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INDUSTRIAL PLANTS

Chapter six:

Potentiality of industrial plants

DOUBLE DEGREE MASTER IN

“PRODUCTION ENGINEERING AND MANAGEMENT”

CAMPUS OF PORDENONE

UNIVERSITY OF TRIESTE

Generality

To define the **potentiality to be assigned to a new plants** is generally used of the appropriate market researches aimed at quantifying the demand for that asset in the market.

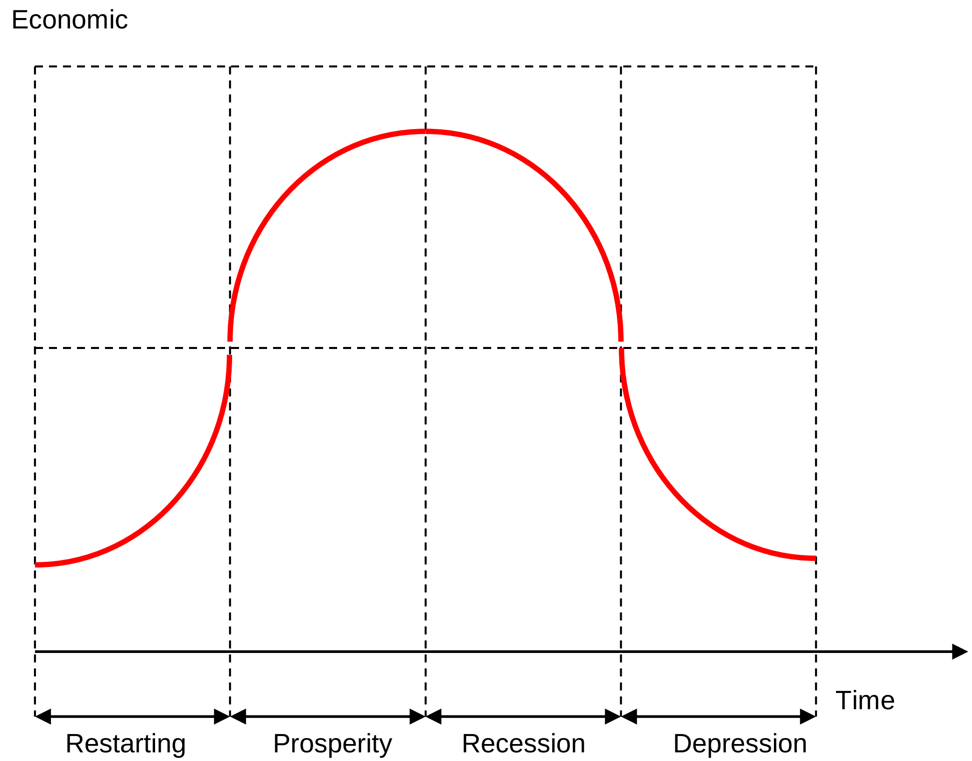
Factors that should be considered in this researches are:

- **economic situation of the Country;**
- **a forecast of future demand;**
- **seasonal variation in demand;**
- **discard and production efficiency;**
- **method of production;**
- **investment necessary.**

We must set objectives ***covering*** of the demand, in percentage terms, which must of course be supported by an appropriate distribution and advertising policy objectives.

Factors that influence the potentiality of an industrial plant

The **economic** has the following behavior:



The ***economic situation*** of a country is influenced by the international economic and inflationary pressures.

Factors that influence the potentiality of an industrial plant

The **potentiality of the industrial plant** must also take account of the **forecast about future demand** required by the market.

The **seasonal variation in demand** must be taken into account for determining the potentiality.

If the change was significant between seasons, you should consider the introduction of complementary products designed to saturate the production system.

In evaluating the potentiality of an industrial plant must be taken into account the **production of discard and of stops due to failure** of machinery, equipment etc. and hence their efficiency (ratio between the effective operating time and the total working time).

Important in recent years is the introduction of the principles of Lean manufacturing.

The principles of Lean Manufacturing are: define the value, that recognized by the client, identify the value stream, flowing the flow, simplifying and elaborating a new, driven by the flow passage than pulled by demand (from push to pull), take perfection for drive continuous improvement

Factors that influence the potentiality of an industrial plant

Exemple:

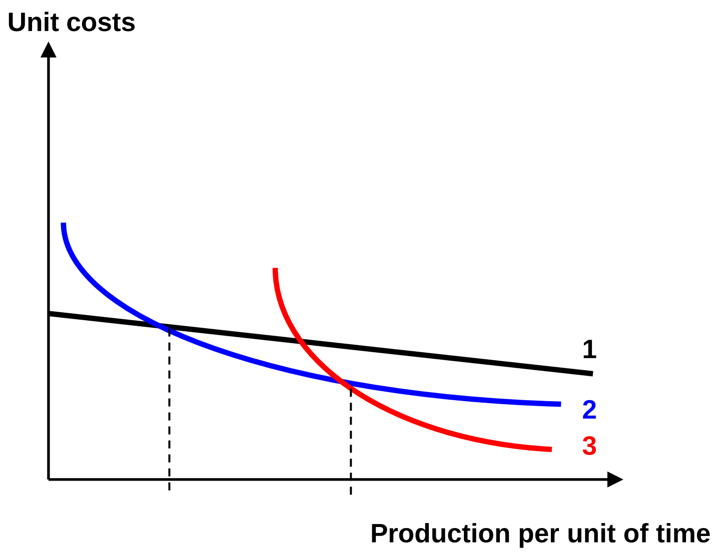
Consider an industrial plant of the sector wood-furniture in which it provides for the production of 10,000 units/year of furniture, with a percentage of discards of 4%, a yield of 90% of the plant system, a number of hours of work weekly 40 and number of working weeks per year of 45. You can determine the production of units/h according to the report:

$$\frac{10.000}{40 \cdot 45 \cdot (1{,}00 - 0{,}04) \cdot 0{,}9} = 6{,}5 \ \ furnishing / h$$

It should also seek to identify the best **processing method** for the production per unit of time which increase from the transition from a manual production system to those of degree of mechanization or automation more stringent

Factors that influence the potentiality of an industrial plant

Analyse the figure:

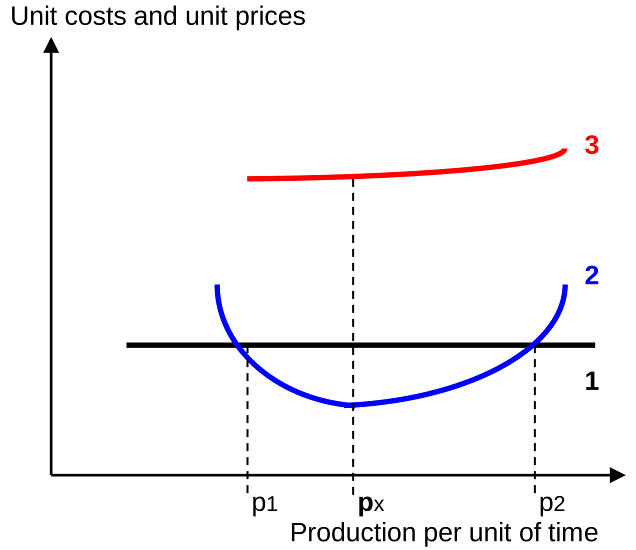


Referring to the single unit of output, the costs of production have a decreasing trend; will be chosen depending on the processing method of production per unit of time specification:

- method of manual work (curve 1)
- mechanized working method (curve 2)
- automated working method (curve 3)

Factors that influence the potentiality of an industrial plant

Referring to the selling price of the unit of product, can be made of the considerations specific to revenues subsequent to the adoption of a method of machining.



In a market where prices are constant (curve 1), whose curve of cost (curve 2) intended to establish the field of production volumes between p_1 e p_2, in correspondence of which costs equals the price. The convenience of this type of processing is one that provides for the production of the quantity p_x and investment content (curve 3)

Determination of the potentiality of units of production

To define the **potentiality effective** and **nominal** of the plants or production units must:

- **determine the number of units**;
- **determine the actual operating time of the same**;
- **determine the yield (use);**
- **determine the discards.**

Interesting is the determination of **measures of potentiality** and **productivity**.

Both "x" a generic product and the "i" a time interval. Through periodic measurements to obtain the desired units of product x can be obtained per unit of time (hours) under normal operating conditions (operating machinery, availability and quality of materials etc.) - **standard production rate**: **RS_{xi}** expressed in units/h.

Determination of the potentiality of units of production

The **standard time per unit of product** x is defined by:

$$TSU_{xi} = \frac{1}{RS_{xi}} \quad (h/unit)$$

Consider a set of products (family) worked according to a given mix, the potentiality of mix P_{mix} is:

$$P_{mix} = \frac{\sum_i (QB+QS)_i}{\sum_i (TPb_i + TPs_i) + TS} \quad (units/h)$$

where:

- QB quantity of product good (conforms);
- QS quantity of the product of discard;
- TPb time taken to produce QB;
- TPs time taken to produce QS;
- TS total time of setup;
- $\sum_i (QB+QS)_i$ total number of units produced in the different intervals of time i;
- $\sum_i (TPb_i + TPs_i) + TS$ time dedicated to the production of the same set of products (good or discard) plus the total time of setup.

Determination of the potentiality of units of production

The **potentiality of mix Pmix** is therefore:

$$P_{mix} = \frac{total\ \ quantity\ \ of\ \ production}{hours\ request\ \ per\ production\ \ \ the\ mix\ assigned}$$

being:

$$\sum_i (QB+QS)_i = \sum_i \left[RS_i \cdot (TPb_i + TPs_i)\right]$$

is:

$$P_{mix} = \frac{\sum_i \left[RS_i \cdot (TPb_i + TPs_i)\right]}{\sum_i (TPb_i + TPs_i) + TS} \quad (units/h)$$

In the face of a mix assigned, one can derive the quantities produced (estimate) as the sum of all quantities producible in each interval i-th of operation. Note that the standard rhythm depends on the product (or family).

$$\sum_i (TPb_i + TPs_i) = \sum_i \left[\frac{(QB+QS)_i}{RS_i}\right]$$

The total production time is equal (at standard conditions) to the total quantity to be produced divided by the standard rhythm.

Determination of the potentiality of units of production

Exemple

It is considered a production line with an open time of plant T = 400 hours. During this period it was produced a mix of two products 1 and 2, the times were:

- TP_{b1} = 150 h, TP_{s1}= 0 h, RS_1 = 750 units/h;
- TP_{b2} = 180 h, TP_{s2} = 5 h, RS_2 = 700 units/h.

The line has maximun rhythm production (Rmax) and potentiality of plate (PT):

PT = 800 units/h

Through the relation:

$$\sum_i (QB+QS)_i = \sum_i \left[RS_i \cdot (TPb_i + TPs_i)\right]$$

we estimate the quantities obtained in the periods measured (TP_{bi} and TP_{si}) if you are working according to the standard rhythms, which are the units producible in period T (NP):

$$NP = RS_1 \cdot (TPb_1 + TPs_1) + RS_2 \cdot (TPb_2 + TPs_2) = 112.500 + 129.500 = 242.000 \ units$$

Determination of the potentiality of units of production

Assigned a mix of production, we can estimate the standard potentiality of the mix in a first mode:

$$\bar{P}_{mix} = \frac{\sum_i (QB+QS)_i}{\sum_i \left[\frac{(QB+QS)_i}{RS_i} \right] + \bar{\bar{TS}}} \quad (units\ of\ mix/h)$$

note:

- the quantity to be produced QB_i;
- the average incidence of discards QS_i;
- the standard rhythms RS_i;
- the total time of setup standard TS

$$\bar{P}_{mix} = \frac{\sum_i RS_i \cdot (TPb_i + TPs_i)}{\sum_i (TPb_i + TPs_i) + \bar{\bar{TS}}} \quad (units\ of\ mix/h)$$

note:

- the standard times used to produce a certain amount, gross incidence (estimated) of the discards;
- the standard rhythm;
- the total time of setup standard.

Determination of the potentiality of units of production

You may want to express the potentiality to mix not in units of mix, but in equivalent units of a product k of the mix.

$$\bar{P}_{mix} = \frac{(QB+QS)_k + (QB+QS)_j \cdot \dfrac{RS_k}{RS_j}}{\dfrac{(QB+QS)_k}{RSk} + \dfrac{(QB+QS)_j}{RS_j} + \overline{TS}} \quad (equivalent\ units\ of\ mix/h)$$

The value of $(QB+QS)_j$, expressed in units of the mix, is converted in units of k through RS_k/RS_j.

The amount of product k which can be obtained in the time of production (at standard rhythms) derives from the constancy of the time to produce j.

$$(TPb_j + TPs_j) = \frac{(QB+QS)_j}{RS_j} = \frac{(\overline{QB+QS})_k}{RS_k}$$

$(\overline{QB+QS})_k$ represents the total amount of product producible k (in standard conditions) in the time.

Determination of the potentiality of units of production

Using the example above, we have:

- product 1

$$\left(TPb_1 + TPs_1\right) = \frac{\left(QB + QS\right)_1}{RS_1} = \frac{112.500}{750} = 150 \;\; h$$

- product 2

$$\left(TPb_1 + TPs_1\right) = (180 + 5) = \frac{\left(QB + QS\right)_2}{RS_2} = \frac{\overline{\left(QB + QS\right)}_1}{RS_1}$$

$$\overline{\left(QB + QS\right)}_1 = 129.500 \cdot \frac{750}{700} = 138.750 \;\; equivalent \;\; units \;\; k$$

Determination of the potentiality of units of production

We will now define the **expected production in an allotted time**.

By defining the **solar time Ts**, you can determine the **time of opening of the plant** : **T = Ts – time non-working = Ta (ore)**

You must consider several times that correspond to states of plant:

a) time taken up by stops for reasons outside the department:
   - TMo, lack orders;
   - TMm, lack material;
   - TSc, causes of trade union;

b) times absorbed by *internal causes* to the department:
   - TO, organizational causes of department (expected, micro-absenteeism, etc.).

   The two components define that the plant is *available*, but *inactive*.

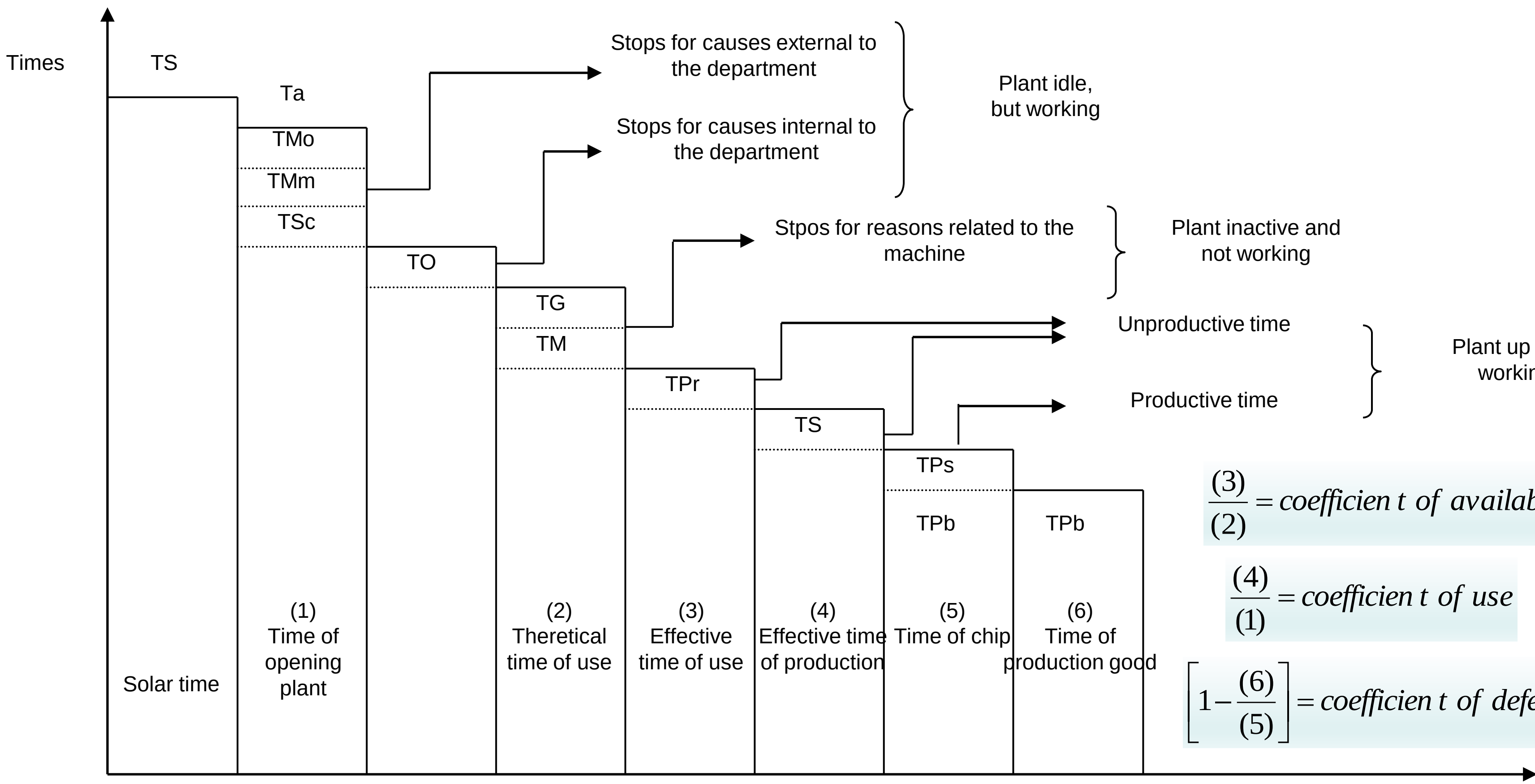
c) times absorbed by stops for *reasons related to the plant*:
   - TG, failures of line or of machine;
   - TM, scheduled shutdowns for maintenance.

   Situation where the plant is *idle* and *not working*.

d) time "unproductive":
   - TPr, activity of tests and sampling;
   - TS, activities of setup.

Determination of the potentiality of units of production

States of the plant:



$$\frac{(3)}{(2)} = coefficient\ of\ availability$$

$$\frac{(4)}{(1)} = coefficient\ of\ use$$

$$\left[1 - \frac{(6)}{(5)}\right] = coefficient\ of\ defectiveness$$

Determination of the potentiality of units of production

The **theoretical potentiality** Pt of a machine (or line) is defined by:

Pt = PT . A (units/h)

where:

PT is the potential for plate (or nominal)

A is the coefficient of availability:

$$A = \frac{T - TM_o - TM_m - TS_c - TO - TG - TM}{T - TM_o - TM_m - TS_c - TO}$$

Can be estimated for a period T (week, month, year) the waiting potentiality of time, ie the **available production capacity standards** CPD defined by:

CPD = Pmix . A . T' (units)

where:

T' = T – TP_r – TS_c – TO, in that in the case of estimate the production capacity is considered the same incidence of tests, strikes and breaks organizational deduced from the past, while remain undeterminable, and not desirable in the prediction TM_o e TM_m.

Determination of the potentiality of units of production

Retaking the example:

TM_o = 8 h, TM_m = 4 h, TS_c = 0 h, TO = 7 h, TG = 16 h, TM = 10 h, TP_r = 6 h, TS =14 h, NB = 215.000 units conform produced e NT = 225.000 total units produced

we obtain:

$$A = \frac{T - TM_o - TM_m - TS_c - TO - TG - TM}{T - TM_o - TM_m - TS_c - TO} = \frac{400 - 8 - 4 - 0 - 7 - 16 - 10}{400 - 8 - 4 - 0 - 7} = \frac{455}{481} = 0{,}946$$

Pt = PT . A = 800 · 0,946 = 756,8 units/h

Determination of the potentiality of units of production

The value obtained by multiplying the P_{mix} for A (P'_{mix}) provides the potentiality of mix on medium to long periods achievable taking into account of the incidence of failure and were scheduled stop, in the case of knowledge of TG e TM.

$$\bar{P}_{mix} = \frac{\sum_i RS_i \cdot (TPb_i + TPs_i)}{\sum_i (TPb_i + TPs_i) + \bar{\bar{TS}}} = \frac{750 \cdot 150 + 750 \cdot 185}{150 + 185 + 14} = 693{,}5 \ units \ of \ mix / h$$

CPD = P_{mix}.A.T’ = P'_{max} · T’ = 693,4 · 0,946 · (400 – 6 – 0 - 7) = 253.928 units

Determination of the potentiality of units of production

Defining a **coefficient of utilization** U:

$$U = \frac{effective\ time\ of\ production}{time\ of\ open\ of\ the\ plant} = \frac{T - TM_o - TM_m - TS_c - TO - TG - TM - TP_r}{T}$$

$$U = \frac{\sum_i \left[\left(TPb_i + TPs_i \right) + TS \right]}{T}$$

it is also purified T of time dedicated to the production of test samples and, thus U is representative of the time used only to produce QB and QS. Continuing the example:

$$U = \frac{400 - 8 - 4 - 0 - 7 - 16 - 10 - 6}{400} = \frac{\left[\left(150 + 0 \right) + \left(180 + 5 \right) + 14 \right]}{400} = 0{,}873$$

The coefficient of utilization is the ratio between the capacity productive used (CPU) and the theoretical capacity (CPT).

Determination of the potentiality of units of production

The coefficients of use should not be confused with those of efficiency.

The yield η is defined by:

$$\eta = \frac{effective\ \ production}{s\tan dard\ \ production\ \ in\ base\ at\ effective\ \ hours} = \frac{\sum_i (QS + QS)}{\left[\sum_i (TPb_i + TPs_i) + TS\right] \cdot P_{mix}}$$

The estimate of the expected production in the time interval T, presumably close to that effective, because as corrected with values of use and performance is equal to:

$CPD' = P_{mix} \,.\, T \,.\, U \,.\, \eta$