

PRODUCTION SYSTEM ANALYSIS IN THE CONDITION OF FLEXIBLE ASSEMBLY CELL

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Abstract: Article deals with various definitions of production systems. Taking into account fact of high diversity of production systems, any definition of the term production system could be understood as unique. From the view point of theory of systems, each system could be defined as an autonomous configuration of mutually interacting units. Production system consists of subsystems, which transforms inputs to outputs by adding a certain value. At present high requirement are posed on production systems, as for example on high flexibility – capability of production system to produce and assemble current as well as future spectra of products in random order and volume.

Keywords: SYSTEM, PRODUCTION SYSTEM, MANUFACTURING CELL, FLEXIBLE ASSEMBLY CELL

1. Introduction

Present days require automation in most of human activities for reasons of simplification of human labor, quality improvement or business viewpoint.

System, as understood in the frame of system engineering, is defined as a set of various elements producing together given results unachievable by elements separately. These elements could be for example humans, hardware, software, tools, devices, documentation and others. Elements, if performing tasks together, produce results on system basis such as quality, properties, characteristics, functions, behavior, performance and others. Added value created by the system mainly consists of developed relationships among single elements.

1.1 Production system

The role of the production system is rationalizing the performance of specified technological process so that half product is transformed into final product with geometry defined by technical drawing and fulfilling qualitative requirements imposed by technical conditions (Fig.1).

According to various authors, system is defined as finite configuration of mutually operating elements. These elements might be objects or methods of thinking and their results (for example: organization scheme, mathematical methods, programming languages and others). Such configuration of elements is separated from surrounding environment by fictive (assumed) surrounding surface. Through this surface links with surrounding environment are passing. The coupling of transferred properties and states yields parameters which mutual relationship describes own relations of the system.[1]

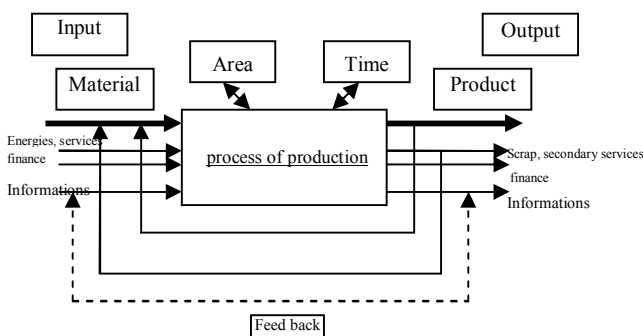


Fig.1 Scheme of production process

Considering different possibilities of surrounding surface definition, term production system may represent elements such as single

device, group of devices or entire company including design and assembly lines.

Production system is therefore organism with production process init. Using other words, it represents sequence of technological and non-technological operations representing relatively closed production cycle.

1.2 Definition of production systems

According to production type:

- phase production (small-scale production) – production process is organized according to technological similarity of production machines, material flow is in batches, general purpose accessory of a work-place, production times are long and assortment is changeable
- group production (small and medium scale production) – regularly repeating production, irregularly repeating production
- flowing production – 1 or more products, layout of workshops corresponds with sequence of technological operations, products having strictly reserved workshops, time between workshops is minimized

According to utilized automation:

- inflexible – building such production system does not take into account frequent change of production program over an entire lifetime. Field of application is mainly for mass production. Machines, transportation and manipulation devices have special purpose design
- flexible – building of such systems takes into account with frequent or repeating change of production program over a period of production system life-time. This is typical predominately for field of single and small scale production. Machines, transfer and manipulation devices have multipurpose design

According to type of products:

- Single object
- Multiobject

According to time bonding:

- Synchronized – operation times are same
- Nonsynchronized – operation times are different

1.3 Elements of production system:

Subsystem of manufacturing and assembly

Subsystem of material flow

Subsystem of information flow

Servise and maintainance

Personnel

Table 1: Elements of manufacturing systems

Subsystem	Function	Objects	Main components
Manufacturing and assembly	Material working, assembly of components of the final product and gradual increase of its value	Products	Manufacturing facilities -machines -tools -allowance -measuring gauges -cutting fluids
Material flow	Transfer, manipulation and product storage	Products, tools, measuring and control devices, secondary facilities	Transferring devices -carts -cranes -manipulators Secondary facilities -palette -storages -jaws
Information flow	Storage, sorting, transfer and processing of information	Specification and information	Hardware -computers -terminals Software -operation systems -application -computer programs

2. Results and discussion

Cell manufacturing have become in last years one of the most important studies of production layouts. These studies comprise various methods based on searching relationship between product and cell, which guarantees production of various products with small number in batch. Cell structures achieve cohesion among machines save time and space. Machine activities are synchronized, material flow is fast (product transfer from one to another machine is on short distance). Assembly cells connects and applies lot of advantages of other types of production.

2.1 Flexible assembly cell

Manufacturing cell FMC is manufacturing system, built by grouping of several NC machines, assembly devices dedicated for certain group of products with similar sequence of operations or certain type of operations. Characteristic feature of a cell is mutual material and information interconnection among machines. Common manipulation devices are used for manipulation between operations.

FMC is one of four types of flexible manufacturing systems, which were defined by B. Maccarthy and J. Liu. This could be characterized as integrated, maccuter controlled complex composed of NC machines and devices for automatic manipulation, dedicated to production in small and medium batches.

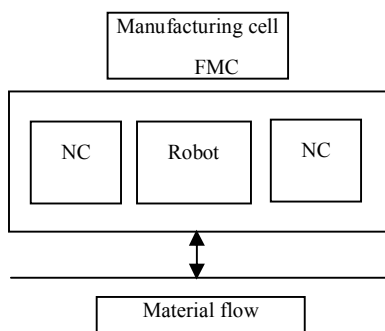


Fig. 2 Scheme of FMC configuration

In case of cell, it is important to mention term “flexibility”. It is term, which is repeatedly topic of a number of discussions, and publications. Growth of importance of flexibility appeared due to enter of IT into production with aim to shorten the production times, improve response on changing conditions, customizing production. Flexibility becomes a key property of current and future production. This property differentiates production system from traditional production. Reality is that current manufacturing could not be described as flexible. In fact every manufacturing has certain level of flexibility. Therefore, views of flexibility does not exclude completely traditional production, although predominately refers to manufacturing systems.

2.2 Analysis of flexible assembly cell

Flexible assembly cell is placed at the department of assembly devices and systems (Fig.3). Flexible assembly cell is composed from following subsystems.

- Industrial robot with Cartesian kinematics
- Shelf storage system



Fig.3 Flexible assembly cell

Five working phases are integrated in the flexible assembly cell:

- storage (storage of semi products, final products before its expedition)
- transport and manipulation (transport and manipulation with half products and final products)
- manufacture (manufacturing of single half products to the final product)
- assembly (assembly of single parts in to the one final product)
- expedition

2.3 Shelf storage system

One of the main parts of the assembly system is shelf storage systems. This storage has many functions in the assembly cell (Fig.4).

Some of them are:

- half product storage,
- final product storage just before its shipping,
- manipulation with half products and also its transport,
- manipulation with final parts and its transport back to the storage.



Fig.4 .Shelf storage system

2.4 Industrial robot with Cartesian kinematics

Important part of the assembly cell is robot created from three axes, which are represented by three electrical power drives. Whole robot works in the Cartesian workplace (Fig.5).

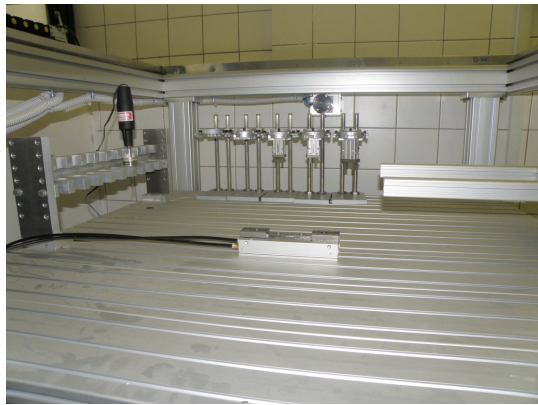


Fig.5 Workplace of Cartesian robot

There are many elements, which are located at the workplace of the robot.

- special tool position used for automated tool changing system,
- rotary transport device,
- pneumatic fixture,
- grippers storage ,
- AHC unit,
- tools storage.

Following the conclusions and knowledge, which are coming from intelligent systems studies, special added sensor units for each device were designed in the flexible assembly cell. That means, that every device possesses its own sensor units capable of processing primer information. Such information ensures communication between single devices and control system. Before single sensor units specification, there was needed to specify requirements on designed intelligent manufacturing and assembly cell. Main requirements used for intelligent manufacturing and assembly cell design were following.

3. Conclusion

Designed intelligent cell is able to react on various situations immersing during the assembly process. Such as:

- reaction on the change of shape of manufactured or assembled part,
- reaction on the change of part dimensions,
- reaction on the usage or not usage of single, subsystems by assembly parts,
- reaction on the part types change,
- reaction on the change of technological parameters,
- assurance in case of collision situations in the cell,
- low manufacturing costs.

During the design of the intelligent assembly cell, there was very important to conserve two basic subsystems: transporting and assembling one. Designed intelligent assembly cell also saves five manufacturing phase: **storage, transport and manipulation, manufacture, assembly and expedition.**

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