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Organizational Design and Rationalization of Production Systems of a Machine-Building Enterprise (by the Example of the Contract Assembly Workshop)

Diseño Organizacional y Racionalización de Sistemas de Producción de una Empresa de Construcción de Máquinas

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Contents

ABSTRACT:

The article suggests a new understanding of the basic principles of the GAZ production system and their impact on the labor processes in the organization, and argues for the need to implement projects in a number of areas, such as the introduction of new production, technological and logistical processes, staff training, and component localization. In the article, the authors turn to the consideration of the feasibility of implementing the largest investment project in recent years in the Russian automotive industry, namely, the launch of the local production of the Mercedes-Benz Sprinter Classic. The authors indicate the volume of production of the workshop for contractual assembly in 2013-2015 in order to calculate the cost of the past years of project implementation (contract manufacturing Daimler for 2015). Speaking about the importance of the basic principles of the GAZ production system, the authors

RESUMEN:

El artículo sugiere una nueva comprensión de los principios básicos del sistema de producción GAZ y su impacto en los procesos laborales en la organización, y aboga por la necesidad de implementar proyectos en una serie de áreas, como la introducción de nueva producción, tecnología y procesos logísticos, capacitación del personal y localización de componentes. En el artículo, los autores recurren a la posibilidad de implementar el mayor proyecto de inversión en los últimos años en la industria automotriz rusa, concretamente, el lanzamiento de la producción local del Mercedes-Benz Sprinter Classic. Los autores indican el volumen de producción del taller para el montaje contractual en 2013-2015 con el fin de calcular el costo de los últimos años de implementación del proyecto (contrato de fabricación de Daimler para 2015). Hablando sobre la importancia de los principios

propose to evaluate the level of quality of the products produced by the workshop to perform the calculation of the indicators: FTC - the percentage of cars taken from the first presentation at the MB-RUS station; DRL - the average number of defects per vehicle; DRR - the percentage of vehicles without entering the repair area; CPA - the score for 1 car. The analysis of quality indicators of the produced products is considered, and conclusions are drawn about their inconsistency with the established normative values. These principles allow us to conclude that on the basis of the work performed and the results obtained, the objectives of the production development in the workshop for the next year should be: Increase in the production of production personnel by 7.5%; The organization of submission of details on workplaces on system “Kanban” in view of a bar coding of 90%; Increase the level of implementation and distribution of the production system by 0,89 points; Reduction of costs and increase in production efficiency at RUB 11,439,000; Improving the quality of the produced car: DRL - by 40.5%; DRR - by 175.2%; CPA - by 40%. To achieve those goals, the authors suggest the following activities: Standardization of workplaces in sections 425-10, 425-20 CCAD; The introduction of a pulling system for the supply parts, taking into account the barcoding for workplaces of assembly sites; Revision of the norms of consumption of material resources, replacement of materials; Reduction in the completion time per vehicle; On the production sites of the CCAD to organize and conduct training for the tools and methods of the PS GAZ of team leaders; Carry out work aimed at eliminating laborious work to eliminate defects; Integration into the technological chain of the conveyor 425-10 operations for installing the roof extension, the organization of new jobs; The organization of the wheel manufacturing cell in the production areas of site and the integration of the process into the technological chain of the assembly conveyor.
Key words: design; rationalization; production systems; industry; engineering enterprises

básicos del sistema de producción GAZ, los autores proponen evaluar el nivel de calidad de los productos producidos por el taller para realizar el cálculo de los indicadores: FTC - el porcentaje de automóviles tomados de la primera presentación en la estación MB-RUS; DRL: el número promedio de defectos por vehículo; DRR: el porcentaje de vehículos sin entrar en el área de reparación; CPA - el puntaje de 1 auto. Se considera el análisis de los indicadores de calidad de los productos producidos y se extraen conclusiones sobre su inconsistencia con los valores normativos establecidos. Estos principios nos permiten concluir que sobre la base del trabajo realizado y los resultados obtenidos, los objetivos del desarrollo de la producción en el taller para el próximo año deberían ser: Incremento en la producción de personal de producción en 7.5%; La organización de la presentación de los detalles sobre los lugares de trabajo en el sistema "Kanban" a la vista de la codificación de barras del 90%; Aumentar el nivel de implementación y distribución del sistema de producción en 0,89 puntos; Reducción de costos y aumento en la eficiencia de producción en RUB 11,439,000; Mejora de la calidad del automóvil producido: DRL: 40,5%; RRD: 175.2%; CPA: en un 40%. Para lograr esos objetivos, los autores sugieren las siguientes actividades: Normalización de los lugares de trabajo en las secciones 425-10, 425-20 CCAD; La introducción de un sistema de tracción para las piezas de suministro, teniendo en cuenta el código de barras para los lugares de trabajo de los sitios de montaje; Revisión de las normas de consumo de recursos materiales, reemplazo de materiales; Reducción en el tiempo de finalización por vehículo; En los sitios de producción del CCAD para organizar y llevar a cabo capacitación para las herramientas y métodos del PS GAZ de los líderes del equipo; Realizar trabajos orientados a eliminar trabajos laboriosos para eliminar defectos; Integración en la cadena tecnológica del transportador 425-10 operaciones para instalar la extensión del techo, la organización de nuevos trabajos; La organización de la célula de fabricación de la rueda en las áreas de producción del sitio y la integración del proceso en la cadena tecnológica del transportador de ensamblaje.
Palabras clave: diseño; racionalización; sistemas de producción; industria; empresas de ingeniería

1. Introduction

The object of research is the Gorky Automobile Plant (GAZ) - the largest enterprise of the Russian automobile industry. In 2003, the Gorky Automobile Plant adopted the ideology of changes, developed based on the principles of the Toyota Product System and called it “Production system GAZ”. The basic principles of the system and their impact on the work processes in the organization are reflected in Table 1.

Table 1
Basic principles of the GAZ Production System and their impact on the labor processes in the organization

Principles	Meaning	Influence on labor processes
People	This is the most valuable asset	The most profitable investments are in the development of people, because Only people develop other factors of production - equipment, methods, materials

		You can buy new equipment, technology and untrained people will make it worthless, that is, a person cannot be considered as a “pair of hands.” People can think, learn, improve themselves and the surrounding space, contribute both personal and working in a group
Production cell	Group (team, team) of people responsible for the production of a certain group of products	The kaizen approaches assume that all the resources needed to perform work are concentrated within the production cell
All attention to the production site (“Gemba”)	Gemba - the site of the production site (work place) with a system of relationships on it all personnel - production, technology, economists, designers, the quality on which work is underway to create value	It is impossible to know and solve problems sitting at the desk in the office. This should be done only while on the production site and see everything with your own eyes
Losses (Muda)	Muda is any activity that, when consuming resources, does not create value for the product for which the customer pays, respectively, it is the manufacturer's losses	Kaizen assumes a constant and targeted reduction in the loss of time
Jidoka “Integration” of quality into the production process	Instruments: Andon - a help signal in case of a problem (if the problem is not solved in giving time, the process stops) Pokeyoke - protection against errors	Providing machines and operators with the ability to easily identify abnormalities and immediately stop work
Standardized work	Standardized work is the most efficient sequence of performing an operation based on the movements of a person, providing quality, safety	Determining the cycle of the operator's work (complete, repetitive sequence of actions)
The “5S” system is a system aimed at the correct, efficient and safe organization of the workplace	System “5S” - is implemented after the Standardized work Sort Follow the order Keep clean Standardize Perfection	Creates optimal conditions for performing labor operations. Saves time and energy and thereby improves the performance of the team (brigade).
TRM (General Equipment Maintenance)	The aim of TRM is to increase the overall efficiency of equipment by eliminating 6 main types of losses: 1) breakage; 2) adjustment and adjustment; 3) decrease in speed; 4) short-term stops; 5) loss on start-up;	If the equipment fails, then this affects the performance, so maintaining the equipment in working order ensures the smooth running of the processes that they serve.

	6) defects and corrections	
"Kanban" - in Japanese means a card	The "Kanban" system (pulling system) is an information system that regulates the production of necessary products in the right amount and at the necessary time at each stage of production	Receiving materials at the right time and in the right place allows achieving a steady rate of progress of the processes, which is not interrupted due to the lack of materials or their excessive shifting

In parallel, in accordance with international standards, projects are being implemented in a number of areas, such as the introduction of new production, technological and logistical processes, training of personnel, and the localization of components [2]. So, in 2012, the capacities of the Gorky Automobile Plant opened production of exhaust systems within the framework of the joint venture of the GAZ Group and Bosal. In 2013, the production of frames for Mitsubishi Pajero Sport cars was started, in 2014 - the manufacture of fasteners parts together with Bulten, the MW SpA wheel line was opened. In July 2013, the production of Mercedes-Benz Sprinter Classic cars was launched. Car production is organized in full cycle mode, including all the main technological stages: welding, painting, assembly.

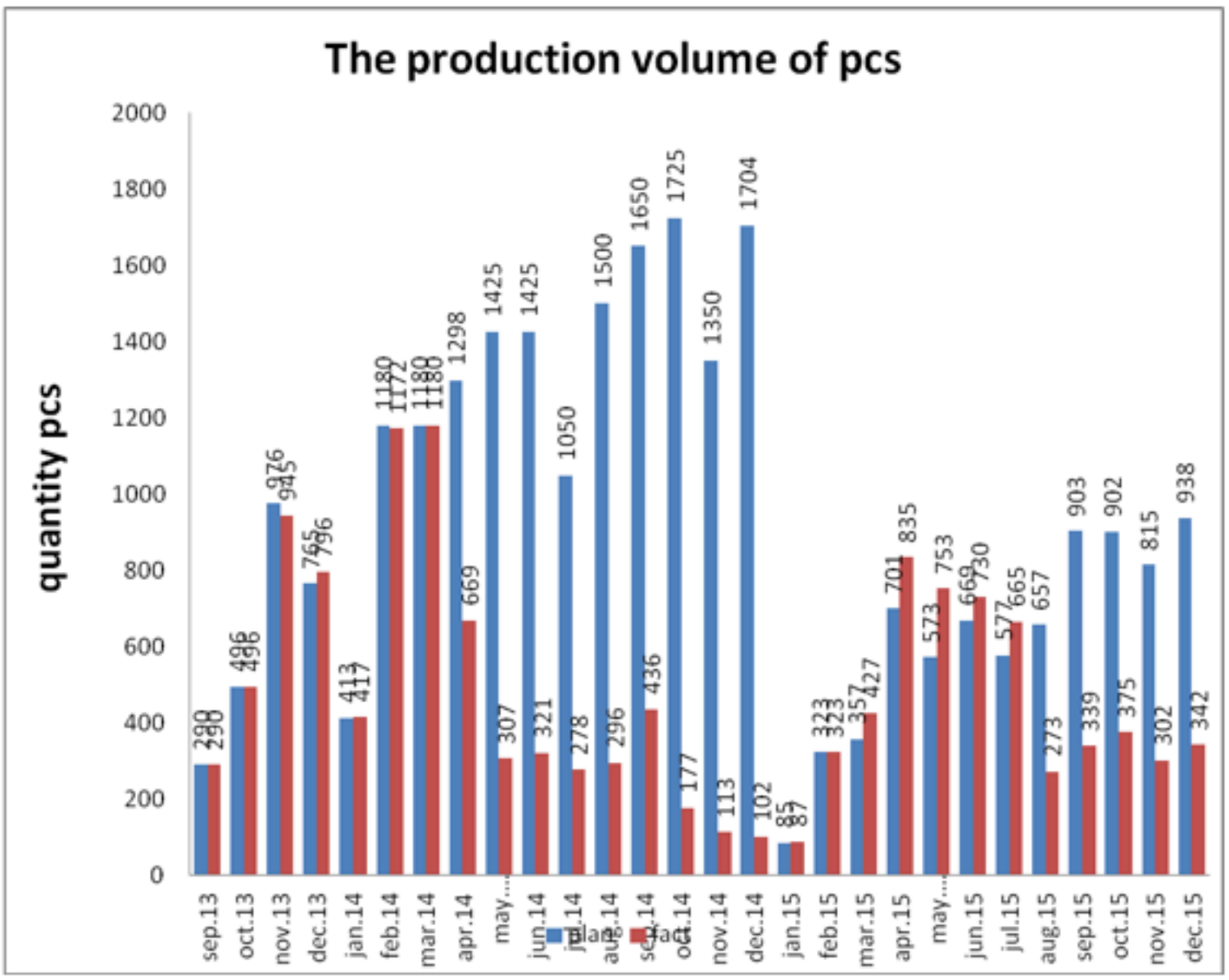
2. Results and discussions

Concern Daimler AG and the Russian "GAZ Group" invested more than 190 million euros in launching the local production of Mercedes-Benz Sprinter Classic. This is one of the largest investment projects in recent years in the Russian automotive industry. The project on the contractual assembly of low-tonnage vehicles allowed the creation of new jobs, upgrading the qualifications of GAZ employees, and establishing work to localize the production of auto components in Russia. For the production of Sprinter Classic cars, GAZ has modernized about 90,000 sq. meters production and logistics facilities; The launch of a new painting complex produced by the German company Eisenmann.

The capacity of the complex is more than 10 bodies per hour, 11 colors are provided for painting cars [4]. New technologies, in which about 50 million euros were invested, allowed to ensure the process of painting cars and guaranteed protected against corrosion.

In addition, a system for quality control of components and finished products was created in Nizhny Novgorod in accordance with the norms of Daimler. The Sprinter Classic is equipped with a modern eco-friendly OM646 diesel engine with high torque and low fuel consumption. The engine will also be produced in Russia. The mechanical gearbox TSG (specialized transmission for small-capacity cars Mercedes-Benz) new Sprinter Classic is adapted for Russia and specific loads. Volumes of production of the workshop for contractual assembly in 2013-2015. Are shown in Figure 1.

Figure 1
The volume of production of the workshop of contract assembly



The cost calculation for the past years of project implementation (Daimler contract manufacturing for 2015) is carried out in Table 2.

Table 2

Calculation of production costs for contract manufacturing Daimler for January - June 2015 (RUB thousand)

Expenditures	January	February	March	April	May	June
Tools		113.4	64.7	45.8	84.8	194.1
Non-refundable materials	16.49	68.41	121.16	293.38	205.58	155.02
Energy and fuel for technology	65.3	71.7	204.2	84.3	81.1	69.1
Petrol						
Wage	625.2	1,866.0	2,918.5	3,842.8	3,324.8	3,365.1
Additional salary	96.3	40.7	19.7	133.7	26.1	35.5
Deduction to social insurance	223.7	591.1	910.8	1 232.7	1,038.8	1,054.2

Total variable costs	1,026.9	2,751.3	4,239.1	5,632.7	4,761.1	4,873.0
Depreciation	6,684.2	6,185.4	6,040.8	6,543.0	6,219.1	5,167.4
Repair costs	535.7	258.5	446.2	491.2	562.1	375.6
Paying the staff	213.2	315.5	329.0	357.3	371.7	338.2
Deduction to social insurance	66.1	97.8	102.0	110.8	115.2	104.8
Other general production expenses	3,348.8	5,287.7	6,911.5	8,133.9	6,925,3	8,531.5
Reserves	477.7	542.6	602.0	801.6	826.3	137.0
Total variable costs	11,325.6	12,687.6	14,431.5	16,437.9	15,019.8	14,654.5
Total cost	12,352.5	15,438.8	18,670.6	22,070.6	19,780.9	19,527.5
Number of cars (pcs)	87	323	427	835	753	790
The cost price for 1 car (RUB thousand)	142.0	47.8	43.7	26.4	26.3	24.7

Table 2 Cont.
Calculation of production costs for contract manufacturing Daimler for July - November 2015 (RUB thousand)

Expenditures	July	August	September	October	November
Tools	204.0	111.1	365.2	327.2	99.2
Non-refundable materials	110.04	51.48	70.33	55.11	58.77
Energy and fuel for technology	86.4	50.1	78.5	85.4	81.2
Petrol					
Wage	2,934.3	1,887.8	1,780.1	1,769.7	1,530.0
Additional salary	267.8	63.4	123.7	68.2	17.1
Deduction to social insurance	973.8	603.6	587.0	569.8	479.6
Total variable costs	4,576.4	2,767,4	3,004.9	2,875.5	2,265.9

Depreciation	4,118,1	4,104,9	4,076.2	4,044.1	3,646.6
Repair costs	390.3	344.0	766.1	391.4	409.8
Paying the staff	263.5	232.4	268.6	291.0	268.1
Deduction to social insurance	80.1	61.0	72.5	76.3	70.4
Other general production expenses	11,560.1	6,236.4	8,356.2	12,878.1	13,812.9
Reserves	126.9	93.5	100.9	99.1	102.5
Total variable costs	16,538.9	11,072.2	13,640.4	17,780.1	18,310.3
Total cost	21,115.3	13,839.6	16,645.3	20,655.5	20,576.2
Number of cars (pcs)	665	273	339	375	302
The cost price for 1 car (RUB thousand)	31.8	50.7	49.1	55.1	68.1

From the table it follows that for the period from January to June 2015 the cost price was constantly decreasing, this is primarily due to a sharp increase in production volumes (from 87 vehicles in January to 790 in June). For the period from July to November 2015, the cost of assembling one car increased (from RUB 31,800 in July to RUB 68,100 in November), which is associated with decrease in the number of cars produced in the second half of 2015.

One of the main problems of the organization of production in the workshop of contract assembly is a high level of losses from defects. Figure 3 shows the dynamics of losses from marriage in the workshop of contract assembly for 2014-2015 - up to RUB 92,000 per month. Monthly losses from defects often exceed the established by the production standard, which by the end of 2015 was RUB 40.000. The average monthly loss from defects in 2015 was RUB 77.443, which is by 55.2% higher than in 2014.

To assess the quality level of the products produced by the workshop, the following indicators are calculated: 1. FTC - the percentage of cars taken from the first presentation at the MB-RUS station (at the end of 2015 the figure was 53.4% (compared to the previous period, this indicator increased), 2. DRL - the average number of defects per vehicle (at the end of 2015, the indicator was 11.54% (compared with the previous period, this figure decreased), 3. DRR - the percentage of cars without entering the repair area (at the end of 2015 the indicator was 68.63% - relatively unchanged), 4. CPA - the score for one car (at the end of 2015 the indicator was 96 points).

The analysis of the quality indicators of the produced products allows us to conclude that they do not correspond to the established normative values. In addition, one of the most important problems in organizing the production of the workshop was the lack of training for managers of the principles of the production system GAZ. In early 2014, the output was 59 cars per day. The structure of CCAD (workshop assembly of Daimler motor vehicles) consisted of 3 sections. On the conveyors, untrained team leaders carried out the organization of production processes, the assembly was carried out in a two-shift mode; the number of production workers was 298 people. Due to the massive number of defects, 23 painters and 12 straighteners worked on the

site for completion and delivery of cars, on external hiring from outside organizations, the amount of expenses for which in 2014 for the period from January to May amounted to RUB 15,186.18.

The internal audit of the production organization made it possible to identify a number of problems in the field of production technology and logistics: The management of the promotion of the EPD is carried out in manual mode; Not enough tools; Working racks are not equipped with devices for assembly of assemblies; Not uniform loading of operators (lack of alignment in the product range); Cluttering of workplaces with containers with large-sized parts; Execution by operators of work on unpacking of parts and waste disposal; Unnecessary movements of operators, waiting, alteration of defects; There is no organized submission of materials on work places. For the purposes of a systematic approach to the efficiency of production organization, to exclude work that does not add value to the product and reduce costs, it became necessary to apply the principles of the GAZ production system and the training (theoretical, practical) to the tools and methods of the GAZ production system for team leaders (leaders).

3. Conclusions

Based on the work performed and the results obtained, the objectives of the production development in the workshop for the next year should be: 1) increase in production of production personnel by 7.5%; 2) organization of submission of details for workplaces on the system “Kanban” with regard to barcoding 90%; 3) increase the level of implementation and distribution of the production system by 0.89 points; 4) reduction of costs and increase of production efficiency by RUB 11,439; 5) improving the quality of the produced car: DRL by 40.5%; DRR by 175.2%; CPA by 40%. In order to achieve the set goals, the following activities are proposed: 1) Carrying out standardization of workplaces on sections 425-10, 425-20 CCAD; 2) Introduction of a pulling system for the supply of parts, taking into account barcoding for workplaces of assembly sites; 3) Revision of the norms of consumption of material resources, replacement of materials. Decreased defects. Reducing the cost of the tools. Reduction of energy costs; 4) Reduction of the completion time for one car; 5) Management (theoretical, practical) of tools and methods of PS GAZ for leaders (leaders) of groups in 2014 in the number of 18 persons was organized and conducted at the CCAD production sites, in the number of 6 in 2015; 6) Carry out work aimed at eliminating laborious work to eliminate defects such as: Tightening on sidewalls; Poor-quality plastering in false windows; Poor-quality welds on buses 20 + 1; Dent on the hood in the area of the company logo; Dent in the opening of the front doors; Dent fuel filler flap, etc.; 7) Integration into the technological chain of the conveyor 425-10 operations for installing the roof extension, the organization of new jobs; 8) Organization of the wheel manufacturing cell in the production areas of the site and integration of the process into the technological chain of the assembly conveyor.

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[Índice]