UP' - Production Unit, a New Method to Measure Costs and Industrial Controls

Valerio Allora, eng.
Tecnosul Engenharia de Sistemas Ltda.
Rua 15 de Novembro, 1336 sala: 75
Blumenau - SC - Brazil - 89010-903

Abstract

This work represents a new method to measure diversified production costs based on measuring the efforts of each elementary operation in the industrial process. Until now, except in the case when only a product is manufactured, the types and quantities of manufactured products can only be counted, which is a slow and meaningless procedure regarding total factory production. To have a better idea of the production we must use one of the known units: feet, meters, gallons, kilos, etc. The UP' (Production Unit) can do this job by using the conception of production effort. This new concept represents for one machine, the human effort, capital, electric power and other direct and indirect efforts applied. The production efforts originating from all kinds of machines such as lathe, cutting machines, etc., can be added. By measuring these efforts, we can have the total effort of one factory as the sum of all the partial efforts developed by each machine. Then each product can be measured by the quantity of effort necessary to manufacture it. This calculation allows our measuring industrial cost and control with a specific unit that measures a diversified production.

The UP' Method

A factory production during a set length of time (period) corresponds to the amount of objects produced or those under manufacturing process. How to measure this production? Up to now, except in the case when only one product is manufactured, the quantity and types of manufactured products can only be counted what's a slow and meaningless job regarding the total factory production. To have a real idea of what's been produced we need to use conventional measuring unit, such as meter, kilogram, peace, etc., which can better apply to the product manufactured.

The number of pieces and meters in the weaving and manufacturing textile units, kilos in the steel foundries, in some cases the number of worked hours, etc., are all faulty units that will not show the real value of the total production. In short, a proper production measuring unit is not available in the market no matter what product you consider.

A single production measuring unit would eliminate those doubts if based on the notion of "Production effort". This new notion is the expression, of the human effort, the machine, the financial, the applied energy, and other efforts directly or indirectly applied. The production efforts, so defined, originated in all the sectors of the factory and their machines, notwithstanding their different sources such as lathes, cutting machines, assemblage, etc. have, all of them, fundamental attributes: they can be added summed up.

We can then assume that the total effort of production of a factory is the result of the addition of all partial production efforts carried out in each one of the operational sites (manufacturing operations). All products, no matter how diversified or how numerous they were can be measured through the amount of effort necessary to manufacture them since they went through the various manufacturing operations and submitted to such efforts.

By means of the diagram below (Figure 1) the effort undertaken can be understood, i.e. the "production effort" is the factory work accomplished to the raw material in a finished product. This work can be called "effort" and it will be the sum and total of the human, financial, energy and other direct and indirect efforts.

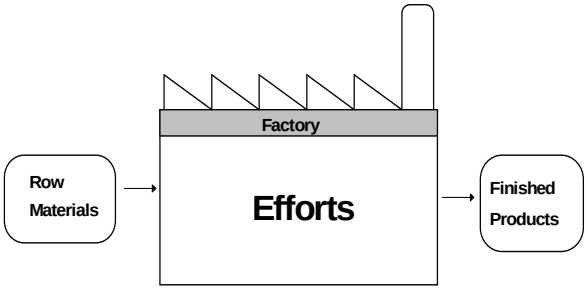

Figure 1: Graphic representation of the production effort.

To measure a production effort, let's take a lathe and a cutting machine working within specific conditions. These two machines develop, per hour, production effort whose absolute value is only abstract. But an element can be defined, calculated and measured: the ratio between the two efforts. This leads to the basic principle of our method, The principle of hidden constants: "No matter how different the unit prices are, the production efforts developed by the various elementary (basic) work operations in a factory, are interconnected to one another through constant ratios in a period of time".

The system (method) measures, at a fixed moment (instant) all the cost of all production efforts and calculates the ratios among them. Once it's done, the system operates only with the "ratios" which are designated as "UP'" or "Production Units" (also known as UEP - Production Effort Unit). The production efforts in each work site are expressed and measured as quantities of UP/h and all the products by the number of UP' accumulated during their manufacturing processes. The total of production efforts in UP', which is equal to the sum of each product, measures the factory production. The periodical UP' value in money, a very simple calculation, will show its actual real value, allowing in this way to quantify in UP's and in money any product or production, no matter how diversified they are.

The UP's (Production Units) remain constant for a long time. The theory accepts that and the experience demonstrated that recalculations and revisions made after 5 or more years in many companies, where there were remarkable increases in plants, employees and machines show insignificant variations for the UP's reinforcing their constant behavior in the long run. All the theorems and principles were exhaustively studied by important Brazilian Universities, proving its suitability and reliability, through Post-Graduation Ph.D. theses, giving, this way, a high scientific content to the UP's method.

Theoretical Example for the Calculation of the UP'

Once acquainted with the concepts relative to the UP' method, it is possible to study its application in a general way, however the method must be adapted to each factory due to its specific needs in real situations.

For each Operational Site (OS), which is a manufacturing operation, we calculate the costs of its unit production efforts and put them as a function of time (cost-value/hour) what we call Operational Site Photo-Index (OSPI), all at a fixed instant in time. The most important items for the transformation costs (efforts) used in the calculation of the OSPI are the following:

a) Direct manpower: Unit value of salary registered in the work-permit, i.e., the real salary, not including the payment of the days of rest over the week-ends, plus all any possible additional charges.
b) Supervision and leadership: Supervisors, leaders, people in charge attributed to the manufacturing operations according to the necessary degree of attention required.
c) Social security: All the charges required by law plus the benefits granted by the company to its employees.
d) Technical depreciation: Fiscal rules establish that a machine or an equipment must be depreciated according to pre-determined rules, being its value also calculated by means of its patrimonial value. To establish a good ratio between the OS efforts, a concept like this cannot be used and the technical

depreciation should be calculated on the real values of the equipment and their true useful life. With this we will be able to establish better ratios relative to the equipment values.
e) Specific use materials: They are the materials used by the machine, i.e., what the machine uses during its operation to execute its task such as sandpaper, drilling bits, knives, lubricants, etc.
f) Spare parts: Parts to replace the worn-out ones.
g) Electrical power: The power used by each equipment according to its specific consumption in KW.
h) Maintenance: The value spent by the Maintenance department attributed to the OS's according to the hours worked by this dept.
i) Utilities: They are all the expenses with the equipment that are not involved with the transformation of the raw materials but help the OS's to transform them. For instance: air compressors, air conditioners, etc. whose cost will be attributed only to the sites which used them and not to the sector.

As a function of the OS definition of and the expenses attributed to them (the items which were described above) it's possible to collect the necessary data to calculate the OSPI. Once these data are available, they will be worked upon, so as to allow the calculation of the various OSPI's of the various OS's. The OSPI's are the sum of the costs of the various items allocated to each OS.

The next step will be to calculate the Base Photo-Index (BPI) which corresponds to the amount spent to manufacture a base product unit in a set instant and considering only the "worked upon" expenses for the OSPI composition. To do this it is necessary to define the base product and its respective process sheet. The base product must be chosen so as to be the most representative of the company's structure (organization). It can be the product which goes through the major number of the OS's. This could be an imaginary product or a combination of several products forming a mix. The base product is the one that defines the "UP'" stability i.e. it will be responsible for the absorption of the variations in the expense allocated to the OSPI which maintain the UP's of the products constant as a function of the variations that may occur in these expenses items during the method employment.

The BPI is obtained through the sum whose parcels are the result of the multiplication of the OSPI of each OS by the respective lengths of time of the base product in the operational sites. The value of a "UP'" corresponds to a multiple of the base index which, itself, corresponds to the monetary value in ideal working conditions at the set instant of time. The OS's UP/hour will be then calculated. This will be done by dividing the OSPI's of each OS by BPI which results the UP/h of each operational site.

Finally, a product value in UP' is calculated using the sum which corresponds to the multiplication of the UP/h of the operational sites (OS's) by the respective lengths of time of the products sites. For that it's necessary to know the processing length of (manufacturing) time of all the products in each of its operations.

At this moment we know the product UP's which represent the transformation of the raw material into a finished product, i.e. the effort made to manufacture it. To obtain the transformation cost of each product we must find out how much the factory produced during an established period of time. To find this out we multiply the values in UP's of each product by the amounts produced what leads us to a production amount expressed in UP's.

Now with the information of the production expenses (except raw material) for the same period, i.e., salaries, energy, parts, etc. the value of one UP' in this period may be calculated. By dividing the total production expenses by the total of produced UP's we will have the monetary value of each UP' produced in this same period.

Finally, the transformation cost of each product can be calculated by multiplying it's value in UP' by the monetary value of a production unit in this period. This result is then the transformation cost or industrial cost.

Simplified Numerical Example

Let's compile a chart (Table 1) with all the operational site and their expenses as described in the previous item, i.e., the OSPI chart:

Where:

1	Direct Manpower
2	Indirect Manpower
3	Social Charges
4	Technical Amortization
5	Specific Consumption Materials
6	Maintenance Spare Parts
7	Electrical Power
8	Maintenance
9	Utilities

Table 1: Costs/hour for each operational site in $/h

Code	1	2	3	4	5	6	7	8	9	Total
7001	4,00	2,00	7,20	3,20	5,30	3,10	3,10	1,20	1,06	**30,16**
7010	5,00	3,00	9,60	5,60	6,10	6,20	2,30	5,20	5,28	**48,28**
7020	7,00	4,00	13,20	2,30	3,10	4,20	1,23	4,10	2,81	**41,94**
7030	5,00	4,00	10,80	2,50	0,50	3,20	2,40	1,90	0,08	**30,38**
7050	4,00	3,00	8,40	1,20	1,00	1,20	3,50	2,30	0,58	**25,18**
7051	4,00	3,00	8,40	1,30	1,00	1,40	2,10	3,20	0,72	**25,12**
7060	4,00	3,00	8,40	1,50	3,10	3,90	2,10	3,80	3,94	**33,74**
7101	5,00	4,00	10,80	1,80	2,30	1,20	2,20	1,90	2,42	**31,62**
7201	8,00	2,00	12,00	4,90	6,20	7,20	4,20	5,20	13,10	**62,80**
7301	5,00	2,00	8,40	2,40	4,20	4,60	2,50	3,60	0,62	**33,32**
7501	9,00	6,00	18,00	5,60	8,60	7,60	5,20	7,00	3,54	**70,54**

According to this chart, we have then the OSPI, calculated in $/h.

Let's suppose we chose the product "X" as the base product, it's BPI will be

OS's	OSPI ($/h)	Time (h)	BPI ($)
7001	30,16	0,01200	0,362
7020	41,94	0,01000	0,419
7201	62,80	0,01000	0,628
7501	70,54	0,00838	0,591
		Total =	2,000

By dividing OSPI's by BPI we will have the OS's UP/h (Equation 1):

$$\textbf{UP/h} = \frac{\textbf{OSPI (\$/h)}}{\textbf{BPI (\$)}} \quad \textbf{(1)}$$

OS's	OSPI ($/h)	BPI ($)	UP/h
7001	30,16	2,00	15,08
7010	48,28	2,00	24,14
7020	41,94	2,00	20,97
7030	30,38	2,00	15,19
7050	25,18	2,00	12,59

7051	25,12	2,00	12,56
7060	33,74	2,00	16,87
7101	31,62	2,00	15,81
7201	62,80	2,00	31,40
7301	33,32	2,00	16,66
7501	70,54	2,00	35,27

Supposing that the company manufactures products A, B, C, D, we'll have to compile their process charts, i.e., flows and time for each operation (OS). Let's do it for products A, B, only:

Product A:

OS's	UP/h	time (h)	UP'
7001	15,08	0,092	1,39
7020	20,97	0,102	2,14
7060	16,87	0,212	3,58
7501	35,27	0,035	1,23
		Total =	8,34

Product B:

OS's	UP/h	time (h)	UP'
7001	15,08	0,086	1,30
7020	20,97	0,093	1,95
7030	15,19	0,103	1,56
7101	15,81	0,082	1,30
7301	16,66	0,150	2,50
7501	35,27	0,022	0,78
		Total =	9,39

Total production in UP's in the period

Product	Total Produced	UP's	Total UP's
A	2.000 pc	8,34	16.680
B	3.000 pc	9,39	28.170
C	500 pc	5,20	2.600
D	2.740 pc	7,30	20.002
E	11.524 pc	2,00	23.048
	Total of UP's produced	=	90.500

UP' value calculation

The UP' value calculation (Equation 2), where the industrial expenses is $ 11.765.000, will be:

$$\textbf{UP' value (\$/UP')} = \frac{\textbf{Total industrial expenses (without raw-materials)}}{\textbf{Total UP's produced in the period}} \quad \textbf{(2)}$$

$$\text{UP' value (\$/UP')} = \frac{11.765.000\ \$}{}$$

90.500 UP's

UP' value ($/UP') = 130 $/UP'

Products transformation costs (effort)

Product A: (transformation)

8,34 UP's * 130 $/UP' = 1.084,20 $

Product B: (transformation)

9,39 UP's * 130 $/UP' = 1.220,70 $

Obs: In this system's example, we are developing only the working cost, transformation cost, without the raw material cost. To calculate this cost we only need to calculate the consumption for each product and multiply it by its unit value.

Cost of each step of the process

Let's show now, step by step, how to calculate a product cost by using the UP' system in its manufacturing process. Consider product B as an example:

OS's	UP's	$/UP'	$ (transformation)
7001	1,30	130	169,00
7020	1,95	130	253,50
7030	1,56	130	202,80
7101	1,30	130	169,00
7301	2,50	130	325,00
7501	0,78	130	101,40
		Total =	1.220,70 $

We can then verify with this calculation the product cost for each machine it goes through, or in every step of the process with the most accuracy.