Practice in the Application of the Production System Tools at the Enterprise During Mastering of New Products

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Abstract This chapter considers contemporary state, problems, and future development of the industrial enterprises. The authors analyze the opportunity to decrease product flow time, to decrease prime cost, and to improve quality at the same time with the help of more clear arrangement of the production processes and using the tools of production system. This chapter determines the prospects of implementation and development of the production system in the practice. The authors have studied applied aspects of development and implementation of the production system tools while mastering of new products at the enterprise that proves the usefulness of the conducted research.

1 Introduction

Rise in the efficiency of the production while mastering of new products, that satisfies customers fully, can be possible in modern economic with the help of expert process flow and development of business systems, that are represented with the assembly of elements—the subsystem with lower level that are connected by business processes, to be more exact the production system and product development system (Vumek and Jhons 2013).

The experience of the leading engineering companies proves that improvements of the production system and alteration in corporate philosophy achieve the needed economic effect only if using multipronged approach.

This chapter considers these problems in some aspects: systematization of adaptation practice in production systems by domestic enterprises and determination of production systems development via increasing workflow to master of new products in the framework of complex usage of the production system tools.

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2 Theoretical Justification

The research suggests using the term "production system" as the assembly of integrated resources and assembly of technological and other processes that provide efficient realization of production process to achieve final output (Ckhirtladze et al. 2015). Production system is based on the workflow of the mass production, standardization, and alignment of the units (Wader 2012). The authors and the founders of the production systems are Henry Ford and Taiichi Ono (Egorova et al. 2016); they determine classic principals: automation, balanced production, "dead in time," but they notice that system is adaptable for internal and external environment of the particular production that has particular conditions and resource limit. Also, it has balanced system of the participants. So, the assessment of implementation systems at domestic engineering enterprises (GAZ group enterprises) revels the combination of adapted production system elements of the production systems "Ford" and "Toyota." For instance, activity in Toyota Production System started with work standardization, to be more exact to implement the complex of the measures to decrease cycle duration at all levels of the technological process (Nenad 2008). Among them there are: primary time-tracking of the operations "kizen" method implementation and assessments of the results. Some operations were excluded from the technological chain and time for production loop decreases. The text step was to organize conveyor operations in 2014 via land utilization for expedition warehouses. The details are delivered in the amount needed for 2 working hours. As the result, the problems of the stock item regarding the details of delivery to the work places and timing of the budget economy were solved.

In the period of 2014–2015 year, 53 benchmark areas were created in the company and working parties acted in order to optimize quality and working processes. As a result, the number of the conveyers decreased, number of the employees also decreased, but the number of output products that underwent quality inspection at the first attempt increased. These facts proof the world statistics: according to "Lean Enterprise Institute," the results of discourse about production systems implementation are: reduction of fault details up to 90%; decrease of the production loop up to 90%; faster entry to the market from 50 to 75%; decrease of the material inventory up to 90%.

At the same time, the needed effect of the production system improvement while corporate ethic is changed cannot be achieved without technical re-equipping and without increasing efficiency of the technological flow in order to produce high-quality products. This fact is proved by the operational evaluation of the average annual rate in management efficiency at "GAZ group" (Ingemansson and Bolmsjö 2004):

1. *Smooth production (Pn)*—is provided by performing and managing duties, orderliness of production and work.

   $Pn = Product_{real}/Product_{plan}$, where: $Product_{plan}$—production plan in time periods (month, quarter, year); $Product_{real}$—real number of produced goods in time period (month, quarter, year).

Low values of rhythmical coefficient in month (Table 1) influence on production work efficiency and it leads to equipment downtime and to share of standing costs increase in relation to prime cost of the goods (increase of deprivation costs and salary for produced costs).

2. *Coefficient of high quality production at the first attempt*

   Кк—characterize the results of quality management from craftsmen and technologists. $Кк = T/К$, where: T—number of products, accepted by QS department at the first attempt; К—number of products that were introduced to QS department (Table 2).

   Significant influence on the product quality: deprecation of production assets and tools, quality of material and work piece, unbalanced load of the workers and equipment, low quality of work.

3. *Coefficient of working time loss (Cwt)*—counted in order to determine ill-time of managerial functions at the work places. $\text{Cwt} = 1 - (Tl/Tr)$ where: Tl—loss in working time at the section because of managers, hour; Tr—real working time at the section (Table 3).

   Judging by the facts above, we have come up to the conclusion that discipline and responsibility of the workers and managers must be increased.

4. *Coefficient of the bonus payments for managers (Kbp_{mn})*—counted as contrasting real percentage of the bonus payments with target figures (according to regulations on bonuses). $Кbr_{mn} = Br/B_p$, where: Br—real bonus percentage in relation to salary; Bp—planned bonus percentage in relation to salary (Table 4).

Bonus calculation must take into account not only quantitative results of the sector but also quality of the production, levelness of the production, discipline, and promptness of the workers, who are responsible for the plan fulfillment and rhythm of the production (Table 5).

Values of the coefficients proof that production system is lack of efficiency (Table 6).

The analysis of the technological flows of the research subject shows: lack of synchrony and not rhythmical production processes, difficulties in re-trimming, not balanced load between technological flows at the sectors, working time loss.

Besides that, cost escalation for management doesn't guarantee the escalation of such showings as economy and prime cost decrease ($Кз2 < 1$) (Table 7).

To solve the tasks of the enterprise while mastering of new product we have formed the project, that are being implemented in 2014–2016 at the testing side—foundry engineering sector of OJSC "GAZ" (Table 8).

The goal of the project is—increase of the technological flow efficiency and increase of the quality level and work place standardization. The tools of the production system that were used: "5S" system, analysis of the VSM slow, production analysis, solutions of the problems using "one by one" system, standardized work, and equipment maintenance.

Particularly, replacement of the net element determined the effect $F = 620{,}000$ rub./year-231,000 rub./year = 389,000 rub./year (Table 9).

Table 1 Ratio counting of smooth production in 2015

Month/quarter	Production plan, item	Real production, items	Taken in	Pn
I	123,765	122,700	122,500	0.99
II	115,049	114,050	114,050	0.99
III	146,771	140,532	139,532	0.96
Total 1 quarter	385,588	377,282	376,082	0.98
IV	132,530	132,000	131,900	1
V	138,529	137,098	136,098	0.99
VI	114,529	113,231	113,131	0.99
Total 2 quarter	385,588	382,329	381,129	0.99
VII	115,049	114,010	113,010	0.99
VIII	123,765	120,141	110,141	0.97
IX	146,771	141,878	131,878	0.97
Total 3 quarter	385,588	376,029	355,029	0.97
X	99,765	978,88	97,688	0.98
XI	131,947	130,762	130,762	0.99
XII	153,876	152,322	152,322	0.99
Total 4 quarter	385,588	380,972	380,772	0.99
Total in a year	1,542,352	1,516,612	1493,012	0.99

Table 2 Coefficient of product quality at the first attempt in 2015

Quarter	Presented, items	Taken in, items	Kк
I	377,282	376,082	0.99
II	382,329	381,129	0.99
III	376,029	355,029	0.94
IV	380,972	380,772	0.99
Total in a year	1,516,612	1,493,012	0.98

Table 3 Count of time loss coefficient in 2015

Quarter	Time loss because of managers, *Tl*, hour	Real working time, *Tf*, hour	Absentee ratio of working time
I	23,984	250,700	0.91
II	20,311	254,324	0.92
III	20,128	253,218	0.92
IV	21,456	250,111	0.91
Total	85,879	1,008,353	0.92

The result of the activities in order to increase AFS when enchanting the pumping out “Minsk package” is introduced in Table 10.

Cost-benefit analysis of ferrosilicon dozing machine implementation is introduced in Table 11.

Collective impact of project implementation is introduced in Table 12.

Table 4 Quality attributes and bonus payments in 2015

No.	Profession	Bonus pay performance targets	Required bonuses
Planning group, production support group, and realization group			
1.	Loader	Fulfillment of treaty obligations about financial responsibility	30.0
Melting-pouring sector			
2.	Remelter	Non-exceedance level of the internal loss (relation between good and poured forms)	34.0
3.	Pourer		40.0
4.	Cupola melter		25.0
5.	Cinder man		27.0
6.	Charger		12.0
7.	Crane man		45.0
8.	Refractory man	Absence of quality remarks about performing works	30.0
Molding point			
9.	Moulder	Non-exceedance level of the internal loss (relation between good and poured forms)	35.0
Core room			
13.	Core man	Non-exceedance level of the internal loss (relation between good and poured forms)	18.0

Table 5 Coefficient of bonus payments for managers at the enterprises in 2015

Quarter	Planned %	Actual %	Kpr_{mn}
I	30	38	1.27
II	30	40	1.3
III	30	40	1.3
IV	30	38	1.27
Total in a year	30	41	1.36

Table 6 Consolidated data of the operational evaluation of the production management in 2015

Assessment ratio	Quarter number				IV to I (%)	IV to III (%)
	I	II	III	IV		
Pp	0.98	0.99	0.97	0.99	1	2.1
Кк	0.99	0.99	0.94	0.99	–	5.3
Кр	0.91	0.92	0.92	0.91	–	−1.1
Kpr	0.76	0.78	0.53	0.81	6.6	52.8
Kbp	1.27	1.3	1.3	1.29	1.6	−0.8

Table 7 Cost expediency counting for management in 2015

Indicator name	Percentage of the fulfilled plan
1. Production level, item	−1.7
2. Economy from prime cost reduction, mln. Rub.	−4.5
3. Managerial costs	5
Temp correlation	
– Production level and managerial costs	−0.34
– Economy from prime-cost and managerial reduction	−0.9

Table 8 Activities on the project

No.	Production entitlement	Result	Scheduled time
1.	Net component replacement	1. Weight loss of the construction from 600 to 150 kg—let us decrease equipment fatigue 2. Loose interlinking lifetime increase and exclusion of friction and blowing out (more than 6 years) 3. Cost cutting for repair materials and labor contribution for preparation	2014–2015 г
2.	Changing of the pumping out flows	1. Movement and storage operations reduction 2. Pumping outs are transferred by electronic telpher to painting without additional movements 3. Reduction of the labor impact when transporting	2014–2016
3.	Increase of the AFS when processing a pumping out that is called "Minsk package"	Processing modernization of the pumping out that is called "Minsk package." Let us decrease casting time; casting pointing; canting time; detaching of the pointing position	2014–2015
4.	Implementation of the machine that dozes ferrosilicon at the casting production	Ferrosilicon dozing machine implementation at the casting sector №4	2014–2016

3 Conclusions

The task of new product mastering demands complex approach to the analysis and problem solution using the tools of the production group "GAZ" and well-coordinated work in order to enhance technological processes and instrumentation.

In spite of suggested activities in order to increase effectiveness of the production management that are effective from economic view, it is necessary to mark that calculations given below resemble only short-term effect. Calculation of the long-term effects must include forecasting elements and take into account social effect of the activities.

Table 9 Changing of the processing flows in cast production

Before	Implemented activity	After
Additional operations of moving and storage of the pumping out	Flow distribution according to the entitlement	Reduction of moving and storage operations
The necessity of the additional operations in order to transfer and paint pumping out with the loader engagement	Changing of the crater and box pumping up flows	Pumping outs are transferred by the electronic telpher without additional moving
Significant labor input when transporting the pumping gout of the cylinder barrels from the blast cabinet to enhancement	Installation of the conveyer belt	Decrease of the labor input when transporting

Table 10 The results of the activity in order to increase AFS when enchanting the pumping out "Minsk package"

Showings	Before	After	Result
Time to install the pumping out at the pointing position	15	9	−6
Pointing time, sec	70	22	−48
Canting time	10	0	−10
Detaching time for pointing position	10	9	1
AFS decrease		0.38%	

Table 11 Cost-benefit analysis of ferrosilicon dozing machine implementation

Material	Material consumption for, kg for 1 suitable *t*		Result, rub for 1 suitable *t*
	Before	After	
ФС 45	57.35	11.54	−2385
ФС 75	0	7.84	+721
Silicone carbide	0	22.67	+1044
Planned cost impact in March 2016		RUB 821,900	

Table 12 The result of project implementation

Showings	Before	After	Result
Tool-cutting time, Tmach., sec	167	69	−98
Manual time and operator's transition, Tman., sec	22	13	−9
Transition Number	3	2	−1
Number of the pumping outs in shift	142	329	+187

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