ANNALS of the ORADEA UNIVERSITY.

Fascicle of Management and Technological Engineering, Volume VI (XVI), 2007

A NEW APPROACH IN THE USAGE OF VALUE ANALYSIS IN THE DIMENSION OF FLEXIBLE MANUFACTURING SYSTEMS

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Abstract

This paper presents, as an concrete application problem, the possibility for to establish the configuration of a Flexible Manufacturing System (FMS) using the value analysis principles. The application starts from a FMS in which 15 types of parts as shafts are processed.

The analysis consists in to determine if it exists a correlation between the value of the module and its utility characterized by the charging degree.

There are correlated the usage time of FMS components with theirs values. It can establish the boundary values for the FMS equipments, and limitations in the flexibility of FMS.

Key words: cost, processing, modules, parts

In the last years, the value analysis method was more and more used in the research and design activities, being one of the most important way for the material costs decreasing, for the increasing of the quality and efficiency of the production and for the labor rationalization.

The value analysis stimulates the creativity for to obtain an optimum ratio between social needs and product quality on the side, and production costs, on the other side.

This method doesn't refer only to the products. The term of product that is used and that materializes the goal of study of the value's analysis is also used for the projection or analysis of the technological processes, labour processes and organizational systems.

The advantages are high, knowing that researches concerning the value's analysis conducted to the conclusion that a significant part from the production costs sometimes passing 50% from their total contributes a little or not at all to the usability value increasing unnecessarily the expenses which must be paid. The value's analysis eliminates these situations showing where exactly must be act on in order to reduce the expenses.

This paper presents, as an concrete application problem, the possibility for to establish the configuration of a Flexible Manufacturing System (FMS) using the value analysis principles. The application starts from a FMS in which 15 types of parts as shafts are processed.

The paper analyzes the results obtained after using the value's analysis in FMS's configuration in dual mode: on the one hand on the basis of the system's static configuration (barring the fact that the system's inputs are not having an aleatory character) and on the other hand on the basis of the system's dynamic configuration (that respects the mentioned aspect) [1].

Table 1 contains the technological routes for the 15 types of parts, including, also, the duration of each operation. The symbols of the table mean:

C - cutting
S - turning
F - milling
G - boring
R - grinding

The prices for the work units involved in the flexible manufacturing system's frame are:

- centring machine – 9000 RON
- lathe – 9000 RON
- milling machine – 5325 RON
- drilling machine – 42500 RON
- finishing machine – 10500 RON

Table 1. Technological routes of the parts

Nr. crt.	Type of part	Operation no. [min/piece]				
		1	2	3	4	5
1	R1	C5	S52	G12	F45	R30
2	R2	C5	S60	F76	G23	R31
3	R3	C5	F54		F63	R22
4	R4	C5	F41	G16	F77	R34
5	R5	C5	S92	F77		R21
6	R6	C5	F72	S72		R33
7	R7	C5	S21	F49	G27	R27
8	R8	C5	S78	F34	S36	R30
9	R9	C5	F78	S94	F38	R21
10	R10	C5	F32		S66	R32
11	R11	C5	F43		F69	R20
12	R12	C5	F76	G17	F61	R25
13	R13	C5	F50		G11	R25
14	R14	C5	S22	F54		R34
15	R15	C5	F72		S34	R37

After the application of the static configuration methodology presented in [1] the following operation modules with the afferent values are obtained:

- the centre drilling module C – 2 machines
  2 · 9000 = 18000 RON
- the turning module S1 – 6 machines
  6 · 9000 = 54000 RON
- the turning module S2 – 6 machines
  6 · 9000 = 54000 RON
- the milling module F1 – 9 machines
  9 · 5325 = 47925 RON
- the milling module F2 – 5 machines
  5 · 5325 = 26625 RON
- the milling module F3 – 6 machines
  6 · 5325 = 31950 RON
- the drilling module G – 2 machines

$2 \cdot 42500 = 85000$ RON

- the finishing module R – 8 machines

$8 \cdot 10500 = 84000$ RON

In the dynamic configuration [1] the systems parameters were calculated (table 2) and with their help the products' times necessary for passing through FMS.

Table 2. Dynamic parameters of FMS

Modul Indicator	C	S1	F1	S2	F2	F3	G	R
$\overline{n}$	1.07	0.942	0.953	0.774	0	0.52	1.4	0.182
$\overline{n_f}$	0.46	$7.3 \cdot 10^{-5}$	$5.4 \cdot 10^{-8}$	$1.1 \cdot 10^{-5}$	0	$4.7 \cdot 10^{-7}$	0.81	$4.2 \cdot 10^{-14}$
$\overline{n_s}$	0.60	0.941	0.953	0.774	0	0.52	0.58	0.182
$\overline{t_f}$ [ore]	0.03	$1.8 \cdot 10^{-3}$	$2.8 \cdot 10^{-4}$	$3.4 \cdot 10^{-4}$	0	$2.1 \cdot 10^{-5}$	0.21	$1.6 \cdot 10^{-10}$
$\overline{t_s}$ [ore]	0.03	0.164	0.111	0.17	0.19	0.163	0.36	0.06
P_0	-	2.124	2.063	1.286	1	1.018	-	1

Admittedly in values' analisys it's working with the notion of function which is considered as a special quality of the goal. In this case of the flexible manufacturing system the functions are represented by the operation modules defined like this: centre drilling, lathe, milling work, drilling, rectification and that compose the flexible manufacturing system. In the values' analisys a very important thing is the ordering, the functions' ranking namely to determine the relative positions and the ponderosity for each function in the usability value of the product. [2,4]

The values' analisys says that the product by itself isn't important but the utility offered by its functions, so in this case it will be discussed about the utility of each module that compounds the flexible manufacturing system.

So the utility of each operation module is perceived through the time fund that must be achieved reported to the total time fund for processing, afferent to the components presumed to be processed.

The utilities are calculated with the next formula, in fact the utilities representing ponderosities:

$$U = \frac{\sum t_m}{\sum t_{tot}} \qquad (1),$$

where:

$\sum t_m$ – the sum of the components' processing times that passes through a specific module;

$\sum t_{tot}$ – the total time necessary for the components' passing through all the modules.

After the calculations for all the 8 operation modules for static configuration the results from table 3 were obtained:

Table 3. The ponderosities of the processing times for static configuration

Module	Processing times [min/buc]	Ponderosity %
Centre drilling	272330	2.9
Lathe 1	1295490	14.1
Lathe 2	1300848	14.2
Milling work 1	1931292	21.1
Milling work 2	1107464	12.1
Milling work 3	1262399	13.8
Drilling	393671	4.3
Rectification	1564296	17.1

After the ponderosities were calculated as processing time, to be able to make a fine comparison it will also be calculated the ponderosities as values for each module. These ponderosities are calculated in the same way as the ponderosities as processing time are, only that in this situation the value of one module will be reported to the total value of those 8 modules.

The formula is:

$$P = \frac{V_{modul}}{V_{tot}} \quad (2),$$

where:

V_{modul} = the value of one module;

V_{tot} = the total value of those 8 modules.

The results were written in table 4.

Table 4. The ponderosities as values for static configuration

Module	Value [RON]	Ponderosities %
Centre drilling	18000	4.4
Lathe 1	54000	13.4
Lathe 2	54000	13.4
Milling work 1	47925	11.9
Milling work 2	26625	6.6
Milling work 3	31950	7.9
Drilling	85000	21.1
Rectification	84000	20.9

As it can be observed there is a little discordance between the ponderosities as processing time for the drilling operation module and the value ponderosity of the drilling machine. After some examinations it was attained to the conclusion that the drilling machine's value is overrated.

Because the number of the machines from the static configuration is different we will present a new case where only the machines' value is modified and not the processing time (table 5).

Table 5. The new situation

Module	Value [RON]	Ponderosity %
Centre drilling	18000	4.18
Lathe 1	72000	16.73
Lathe 2	54000	12.55
Milling work 1	58575	13.61
Milling work 2	26625	6.18
Milling work 3	31950	7.42
Drilling	85000	19.76
Rectification	84000	19.52

There must be made some assignations concerning the work units: would be wrong to refer to the accuracy of the obtained values from several reasons. One of this is that the prices fluctuate. For example in this flexible manufacturing system the prices of the processing units represent levels of selling as second-hand units.

So the presented calculation modality offers a better orientation and locates us in a certain area of value.

Besides in the special literature it's mentioned with the help of arguments that reduces the rhythm of insertion of these flexible manufacturing systems, exactly the fact that not always can be precisely established the costs of investments, these costs mostly exceed the predictions.

For a practical examination of those identities it is used a regression analysis. The analysis consists of determining the possible concordance between the module's value and its utility characterized through loading degree. The regression curve must pass through the origin of the coordinate axes because it's considered that a function with zero ponderosity must cost zero.

From the regression analysis has resulted:

For static configuration by regression between the ponderosities of processing time and the value ponderosities was obtained the regression curve's equation:

$Y = - 1.51 + 9.72X – 2.06X^2 +0.15X^3 – 0.003X^4$

The coefficient of correlation: 0.8

For static configuration by regression between the degree of the machines' usability and the machines' value was obtained the correlation:

$Y = - 0.96 – 73675.12X + 2682.38X^2 – 31.33X^3 + 0.12X^4$

The coefficient of correlation: 0.94

For dynamic configuration the first graphic (fig.1) presents on X axis the ponderosities of processing time and on Y axis the value ponderosities for operation modules acquiring the equation of regression:

$Y = - 1.34 + 8.77X – 1.81X^2 + 0.13X^3 – 0.003X^4$

The coefficient of correlation: 0.78

The second graphic from dynamic configuration (fig.2) presents on X axis the degree of the machines' usability and on Y axis the machines' value:

$Y = - 19.03 + 4689.33X – 274.46X^2 + 5.014X^3 –0.02X^4$

The coefficient of correlation: 0.76

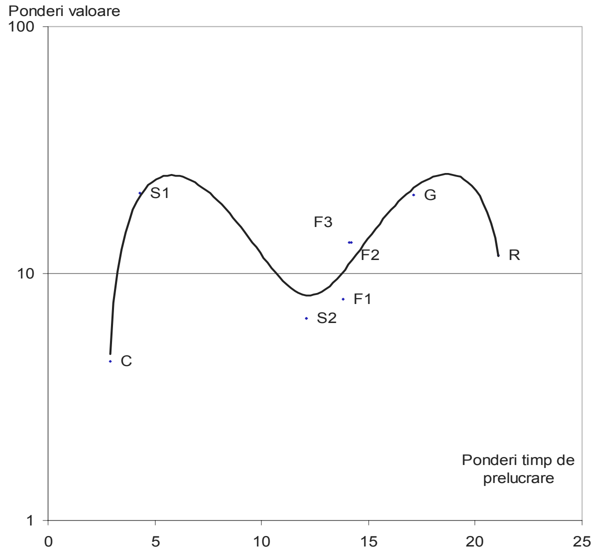

Fig.1.

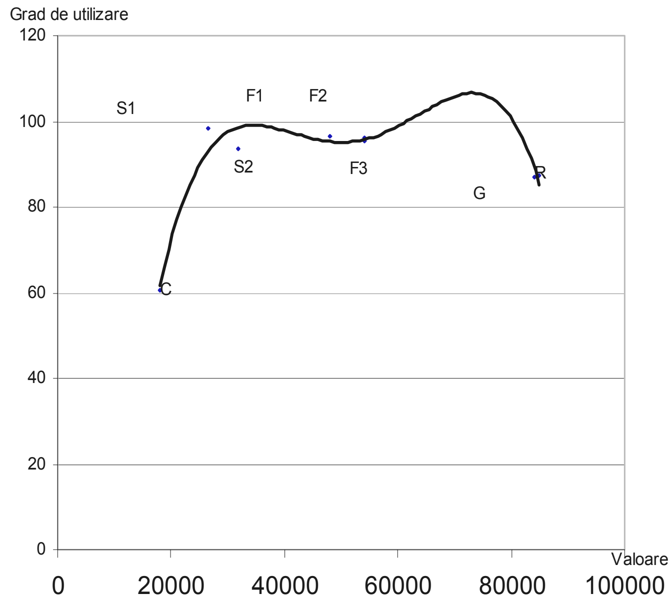

Fig.2.

The coefficients of correlation have good values that lead on the conclusion that there is a link-up between the analyzed data.

In the graphic we observe that some points are positioned over the regression curve and the conclusion is that the modules corresponding to these points are achieved with the costs greater than theirs contribution to the achievement of parts. These modules are overdimension.

On the other hand, the modules represented by the points under the regression line are underdimension.

These conclusions are very useful because they help very well at the re-designing of the processing modules who was unsatisfied in the analyzed variant.

Having in view the greatest costs need for to set-up of a Flexible Manufacturing Systems, we consider as very necessary the usage of the value analysis as modern method in the designing of FMS.

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