supporting components are more and more bound and dependent.

The importance of logistic is in integration of so far self-governing production functions (and often also production divisions) of technology, handling, transport and storage into

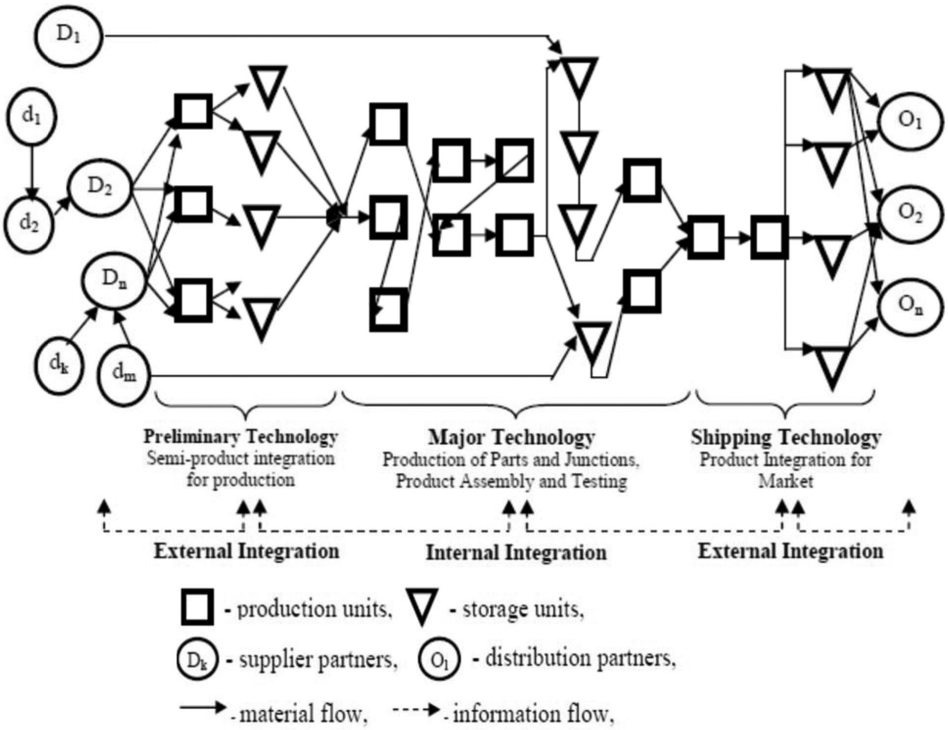

Figure 1 Production and logistic network

one orderly oriented system (internal integration) and then after linking the production company with its suppliers and distributions partners up to final customer into the integrated logistic chain (external integration) according to integrated material flow (Fig 1). Using of logistic, integration and integrated solutions for creating of production systems structures wants to specify and increase efficiency of internal material flow among various logistic junctions, incliding appropriate information flow in manufacturing centres [4]. Structure logistic production systems vitality and outlook have to be understood within wider interconnection of manufacturing functions by way of integrable and compatible handling and technology systems.

This trend conditions applying of progressive conceptions of manufacturing, transporting and storage systems. The way to these targets is introducing of logistic structures of machine-controlled production systems respecting variety of production objects and basic technology methods, mechanization and flexibility level as well as other indicators.

4. PRODUCTION SYSTEM PROFILING PRINCIPLES

From sources for machine-controlled technology processing, handling, controlling and from their linking elements, the controlled production systems are assembled. The least structural units, which are a base for particular production systems, are elements and units (construction moduls). These elements and units are linked by material and information links and can be grouped into more complex units (manufacturing section, department, plant). According to grouping of physical elements and units, their spatial arrangement and ways of material and information linking, the productions systems can be developed onto new and higher integrated level, i.e.:

- into fully valuable technology or manufacturing module and its extending (a production system basic model),
- into complex production system of a higher level (a complex production level).

A determining fact is that decisive activities of material and often of information flow are implemented through integrating devices of operational handling (handler, industrial robot) and transport (pushcart and conveyor systems) and they are differentiated according to a hierarchical level.

In case of the basic model of production system (VS) these things can be expressed as follows:

$$VS = \left\lfloor IM \xleftrightarrow{i,m} \left[\{T_a\}_{a=1,\ldots,o}, \{MU_e\}_{e=1,\ldots,p} \right] \right\rfloor \qquad (1)$$

where:

IM – integrating handling device (handel, industrial robot),

T_a – technological device (NC machine, CNC machine),

MU_e – handling junction (receiving and delivering device for objects, pallets),

a – number of technology device,

e – number of handling junction,

$\xleftrightarrow{i,m}$ – information and material communication.

Basic model

In (Fig 2) standard forms of the production system basic models have been defined [5]. They are formed by level of integrity of information and material links in the process of time, as e. g. technological modul ™, production modul (VM), production cell (VB).

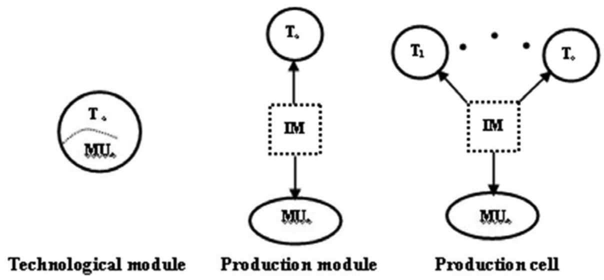

Figure 2 Forms of production system basic model

Complex model

To describe wider ties of information and material flow it is able only at solution of comples production systems integrated and grouped by means of linking of production systems and storage systems basic models by a central system of interoperational transport and central control system. The structure of the comples production system (KVS) can be expressed as:

$$KVS = \left[ID \xleftrightarrow{i,m} \left[\{VS_k\}_{k=1,\dots,t}, \{SU_l\}_{l=1,\dots,s} \right] \right] \quad (2)$$

where:

ID – integrating transport system (cart, conveyor),

VS_k – production system basic model (technolgical modul, production modul, production cell),

SU_l – storage junction (interoperational, central enter-exit storehouse),

k – production system number,

l – storage junction number.

Complex production systems (Fig 3) extend integration among production system basic models (technological and production module, production cell) so that they group them around transport system which links tangible moduls and cells with storage junction. The transport system carries out material flow in dependence of situation between the storage junction and technoloigical and production modules, production cells or between technoligcal and production modules and production cells mutually. Poly-bond combined integration of technology and technological professions in forms of serial, paralel, serial-paralel and reversible processes can be obtained.

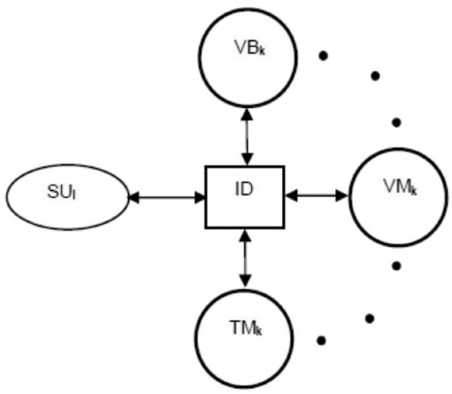

Figure 3 Complex production system

5. PRINCIPLES OF DEVELOPMENT

Compact models

Integrated solutions of production systems on the base of information and material bonds are substantial but not final. Contemporary technical practice requires new solutions representing concentration of functions and activities directly implemented into the integrating device. Thus, at production systems development it is necessary to take into the account also physical bonding of elements and units which is supported by already spread principles of modularity, compatibility and integrity of technical means and means of realizaton. The results are solutions oriented at compact integrated models developing (fig 4), both on the level of production module or of production cell.

In case of the production module, the starting point is the most often used configuration which is defined by a symbolic model (Fig 4 – case I1). General trend focused at production concentration, combination of several methods and on increase of output parametres leads to the fact that new conceptions of production technique arranged on the base of serial or paralel superstructures enabling to manage integration of technological and handling activities (Fig 4 – case I6) till to the form of production-handling system are used more and more. (Fig 4 – Case 16). The effort to catenate all activities completely not only on the base of production system basic model but also of complex production system leads to application of production-transport systems (Fig 4 – Case I4, I5), whose main task is improvement of compatibility and catenation of individual levels of material flow in production systems with indirect bond or extending of integration at production systems with direct bond [4]. These solutions help create strategy of production company with respect of equivalency and synergy [2] which is generated among individual system functions and parametres and which is invaluable at modification of production system.

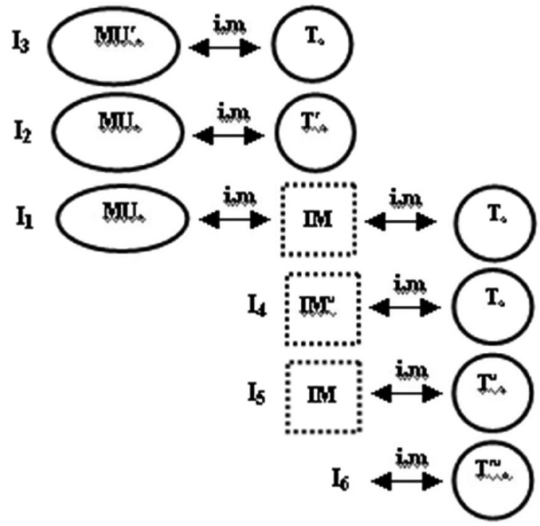

Figure 4 Production module compact integrated models

where:

MU^r_e, IM^u, T^r_a, T^u_a, T^{ru}_a – production module elements and units mutually integrating functions,

r, u, ru – indicator expressing integration (substitution) of functions (r – handling device

u – handling junction),

a = 1,...,o – technological device number,

e = 1,...,p – handling junction number.

Logistic chains

Principles of integration from operational and interoperational level of material flow can be applied also at a central level (Fig 5), but they are also a significant contribution at material flow solutions in framework of complete production-logistic chain. The center of a problem is the fact that integrating device (handling device – IM, transport system – ID) is in one of these forms: as an individual unit, a unit linked to a technoligical device (T), to a production model (TM, VM, VB), to a storage junction (SU) or as an integral part of these devices. No default configurations of production systems which contribute to considerable variability of type models structures and which are conditions for new and higher technical-economical effect, from these forms are derived. Actually, these solutions are presented as logictic and they are understood at wider links of information and material flows in pre-production, production and post-production processes.

Production system logistic structure (LVS) integrating material flow within production-logictic chain can be expressed by relations which respond to levels of production system basic model:

- production-handling

$$LVS = \left[ID_v \xleftrightarrow{i,m,f} \left[\left\{ T^{ru}{}_a \right\}_{a=1,\dots,o}, \left\{ SU_l \right\}_{l=1,\dots,s} \right] \right] \quad (3)$$

- production-transfer

$$LVS = \left[ID^r{}_v \xleftrightarrow{i,m,f} \left[\left\{ T^u{}_a \right\}_{a=1,\dots,o}, \left\{ SU_l \right\}_{l=1,\dots,s} \right] \right]$$
$$LVS = \left[ID^u{}_v \xleftrightarrow{i,m,f} \left[\left\{ T^r{}_a \right\}_{a=1,\dots,o}, \left\{ SU_l \right\}_{l=1,\dots,s} \right] \right] \quad (4)$$
$$LVS = \left[ID^{ru}{}_v \xleftrightarrow{i,m,f} \left[\left\{ T_a \right\}_{a=1,\dots,o}, \left\{ SU_l \right\}_{l=1,\dots,s} \right] \right]$$

where:
ID_v – compactibile transport system,
$ID^r{}_v$, $ID^u{}_v$, $ID^{ru}{}_v$ – compact models of compatibile shipping-handling system.
$T^r{}_a$, $T^u{}_a$, $T^{ru}{}_a$ – compact integrated models of production module mutually integrating functions,
SU_l – storage junction (interoperational, centra, enter-exit storehouse),
r, u, ru – indicator expressing integration of functions (r-handling device, u – handling junction),
a = 1,....o – production lodule number,
l – storage junction number ,
$\xleftrightarrow{i,m,f}$ - symbolical expression of information, material and physical communication.
where:
MU,IM, T, SU,ID,TM, VM,VB- building moduls and production system basic models
* - information and material feedback,
\+ - physical feedback,
U_1 – input-output storehouse ,
U_2, ...,U_n – production/assembling cells,
u_{ij} – technological/storage areas.

The defined integration principles (information, material, physical) provide information on ability and extend to integrate

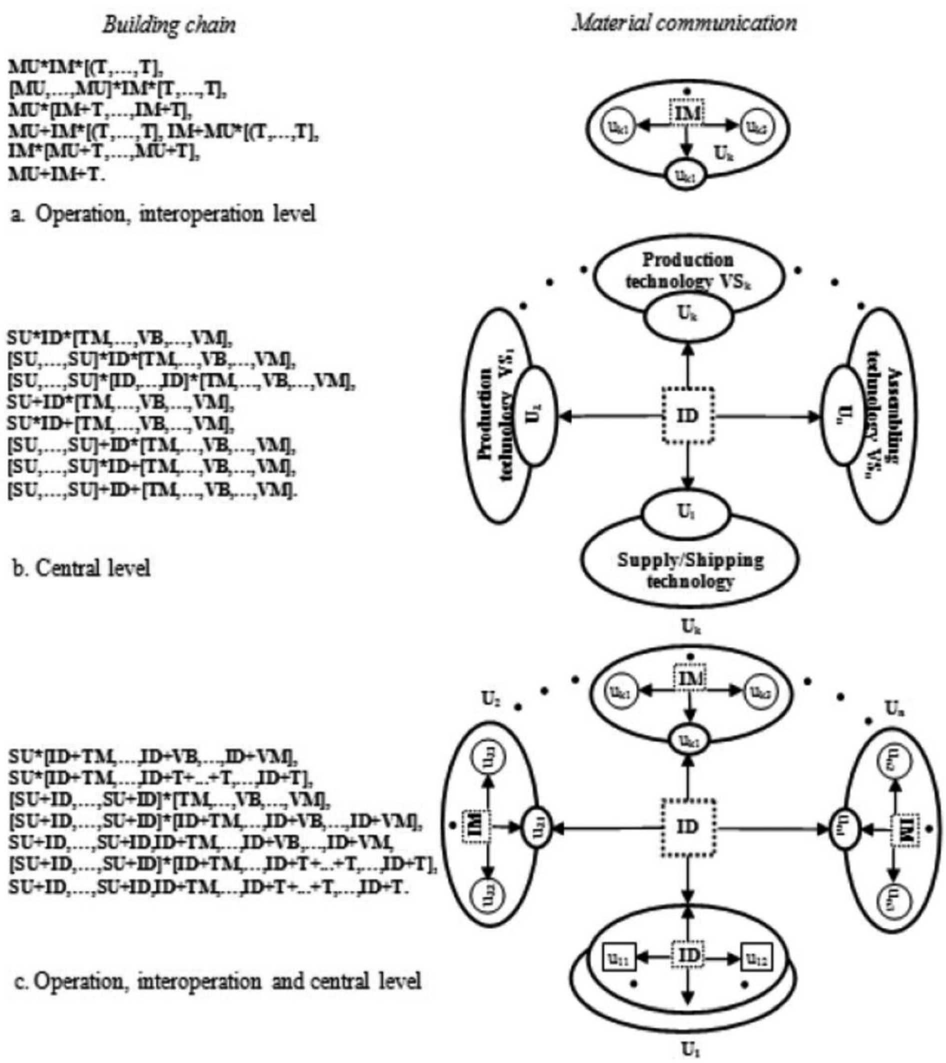

Figure 5 Production system logistic chains

(merge, substitute) technological and handling operations at production system. The integration can also say about reserves in functional (equivalency, system coherence and flexibility), substantial (system elements, modules and sets) and structural (system bonds, composition and stability) component of production system. It can be used not only for optimalization of functional regimes and activities but also for restructulization or design of new production structures and relating problems of controlling, production tasks planning, placement of disposal, and material and information links. [4]

Bringing integrated chains of a production company into reality by logistic structures from now on requires to complete basic levels of knowledge, methods, technique and tools from area of modules of technological and handling technology including its forming into complex production systems.

6. CONCLUSION

Machine-controlled production systems logistic structures creating requires a systematical analysis of function and activity of used technical means, trends, their applications in productions and implementing into logistic chain, so that they would be flexible and efficient also at unstable external relations. To fillful this goal means to be able to construct integrated relations within production. The starting point of this is also gradual construction of production structures beginning with the basic model through the complex model and with production system logistic model in the end.

It is important to point out that production systems module configurations are currently considered to be standard already at various kinds of technology (welding, heat processing, inspection, testing and palletization) and they are supported by companies oriented at profits from contemporary logistic technologies as JIT, TQM, group technology, handling groups creating, computerized integrated technolgies at production and circulation.

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