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Special Aspects of Modern Production Systems Organization

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Abstract: We conducted analysis of content and key elements of the production systems of Toyota, Ford and "GAZ Group" companies. It was determined, that general principles of the production system buildup and its philosophy are established at this stage of development. However, when replicating the experience of the industry leaders, the system in its pure form cannot be "transferred" to another economic environment. Therefore, in the context of domestic practice, the experience in building up production systems requires further development and adaptation to the existing environment.

Key words: Complex systems, production system, flexible production, systems for creating a high-tech product, reference areas

INTRODUCTION

In the modern economic paradigm of Russia, starting from 1990, efforts for development of integrated adaptive production systems (Kuznetsov *et al*., 2015) and technologies for mastering new products, in replicating and projecting the best international practices in this field in development of industrial production flexibility and its operational capabilities that best suited for adaptation to the changing demands of market agents (Gupta and Krishnan, 1999) play the dominant role in production management. At the same time, the results of European experience replication by domestic enterprises in the last decade have shown that research and development of foreign scholars on issues of economics and management cannot be transferred to domestic conditions in their pure form due to a variety of differences in economic and social systems. Development of large industrial complexes as business systems on the whole represented by a set of elements-lower level subsystems interconnected in organizational, economical and technological aspects, in particular, production systems and systems for product development is also impossible without an effective system of regulation and working out of the issue with the use of scientific basis for production and technological management (Liberatore and Stylianou, 1995). Solution of the designated tasks determines the relevance, both in theoretical and practical terms. The study in question deserves attention in several aspects: systematization of problems and determination of development trends of the systems for creation of a high-tech product by domestic industrial enterprises through the development of production systems.

MATERIALS AND METHODS

Theory: Various interpretations of the concept "production system" are suggested: a set of tangible objects, group of people, industrial, scientific and technical, information processes intended to release final products and to ensure an efficient implementation of the production process (Noda and Bower, 1996). Business system, the management model of which is determined by the type of production, equipment used, materials, technology, component parts supply chain, etc. (Pahl and Beitz, 1996). Philosophy of the company which is physically implemented as a set of elements: process equipment, intangible assets, information and power subsystems. The company philosophy implementation results in transformation of raw materials (subject of labor) to the finished product; production potential of the company, nominal capacity of which can be measured by machine hours, production output, rate of quality products production (Oswaldo and Borges, 2010). Researchers' conclusions are as follows: production systems of the industry enterprises have a certain set of "top-level" functions for control over the implementation of production processes; business systems with

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discrete-continuous production process require a well-organized components/modules supply chain. efficient operation of the production system requires a preliminary implementation of the Kanban system which is a matter of some difficulty due to the fact that assembly facility and components suppliers have different levels of this system. Henry Ford and Taiichi Ohno are considered to be the creators and establishers of the production systems in automobile manufacture. The basis of a new method of production and labor organization developed by Ford was an assembly conveyor. The production system is based on the mass production workflow system, standardization and unification of component parts (Porter, 2008). The idea is to extend the concept of production flow from the main assembly line to all other processes, from mechanical processing to stamping. Adjusting the flow connecting not only the main assembly line but also all other processes, reduced total production time.

Let's consider the production system of the company "Toyota" which is focused on the complete elimination of losses and production of small series. The basic principles of this production system are: "just-in-time" which means that during production process the parts necessary for assembly are available on the production line at the right time and in the right quantities.

Autonomation or automation with application of artificial intelligence. Most of the equipment at all plants of the company, both new and old one is equipped with such devices as well as various safety devices, maintenance fixtures for quick changeover. Machines are given the element of the human mind. Autonomation changes the nature of machine operation. Thus, the number of operators is reduced and production efficiency is increased. "balanced production". Uniform distribution of operations between production areas allows optimal process utilization and maximum reduction of operating time for each cycle.

RESULTS AND DISCUSSION

When studying Ford and Toyota production systems, it should be concluded that each of them reflects the philosophy of business management and individuality of people managing the enterprise; that the system is adaptive to internal and external environment of the particular production with certain conditions and sufficiency of resources supply as well as certain balance of the processes of all system participants. For this reason, the system in its pure form cannot be "transferred" to another economic environment. Therefore, in the context of domestic practice, the experience of the industry leaders in building production systems requires further development and adaptation to the existing environment. Production system of domestic engineering companies was formed by combining elements of the production systems of Ford, Toyota and their own experience. For example, the main tool for its implementation at the enterprises of GAZ Group was the activity in the field of Toyota Production System. Production system of domestic industrial enterprise is shown as a pyramid (Fig. 1).

At the initial stage of building the production system of domestic enterprises, standardized work was the main tool for increasing production efficiency, that is a set of measures has been implemented to reduce the cycle time for all operations of the process (Dassisti, 2010) initial timing of operations was conducted; problems were identified; the basics of "kaizen" were introduced; the results of problems solution were evaluated; re-timing of operations was conducted. As a result some operations were excluded from the production chain and as a consequence cycle time was reduced.

Practical solution of operational capabilities of the domestic company production system has been realized with the use of the following tools. Kaizen-culture of improvements, continuous improvements in small steps, in which each process is evaluated and improved in terms of such indicators as time required, resources used, quality of finished products.

Kanban philosophy of continuous improvement implemented in the form of development of "pull system for delivery of parts and components to conveyor." In this case, defective parts must not go beyond the zone of origin; the number of produced parts should be equal to the number of parts required by downstream users, etc., system 5 S-lean manufacturing tools.

SMED method changeover of process equipment for switching between production of two different types of parts in the shortest possible time. Why-a tool for identification of the problem root cause. To find out what is the objective cause of the problem we should consistently ask questions "why", until the root cause is found (Persi, 2008).

The first priority in creating a corporate production system is standardization of the operations performed, which is implemented through the use of the system 5S and the Kaizen philosophy. The overall cycle of standardized operation of the enterprise is shown in Fig. 2.

Let's consider the operation "hood lock attachment" on the vehicle "Gazel-Business" for analysis of operation execution at the production site. For ease of measurement the operation was divided into individual actions and the

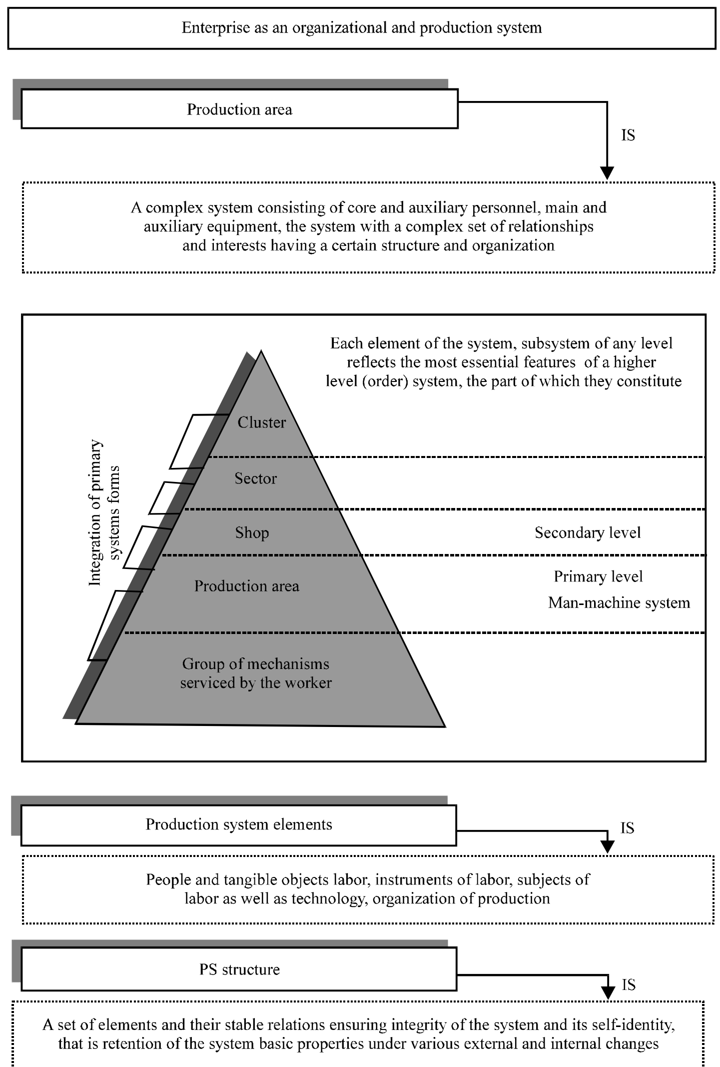

Fig. 1: Enterprise as an organizational and production system

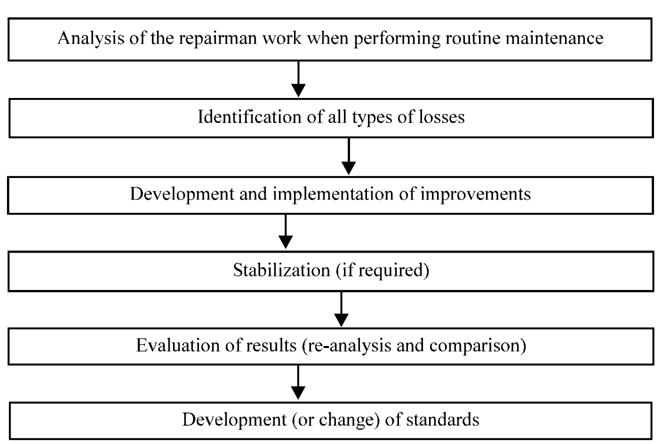

Fig. 2: Cycle of standardized operations of domestic enterprises

Table 1: Dynamics of reference site performance

Indicators	2005	2009	2013
Conveyor stroke (sec)	245.0	155	124.0
Number of cabins assembled per shift (pcs)	98.0	145	204.0
First pass yield (%)	1.5	81	91.1
Number of conveyors per area	3.0	2	2.0
Number of workers per area (persons)	258.0	196	184.0
Average wage (rubles)	6333.0	11180	18876.0
WIP volume at the workplaces (h)	8.0	2	0.6

duration was measured using the chronometer. As a result of measurement, it was determined that the main steps are performed within 1-4 seconds with slight fluctuations. This indicates the stability of the operation execution by the worker. The unnecessary movements in the shop for collection of new parts were also eliminated. The workflow of operations at this level of production organization was as follows: take the hood lock, approach the cabin, take the mascot of the vehicle, go to the cabin; install the hood lock, install the mascot; return to the workplace.

The cycle duration is also affected by the imperfection of fixing of welded nuts on the cabin which showed an increase in the time of execution of actions by the worker in a number of measurements. Kaizen proposal was considered to optimize this cycle such as: tool pallet for 9 sets for a hood lock and a mascot was created. This proposal results in reduction of unnecessary movements of the worker along the production site. Penalty points system has been proposed to maintain optimized processes, it allowed this defect to be removed in the subsequent work. Proposed changes to the organization of production allowed for decrease of the operation duration which provided the reduction of time for execution of the operation. Economic indicators in terms of production output and respectively in terms of wages increased which further encouraged the worker to quality performance of work.

When building the production system by domestic companies using the Kanban system, first of all the operation of conveyor was organized starting from area development for warehouses of expeditions. The Kanban system allowed for arrangement of expeditions in close proximity to the conveyor, near the areas, where the installation on the vehicle is performed. It resulted in feeding as much parts as required for 2 h of work to the working area. As a result, the problems of misgrading of stock items, delivery of parts to work positions, saving of time resource were solved. The Kanban system was started to be applied when working with suppliers. The result was a 30% reduction in transport costs and optimization of warehouse stock from four days supply level to two days supply level. Furthermore, the introduction of effective methods of motivating suppliers to develop and implement measures aimed at preventing defects allowed the reduction of reclamations for the main bought-in components.

"Jidoka" a tool for prevention of problems, implemented in the production system of the company in the following way: each operator controls the operation performance quality at his workplace and is responsible for it. This reduces the number of defective parts at the level of workplace and consequently, quality control costs; the possibility of passing the defective product to the consumer is eliminated.

Another, tool of the production system of the domestic company started to be applied was SMED method which resulted in reduced stock, partial elimination of the need for setup time and errors occurring during setup, increase of equipment utilization rate. The result of this method was increased production flexibility. A plan of phased project promotion has been developed for effective implementation of the production system in the practice of the company. In particular, the idea of reference production areas for the assembly of "Gazel" dropside trucks cabins was implemented with the following main objectives effective workplace arrangement, reducing of production stock level and optimization of material flows. The main objectives included creation of 2 h in-process stock of materials and their supply to the conveyor through the Kanban system, elimination of the activities that do not bring added value. Initial project specifications were: assembly of 186 cabins per day.

Production stock at the workplaces was build up for 4-7 days. Implementation of the project resulted in almost 2 times increase of labour efficiency; output of cabins increased up to 408 per day, first pass yield of which amounted to 91.1%; stock at the workplaces reduced to 2 h level. Furthermore, the number of conveyors reduced after optimization. Dynamics of reference site performance is shown in Table 1.

The success of reference areas has proved the efficiency of the production system developed by the company, so at the next step it was decided to establish reference areas in all subdivisions. At that time, 53 reference areas were established in the company, work groups for quality control and process optimization were functioning. These groups are currently working at production costs reduction.

CONCLUSION

Summarizing the results, it should be noted that in today's economy the increase in the efficiency of material production by achieving the goal of creating a product meeting the highest customer needs with minimal costs is possible through production process organization. According to the experience of the leading engineering companies, the desired effect can be brought only by retrofitting and upgrading of production, supported by the production system improvement and changes in corporate philosophy. It is important to develop a business system of all others through personalization of production, increase of production flexibility by concurrent design of products and processes; gradually move to the integral use of tools of production system, abandoning the idea of reference areas.

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