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ASPECTS OF REDUCING THE RESPONSE TIME IN CASE OF DEMAND VOLATILITY

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***Abstract*—**The present paper aims to present some aspects of efficient production systems organization and management, especially in the romanian automotive industry, which came as a response to the reported demand volatility influences, being emphasized some aspects related to an increased short-term flexibility of the production units. The presented case study highlights the possibility of human resources reallocation within the organization, changing from 3 shifts to 4, and analizing the influences generated by these changes. Identified comparative differences were evaluated in terms of operator efficiency and used machine effectiveness, resulting quite similar values, also proposing a human resources allocation scheme on a variable number of machines. Proposed schemes limitations are given by the need of additional qualified workforce and the establishment of homogeneous working groups. Future research may demonstrate the appropriateness of preparing such an approach in terms of involved costs and further industrial units development possibilities.

***Keywords*—**automotive industry, demand volatility, flexibility, shifts.

I. INTRODUCTION

THE STRONG TENDENCY of industrial organizations to adapt permanently to the changes that are necessary in solving current situations due to the development of the environments in which they operate, require high effort on their part. The present context is characterized as being "the most complex, interdependent and interconnected era in human history" in which the management challenges are to build a system able to provide high resistance to risk and adequate knowledge and control of strategic agility. [1]

The European automotive industry is of particular importance due to its economic and social dimensions, being considered a "key contributor" to the economy and society. [2]

In [2], the automotive industry is identified as the "engine of Europe" because of the number of jobs provided – 12 million, of which 2 million are directly involved, while 10 million are involved in the production of components and other sectors; on average, 17 million cars, vans, trucks and buses are produced annually, which represents 24% of global production; the annual investment in research and development amounts to over 26 billion: this figure shows the level and contribution to innovation in this sector.

At the same time, this industry is at a critical juncture, as major problems are identified in the European market, which is however driven by global statistics that read increases in sales, especially in the BRIC nations and other emerging markets.

The tense and fluctuating market, the legislation which is becoming more stringent and costly, the increased competition in terms of imports, and the low profitability are challenges that may affect the future global competitiveness of the European automotive industry.[3]

Thus, the main goal is to have a high responsiveness capacity to customer needs, whether final or other industrial unit, with high constraints on the increased level of competitiveness in the sector, while keeping a low cost and high efficiency.

II. MANUFACTURING FLEXIBILITY

Manufacturing flexibility, as an imperative goal needed by production units in this sector, is an important component of a company's agility, which defines the capacity / ability of an organization to succeed in a constantly changing and unpredictable environment.[4] This can be achieved by various means – there is a general tendency to give scale to the phenomenon by introducing new functions and skills, departments, but which considerably increase their structure, becoming less robust, which contradicts the very definition of agility. Therefore one must identify developmental pathways which should limit themselves to the involvement of existing resources, which should not attract new expenses, and which should maintain the current level of costs.

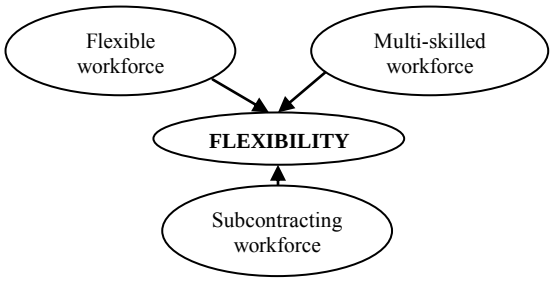

Fig. 1 Manufacturing flexibility from the workforce perspective

The human resource engaged in the productive activities of the society is a major factor which influences the improvement of flexibility and which requires special attention. Their good management reduces the negative effects that may be caused by environmental uncertainty and demand volatility.

Figure 1 presents three ways of obtaining manufacturing flexibility from the perspective of human resources involved in the process:

A. Flexible workforce

A possible adequate organization of the number of work shifts is an important element in production planning, with influences in reducing manufacturing costs. The possibility of increasing the number of weekly work hours has advantages related to time, and hence larger volumes of processed parts; there are however additional expenses with the human factor, but at a much lower level compared to the benefit thus obtained, the influence of demand volatility being much diminished. Changing working hours while maintaining the same effective work, involves the necessity of reconstructing some well-balanced teams in terms of skills and competencies, and the identification of those individuals who can successfully execute a greater number of tasks.

B. Multi-skilled workforce

Preparing and training the human resource to acquire knowledge and practical skills required to carry out the work tasks assigned, are issues which concern in full the employing company. The importance of multi-skilled workforce is given by the fulfillment of multiple job assignments; it allows for the possibility of distributing qualifications and performance based on a grid, and supplementing with additional work staff where necessary. This reorganization should be made taking into account the performance of such persons; this requires a good knowledge and a detailed record of skills, such tasks being under the responsibility of human resources managers, who should directly consult with those in charge with the production.

C. Subcontracting/Outsourcing (Lease HR)

One possibility increasingly used among multinational companies present in the national market is that of subcontracting / outsourcing human resources. Thus, the company which provides services deals with recruitment, qualification and management of employees, and payment of salaries to them. The customer, especially the production company, bears the burden of occupational safety briefing, and of paying the bills to the supplier on time. Thus, given the conditions of variation in demand and of sufficient production capacity, the time required for human resource recruitment and its qualification shortens considerably; the same is valid for taking the necessary steps needed to fulfill all legislative requirements, which offers advantages in situations where society is faced with a sudden reduction in orders.

III. CASE STUDY

The case study aims at presenting a model of effective human resource management, by switching from 3 to 4 shifts, thus implicitly increasing the number of hours worked. This practice is more and more frequently met in production, under the conditions of a considerable variation in the level of demand, obtaining thus flexibility in the needed period of time. The analysis performed highlights the difference between the two models in terms of indicators used in industry, effectiveness of equipment, and work efficiency of the operator, defined in the specialized literature.

Effectiveness was defined in the Business dictionary as "the degree to which objectives are achieved and the extent to which targeted problems are solved. In contrast to efficiency, effectiveness is determined without reference to costs."[5] With other words, related to production, effectiveness (E_f) measures the percentage of production done in an effective way from the total production capcity (utilization of production capacity), being calculated using equation 1. [6]

$$E_f = \text{Production time} / \text{Total time}\,(\%) \quad (1)$$

Efficiency (Ec): Ratio of the standard-hour value of a job or activity to the actual hours consumed, being calculated using equation 2. [7]

$$E_c = \text{Planned time} / \text{Real time}\,(\%) \quad (2)$$

where: planned time refers to the calculated time to perform a specific task, related to operator's workload, and real time refers to the time obtained by the operator to carry out the task succesfully.

A. Assumptions

The normal work mode is 3 shifts of 8 hours, 5 days a week, every machine (equipment) being served by an operator. An important aspect is the specification of activity, since it assumes the existence of qualified staff, which does not allow the use of human resources in the form of "lease HR" or the use of external companies in the field.

TABLE I
WORK DISTRIBUTION ON 3 SHIFTS, TO *n* MACHINES

Shifts / M_i	I	II	III	Total
M_1	1	1	1	3
M_2	1	1	1	3
…	…	…	…	…
M_{n-1}	1	1	1	3
M_n	1	1	1	3
Σ	n	n	n	3n

According to Table I, the 3 shifts model can be generalized taking into account the number of machines used and the number of people unavailable for various reasons, and one can identify the mathematical equation (1) to calculate the maximum number of persons required.

$$N_m = 3n + a \times 3n \quad (1)$$

where:

N_m – number of workers;

n – number of used machines;

a – time share related to leaves (expressed in percentages and statistically calculated for the previous year).

In terms of effectiveness and efficiency indicators considered, the current distribution system indicates the following:

- 85% in the case of machine effectiveness (15% maintenance and downtime, 85% nominal work), resulting in a total of 102 hours / week, where the machine (the equipment) is at nominal work;
- 93% of the time, the operator is producing with efficiency, resulting in a working time with nominal human-machine efficiency of 94.86 hours / week.

The performance / output calculated by dividing the working time with nominal efficiency human-machine to the total available time (5 days / week x 24 hours / day) is 79% in the case of allocating the existing human resource in 3 working shifts.

B. Proposed model

The proposed model is shown in Table II. The work regime consists of 4 shifts, 8 hours / shift, 7 days per week, the number of workers being the same as in the case of distribution on 3 shifts. The study performed identifies the need for a number of operators who must work simultaneously on two machines / equipment, this number being the same as the number of machines used (n).

TABLE II
DISTRIBUTION ON 4 WORK SHIFTS, TO *n* MACHINES

Shifts / M_i	I	II	III	IV	
M_1	1	1	1	1	2n
M_2	1	1	1	1	
M_3	1	1	1	1	
…	…	…	…	…	
M_{n-3}	1	1	1	1	n
M_{n-2}	1	1			
M_{n-1}	1	1	1	1	
M_n					

TABLE III
ALLOCATION OF HUMAN RESOURCES IN 4 SHIFTS, BETWEEN 1 AND 16 MACHINES

Shifts / M_i	M_1	M_2	M_3	M_4	M_5	M_6	M_7	M_8	M_9	M_{10}	M_{11}	M_{12}	M_{13}	M_{14}	M_{15}	M_{16}	N_m	n
I	1		1	1	1		1	1	1	1	1						9	12
	1		1		1		1	1	1	1	1		1				9	13
	1		1		1		1	1	1	1	1		1	1			10	14
	1		1		1		1	1	1	1	1		1	1	1		11	15
	1		1		1		1	1	1	1	1		1	1	1	1	12	16
II	1		1	1	1		1	1	1	1	1						9	12
	1		1	1	1		1	1	1	1	1		1				10	13
	1		1		1		1	1	1	1	1		1	1			10	14
	1		1		1		1	1	1	1	1		1	1	1		11	15
	1		1		1		1	1	1	1	1		1	1	1	1	12	16
III	1		1	1	1		1	1	1	1	1						9	12
	1		1	1	1		1	1	1	1	1		1				10	13
	1		1	1	1		1	1	1	1	1		1	1			11	14
	1		1		1		1	1	1	1	1		1	1	1		11	15
	1		1		1		1	1	1	1	1		1	1	1	1	12	16
IV	1		1	1	1		1	1	1	1	1						9	12
	1		1	1	1		1	1	1	1	1		1				10	13
	1		1	1	1		1	1	1	1	1		1	1			11	14
	1		1	1	1		1	1	1	1	1		1	1	1		12	15
	1		1		1		1	1	1	1	1		1	1	1	1	12	16

Table III shows the possible allocation of human resources in 4 shifts, emphasizing the necessary organizational differences between 12, 13, 14, 15 and 16 machines. One may notice that the number of persons to be qualified to work on two machines equals the number of machines used, the rest (up to 3n) working on a single machine; as far as the work group available per shift is concerned, one may notice that if the number of available machines is a multiple of 4 and if the work group is made up of 4 teams with equal number of workers, in other situations, the groups are not uniform from this viewpoint.

Analyzing in this situation as well the efficiency and efficacy indicators, one may notice that:

- 85% is kept as a value for machine effectiveness, resulting in a total of 142.8 hours / week, where the machine (the equipment) works in nominal regime, being considered as working days, 7 days a week;
- with 1 operator that serves a number of 2 machines, we believe that the loss of time increases, totaling 14% on both machines, the operator efficiency being considered 86%, resulting thus a working time with nominal human-machine efficiency of 122.8 hours / week.

The performance calculated by dividing the working time with nominal human-machine efficiency to the total available time (7 days / week x 24 hours / day) is 73.1% in the case of distributing the existing human resource on 4 work shifts.

IV. Conclusion

Comparing the two work models, it is found that the human-machine performance decreases when switching from 3 to 4 work shifts, but one may notice a considerable increase in the productive time. The decrease in performance, previously identified to 6%, is compensated by an increase in the production time by 40%.

The research also identifies two important aspects of the transition to 4 shifts, one is related to the number of employees from each shift, that is always equal when the number of machines is a multiple of four, and the second aspect emphasizes the equality between the number of employees assigned to work simultaneously on 2 machines and the number of machines in use. In other words, if the work is developed for 10 machines, 10 employees are needed to be trained to work simultaneously on two machines.

Proposed schemes limitations are given by the need of:

- additional qualified workforce, that can be made inside the company, on a well prepared training scheme, which involves the existence of individual training records to prove the performance achieved by each individual, and being allocated different degrees corresponding to the needed tasks levels. This qualification is gradual and takes time;
- adequate employees, the selection of those who will enter the training program must be very well made in order to avoid money and time losses, and to have operators that will handle the tasks successfully;
- Establishment of homogeneous working groups, which also requires a proper human resources selection and repartition in four groups.

Future research may demonstrate the appropriateness of preparing such an approach in terms of involved costs and further industrial units development possibilities.

References

[1] World Economic Forum, "Resilient Dynamism", Annual meeting 2013, Davos-Klosters, Switzerland 23-27 January, http://www.weforum.org/events/ world-economic-forum-annual-meeting-2013, *accessed at: 20.03.2013*
[2] European Automobile Manufacturers Association -ACEA, "The automobile industry pocket guide 2012", http://www.acea.be /images/uploads/files/ACEA_POCKET_GUIDE_2012_UPDATED.pdf, *accessed at: 01.03.2013*
[3] European Automobile Manufacturers Association –ACEA, "A Competitive Auto Industry for Europe", Brussels, 20 September 2012
[4] Agility-Forum, "Introduction to Agility Workshop, Instructor's Manual.", 1994
[5] Business Dictionary, http://www.businessdictionary.com/ definition/effectiveness.html, *accessed at: 21.03.2013*
[6] Key performance indicators – KPI's, "Alegerea potrivita in managementul performantei" http://www.indicatoride performanta.ro/, *accessed at: 20.03.2013*
[7] Projektmagazin. Das Fachportal für Projektmanagement, http://www.projektmagazin.de/, *accessed at: 20.03.2013*