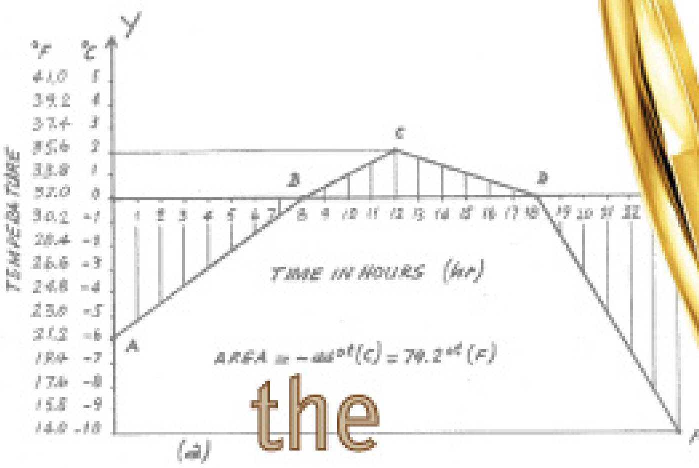
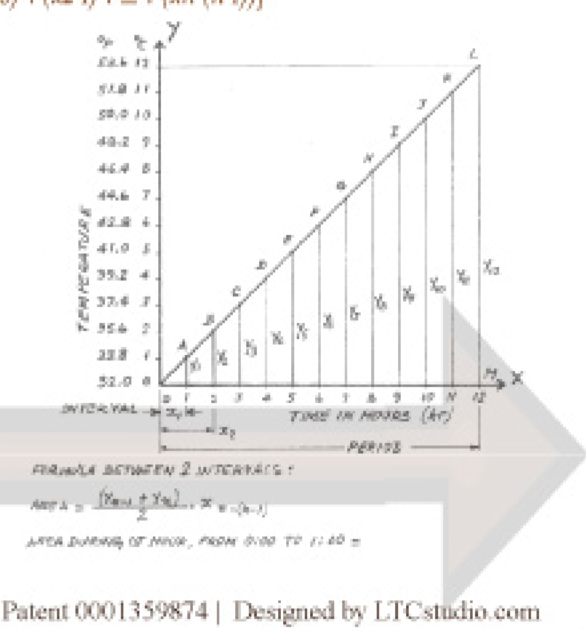
PiazzaDegree.com



the °Piazza Degree

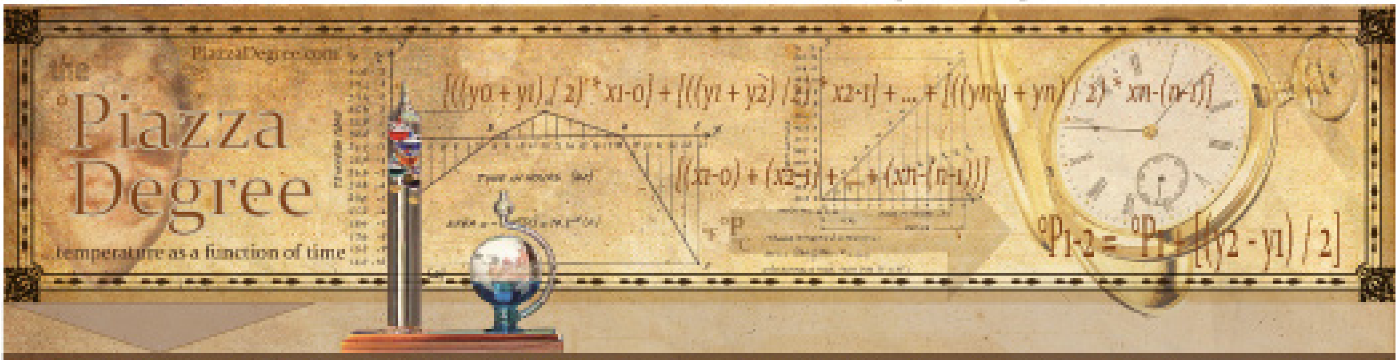
...temperature as a function of time

$$\frac{\left[\left(\left(y_0 + y_1\right) / 2\right) * x_{1-0}\right] + \left[\left(\left(y_1 + y_2\right) / 2\right) * x_{2-1}\right] + \ldots + \left[\left(\left(y_{n-1} + y_n\right) / 2\right) * x_{n-(n-1)}\right]}{\left[\left(x_{1-0}\right) + \left(x_{2-1}\right) + \ldots + \left(x_{n-(n-1)}\right)\right]}$$



$$°P_{1-2} = °P_1 + \left[\left(y_2 - y_1\right) / 2\right]$$

°F °P °C



I dedicate this study to my brother Vincent (Enzo), who was my inspiration for this function with his practical and schematic logic.

The Piazza Degree: temperature as a function of time

The Piazza Degree evaluates the variation of the temperature as a function of time, expressing the value in a quantitative form, whereas the meteorological reports of today based on minima and maxima are indicative only, not reflecting the real heating and cooling degree days. The mathematics (based on the instantaneous area resulting from the product 'temperature times time') demonstrates that the Piazza Degree is a derivation of Celsius and Fahrenheit degrees and its application is relatively simple; dedicated software develops the product temperature-time. Recorded experimental data have proven the validity of the system in daily meteorological reports, in extended periods and in forecasting based on differentials.

... The Piazza Degree interpretation is an innovative concept in metrology.


Pietro Piazza (*left*) and Vincent (*right*) at Epcot, Disney World, Orlando, Florida, presenting one of their inventions sponsored by the U.S. Patent Office.

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°P=f(t)
Temperature as a function of time

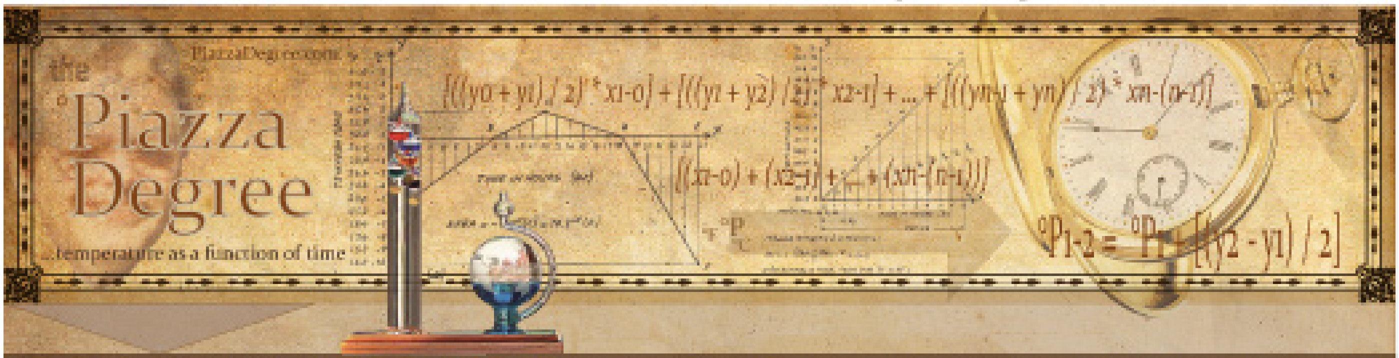
INTRODUCTION

The ***Piazza Degree*** is a system to measure the temperature as a function of time; that is a form of quantitative heat, rather than minima and maxima of daily weather reports which is only indicative. A system that represents a quantitative form that is related to an area on a Cartesian diagram, not to a point, by developing the product ***temperature-time (degree times time)***. Temperature, being an indication of heat, has no direct correlation with the quantity of it. Factor time is multiplied by the temperature which determines an area between the curve of the temperature and the axis X in analytic geometry.

The ***Piazza Degree*** is similar to Celsius and Fahrenheit, since it is a derivation, however it incorporates within itself the dimension of time, assuming a different value in accordance with a selected interval and period of time. When the temperature is multiplied by a certain period of time, it results in duration of time, which may be sustained at that level for the period considered. The temperature-time concept has an instantaneous value, referring to an interval approaching 0 (-zero-). There are many intervals in a selected period, as many as can be selected.

The meteorological reports of today are based on minima and maxima over a 24 hour period, with no consideration of the variations within these limits. It is assumed that the maximum temperature at a certain hour is indicative of the quantitative heat, whether it was "hot or cold", without evaluating the duration of the temperature. It is well known in kinematics that velocity is the derivative of distance with respect to time. Since the velocity is the increment of the distance in the unit of time, therefore we can define the ***Piazza Degree as the velocity of the temperature***, being the derivative of the temperature with respect to time.

This parametric concept could be continued in the second derivative from which can be obtained the acceleration of the ***Piazza Degree***, resulting in a rate of increments when two or more periods are considered, this would lead to a quantitative evaluation of weather at various spatial scales. In synthesis, the temperature, as we have interpreted it, has turned into a dynamic dimension. The mathematics applied to the system temperature-time is relatively simple: a computerized software algorithm can be designed to obtain in real time the quantitative data related to selected periods, from an infinitesimal fraction to years, with greater accuracy in quantitative value and its incremental variations.



CONCEPTION

The idea of degree-time, the product of ***degree times time***, is the analytic geometrical expression of the ***temperature as a function of time***, from which derives the Piazza Degree. My brother Vincent and I began to record hourly air temperature in 1999 in Prospect, CT and in 2000 in Flagler Beach-Palm Coast, FL as well as in Rome, Italy. The results were surprising, because many times the daily maxima from the three stations were similar, even equal. However the Palm Coast maximum of 22°C (71.6°F) was reached at an early hour, around 9:00 am and stayed at this level with small variations into late afternoon, while, in Rome, the maximum daily temperature was achieved around 1:00 pm, remaining not longer than one hour at this level.

I have written about this theoretic system by starting with the notion of positive or negative increments, considered as synonymous to the derivative and utilizing examples that the majority of people intuitively understands. The example: velocity and space. Space representing a function of time, space intended as a distance. I emphasize, ***apropos***, the fact that there is no science that cannot find its origin in simple matters, no matter how high a science is considered, it is sufficient to envision in a simple manner to clearly understand them.

The value of a variable can be ***definite or indefinite***: for example, if we say that today the maximum temperature has been 20°C (68°F) and the minimum 10°C (50°F), we do not know if it refers to a determined time: consequently it does not represent a series of value in different points between those two extreme values, it is then a variable of an ***indefinite*** value. However, if all the instantaneous values of the temperature are measured and are represented with only one value, then the variable would be ***definite***. The quantitative value of temperature is constituted by all the values of y through the intervals of a definite period. A function is a value; there is nothing other than the idea of dependency. The following defines a function:

1. **A function is an entity;** *the temperature is an entity.*
2. **A function is a variable entity;** *the temperature is a variable entity.*
3. **A function depends on another entity;** *the temperature depends on another entity, on time.*

Therefore, indicating with y the temperature and x the time, then y is a function of x:

$y = f(x)$ The graphic representation of this function y is shown in figure 1:

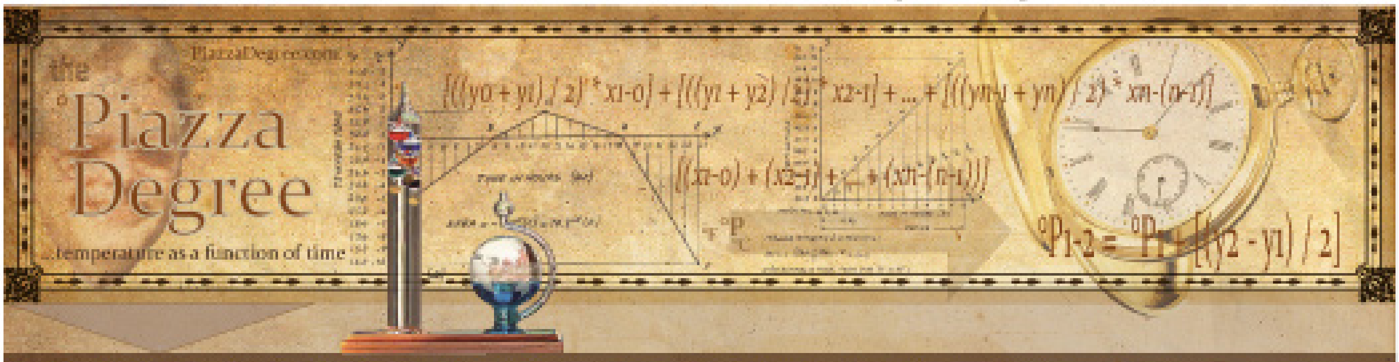
The lines drawn parallel to 0X and 0Y, intersect at points A, B, C… L; the line 0L that passes through these points represents graphically the function of the temperature. This line 0L is called ***the diagram of the function of the temperature***; in our case the diagram is a straight line, in order to facilitate the interpretation and understanding. This diagram is considered a ***definite function*** because it represents a series of values in different points of its path, whereas the diagram of minima and maxima is a ***discontinuous function***, because from a minimum value jumps to a maximum. In mathematics and in algebra we measure dimensional entities, whereas in analysis we measure the variations of these dimensional entities, we measure their increments, positive or negative; the idea of the differential and integral calculus is to calculate the increments of variations. In our study on the temperature function, we actually measure its increment, that is, we calculate its derivative, and by knowing the increment we can find the function that permits us to calculate the area.

Referring to figure 1, the area of the triangle 0-L-M is equal to:

$$Area_{1-12} = [(0 + 12) / 2] \cdot 12 = 72°^{t}C = 129.6°^{t}F$$

This triangle is divided into 12 interval hours, however if we divide in intervals close to 0 (-zero-), we would obtain a number representing the ***temperature-time*** with greater accuracy; at this point the result is instantaneously the derivative of the temperature with respect to time, ***where the temperature in degrees is the function and time is the variable***. Dividing the area of 72°^{t}C (129.6°^{t}F) by the number of intervals of the selected period of 12 hours, we obtain the Piazza Degree:

$$\text{Piazza Degree } °P(C) = 72°^{t}C / 12\ hr = 6°P(C) = 42.8°P(F)$$



MATHEMATICS

In **figure 1**, the area between 0:00 and 1:00 is limited by the segments 0A-1A-01, a triangle having base 01, height 1A and hypotenuse 0A:

$$\text{Area} = (b \cdot h) / 2$$

in our specific case, we consider it a trapezium having as base the 2 ordinates *y* and *x* as height:

$$\text{Area} = [(y_{n-1} + y_n) / 2] \cdot x_{n-(n-1)}$$

The area of the 1st hour, from 0:00 to 1:00 is:

$$\text{Area}_{0-1} = [(0+1) / 2] \cdot 1 = 0.5°^tC = 0.9°^tF$$

Dividing the A_{0-1} by the number of intervals, in this case equal to 1, we obtain:

$$\text{Piazza Degree} = \text{Area}_{0-1} / 1_{\,hr} = 0.5 / 1_{\,hr} = 0.5°P(C) = 32.9°P(F)$$

Considering now the 2nd hour, from 1:00 to 2:00, the area is:

$$\text{Area}_{1-2} = [(1+2) / 2] \cdot 1 = 1.5°^tC = 2.7°^tF$$

To this area Area_{1-2} we add the precedent area Area_{0-1}, the result is:

$$A_{1+2} = 1.5 + 0.5 = 2°^tC = 3.6°^tF$$

Dividing the area A_{1+2} by the number of intervals 2, we obtain the Piazza Degree:

$$°P = \text{Area}_{1+2} / 2_{\,hr} = 2 / 2 = 1°P(C) = 33.8°P(F)$$

The processing unit calculates the area of an interval and sums it to the precedent one and then divides the sum by the number of intervals in the period. The number obtained is the Piazza Degree, **°P** followed by a **(C)** for Celsius, or by **(F)**, for Fahrenheit. The applicative formula:

$$°P = \frac{[((y_0 + y_1) / 2) \cdot x_{1-0}] + [((y_1 + y_2) /2) \cdot x_{2-1}] + \ldots + [((y_{n-1} + y_n) / 2) \cdot x_{n-(n-1)}]}{[(x_{1-0}) + (x_{2-1}) + \ldots + (x_{n-(n-1)})]} \qquad (1)$$

where *y* is the temperature and *x* is the interval of time.

The interval *x* is equal to one, is constant in the period; reducing it to infinitesimal values, when *x* is approaching 0 (-zero-), then *y* represents the area, because if we consider the diagram ***temperature-time*** as the primitive or integral curve, then y totalizes the area of the derivative between the intervals y_1 and y_2:

$$\int_{x_1}^{x_2} y' d_x = y_2 - y_1$$

The result is then "an integral defined between 2 limits", because integration of a derivative is a means for measuring an area between 2 limits; we can calculate the area between 2 intervals with integration. By substituting the various members of the equation and dividing the differential $(y_2 - y_1)$ by 2, we obtain the Piazza Degree at y_2:

$$°P_{1-2} = °P_1 + [(y_2 - y_1) / 2] = \text{Piazza Degree} \qquad (2)$$

continued on page 4

MATHEMATICS - continued from page 3

The Piazza Degree is an instantaneous value at the end of each interval; the general formula is:

$$°P_n = °P_{n-1} + [(y_n - y_{n-1}) / 2] \qquad (3)$$

We can return to the area of the diagram by multiplying the Piazza Degree by the number of intervals:

$$Area_{0-n} = °P_n * N \qquad (4)$$

Where $Area_{0-n}$ is the area from beginning to end of the period considered, ***N*** is the number of intervals. Referring to **figure 2**, the area of rectangle 0-A-B-C is equivalent to the area of triangle 0-L-M shown on **figure 1**; dividing the area by the number of intervals we obtain the Piazza Degree:

$$°P(C) = Area / no.\ intervals = 72^{°t} / 12_{hr} = 6°P(C) = 42.8°P(F) \qquad (5)$$

Segment AB parallel to 0X axis is the quantitative concept:

$$AB = 6°P(C) = 42.8°P(F) \qquad (6)$$

In **figure 2**, all values of y, from y_0 to y_{12}, are equal to **6°P(C) = 42.8°P(F)**.

Referring to **figure 3(a, b, c, d)**, there are 4 diagrams shown:

(a): is the diagram of figure 1
(b): is the diagram of figure 2
(c): is a diagram having the same value of minimum and maximum of (a), but the area of quadrangular polygon O-A-B-D ($96^{°t}C = 172.8^{°t}F$) is larger than the area of triangle O-L-M of (a) ($72^{°t}C = 129.6^{°t}F$) due to a faster temperature rise.
(d): is the diagram of Piazza Degree related to (c); segment AB is the quantitative concept. The increment is 33.3% with respect to (b).

In **figure 4(a)** are shown the temperature diagrams of 3 geographic areas:

curve a - Palm Coast, FL (USA)
curve b - Rome, Italy
curve c - Prospect, CT (USA)

Calculating their areas:

$$Area_a = 408^{°t}(C) = 734.4^{°t}(F)$$
$$Area_b = 336^{°t}(C) = 604.8^{°t}(F)$$
$$Area_c = 264^{°t}(C) = 475.2^{°t}(F)$$

Area ***a*** has more quantitative degree-time than ***b*** by 21.4%, with respect to ***c*** 54.5%. In **figure 4(b)** are represented the values of those areas expressed in Piazza Degree:

x_2

$$y_a = Area_a / 24_{hr} = 408^{°t}(C) / 24_{hr} = 17°P(C) = 62.6°P(F)$$
$$y_b = Area_b / 24_{hr} = 336^{°t}(C) / 24_{hr} = 14°P(C) = 57.2°P(F)$$
$$y_c = Area_c / 24_{hr} = 264^{°t}(C) / 24_{hr} = 11°P(C) = 51.8\ °P(F)$$

A temperature diagram that Vincent and I recorded in Prospect, CT is shown in **figure 5(a)**; by summing algebraically the 3 areas formed by the temperature trace, we obtain:

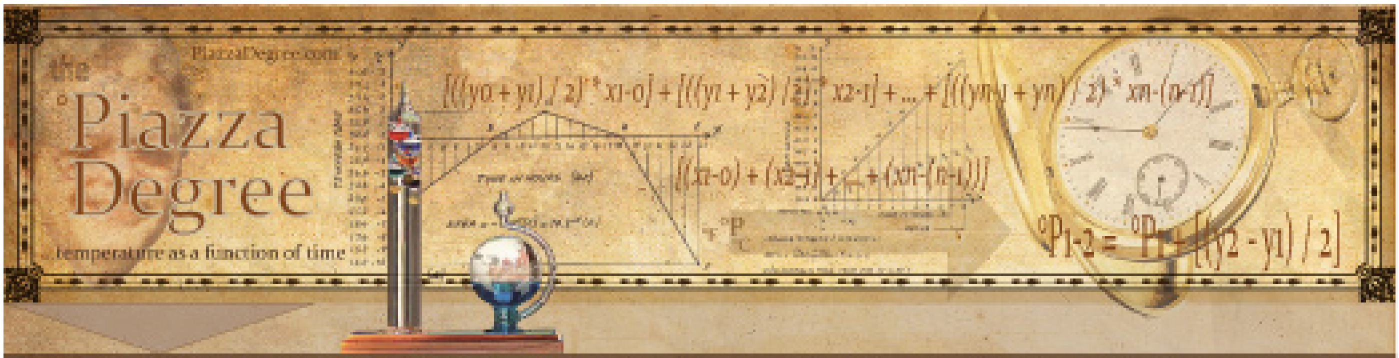
$$[(-Area_{0\text{-}A\text{-}B}) + (Area_{B\text{-}C\text{-}D}) + (-Area_{D\text{-}E\text{-}F})] = -44^{°t}(C) = 79.2^{°t}(F)$$

$$°P = Area\ -44^{°t}(C) / 24_{hr} = -1.83°P(C) = 28.7°P(F)$$

The Piazza Degree is negative in **figure 5(b)**, even though its maximum exceeded 0°C (32°F) for 10 hours. The Piazza Degree should be specified with a subtitle in relation to: 24 hours with °P, or with $°P_{24}$, in parenthesis **(C)** for Celsius, **(F)** for Fahrenheit; other periods: ***wk*** for week, ***mo*** for month, ***3mo*** for trimester, ***yr*** for year, ***2yr*** for 2 years:

$°P_{wk}$; $°P_{mo}$; $°P_{3mo}$; $°P_{6mo}$; $°P_{yr}$; $°P_{2yr}$, and so on;

Data organized by a central processing unit can be extracted and reprocessed in accordance to a specific input. Various formats can be used, those related to absolute temperatures Kelvin or Rankine.



DIAGRAMS

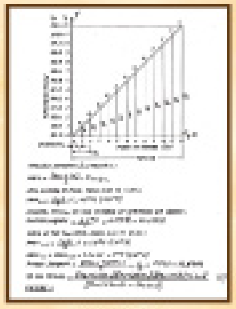


FIGURE 1

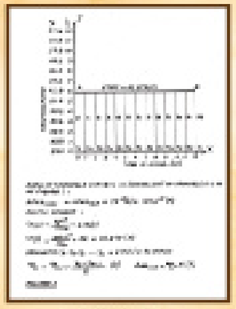


FIGURE 2

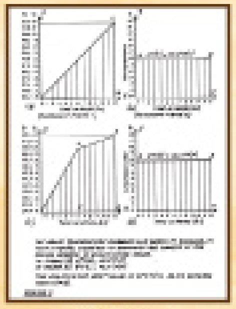


FIGURE 3
(a, b, c, d)

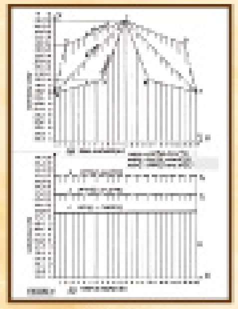


FIGURE 4
(a, b)

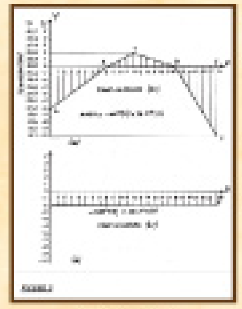
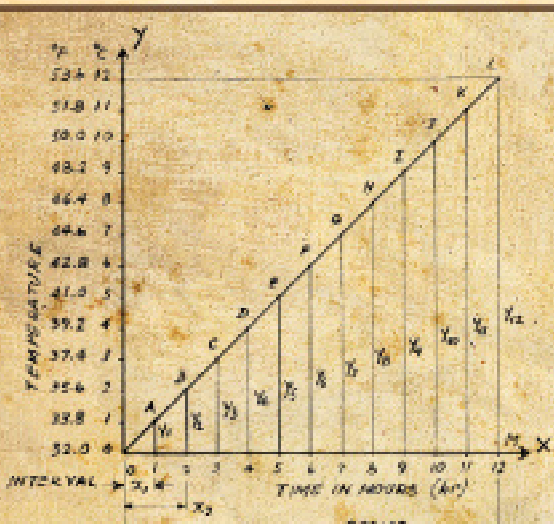


FIGURE 5
(a, b)



FORMULA BETWEEN 2 INTERVALS:

$AREA = \frac{(Y_{n-1} + Y_n)}{2} \cdot X_{n-(n-1)}$

AREA DURING 1ST HOUR, FROM 0:00 TO 1:00 =

$AREA_{0-1} = \frac{(0+1)}{2} \cdot 1 = 0.5^{\circ t}C\ (0.9^{\circ t}F)$

DIVIDING $AREA_{0-1}$ BY THE NUMBER OF INTERVALS, WE OBTAIN:

PIAZZA DEGREE $= \frac{0.5^{\circ t}C}{1} = 0.5°P(C) = 32.9°P(F)$

AREA IN THE 2ND HOUR, FROM 1:00 TO 2:00 =

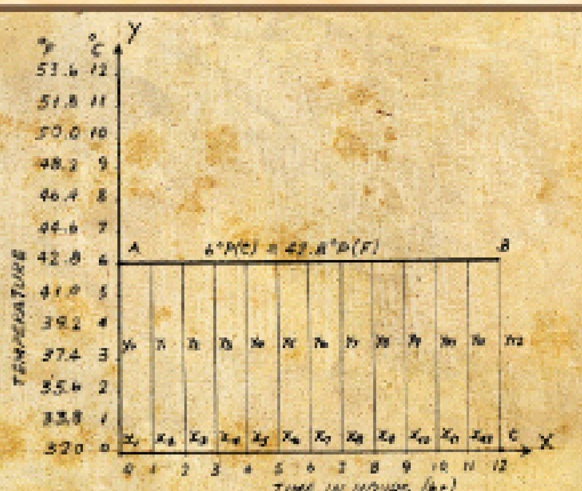
$AREA_{1-2} = \frac{(1+2)}{2} \cdot 1 = 1.5^{\circ t}C\ (2.7^{\circ t}F)$

$AREA_{0-1} + AREA_{1-2} = 0.5 + 1.5 = 2^{\circ t}C\ (3.6^{\circ t}F)$

PIAZZA DEGREE $= \frac{AREA_{0-1} + AREA_{1-2}}{2} = \frac{2}{2} = 1°P(C) = 33.8°P(F)$

$°P\ \text{FOR PERIOD} = \frac{[((y_0 + y_1)/2) x_{1-0}] + [((y_1+y_2)/2) x_{2-1}] + [((y_{n-1}+y_n)/2) x_{n-(n-1)}]}{[(x_{1-0}) + (x_{2-1}) + \dots (x_{n-(n-1)})]}$ (1)

FIGURE 1



AREA OF RECTANGLE 0-A-B-C IS EQUIVALENT TO TRIANGLE 0-L-M OF FIGURE 1:

$AREA_{0ABC} = AREA_{0LM} = 72^{\circ t}(C) = 129.6^{\circ t}(F)$

PIAZZA DEGREE:

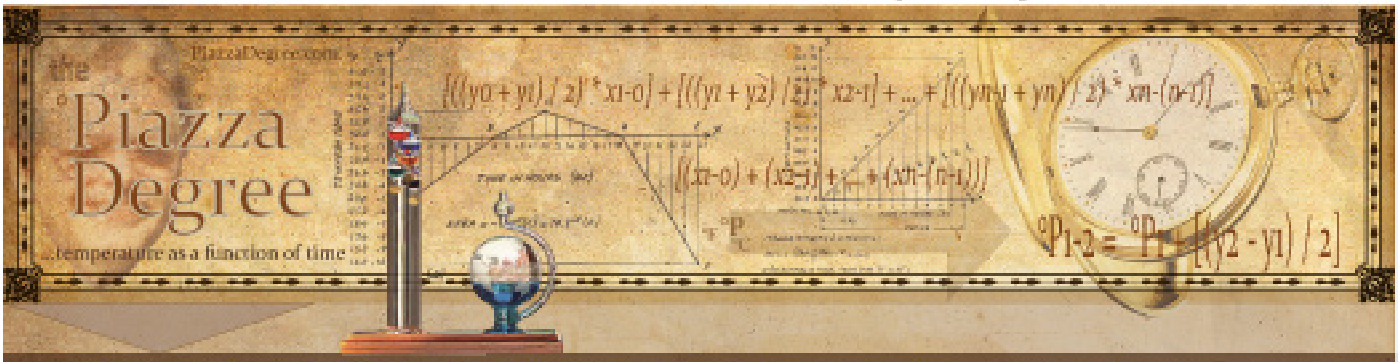
$°P(C) = \frac{72^{\circ t}}{12\ hr} = 6°P(C)$

$°P(F) = \frac{129.6^{\circ t}}{12\ hr} + 32 = 42.8°P(F)$

ORDINATES $Y_1 = Y_2 = Y_3 \dots Y_{12} = 6°P(C) = 42.8°P(F)$

$°P_n = °P_{n-1} + \frac{Y_n - Y_{n-1}}{2}$ (3) $\quad Area_{0-n} = °P_n \cdot N$ (4)

FIGURE 2



DIAGRAMS

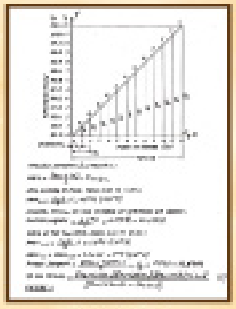


FIGURE 1

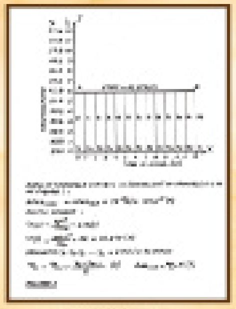


FIGURE 2

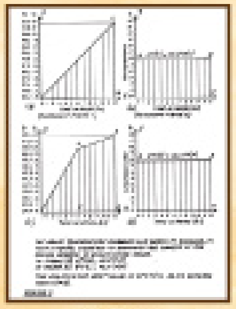


FIGURE 3
(a, b, c, d)

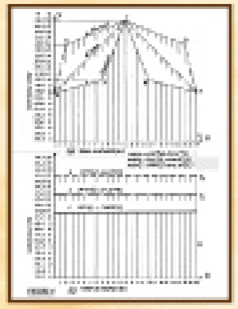


FIGURE 4
(a, b)

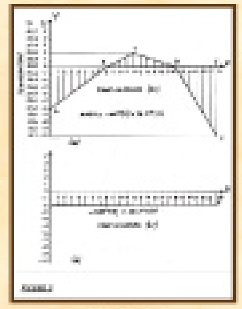
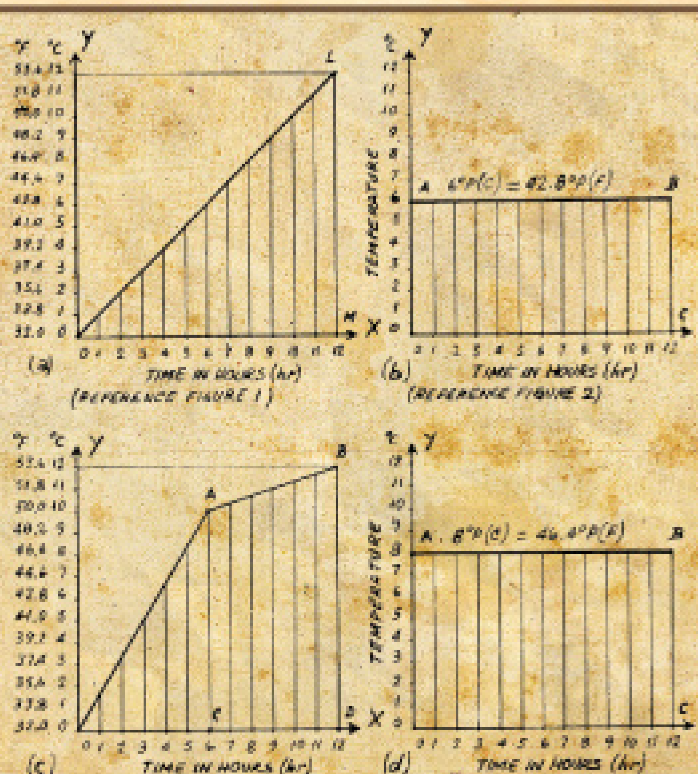


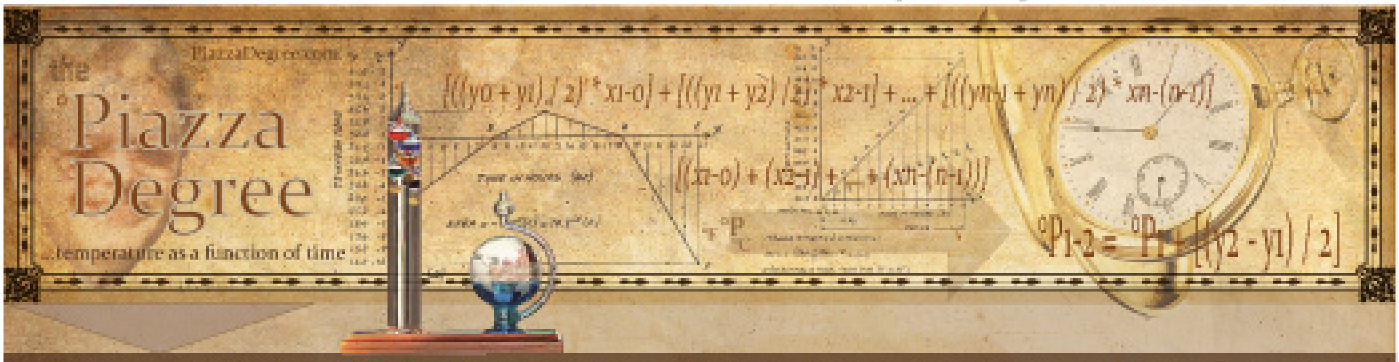
FIGURE 5
(a, b)



THE ABOVE TEMPERATURE DIAGRAMS ARE SHOWN TO VISUALIZE, TO FORM A MENTAL VISION AND TO EMPHASIZE THE CONCEPT OF THE PIAZZA DEGREE IN QUANTITATIVE VALUE.
IN FIGURE 3b 6°P(C) ; 42.8°P(F)
IN FIGURE 3d 8°P(C) ; 46.4°P(F)

THE QUANTITATIVE HEAT VALUE OF 8°P(C) IS 33.3% GREATER THAN 6°P(C).

FIGURE 3



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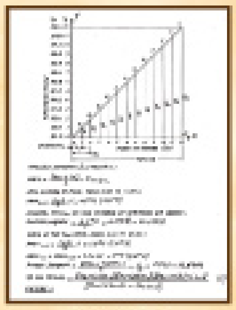


FIGURE 1

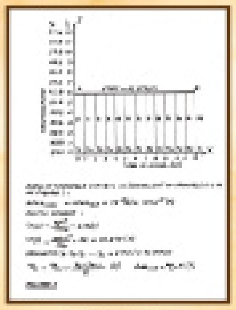


FIGURE 2

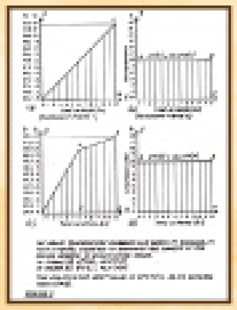


FIGURE 3
(a, b, c, d)

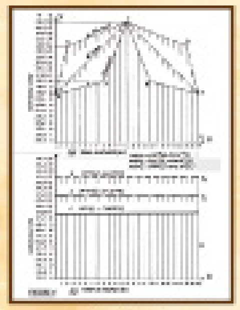


FIGURE 4
(a, b)

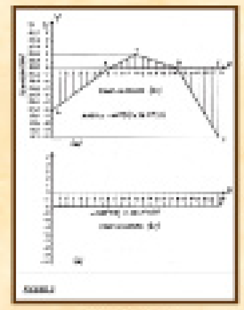
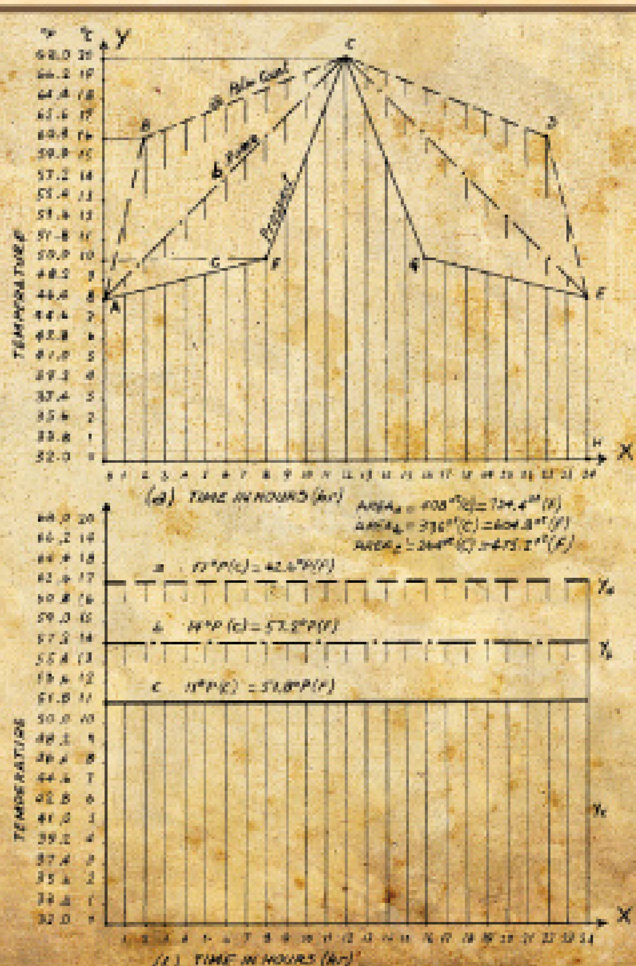


FIGURE 5
(a, b)



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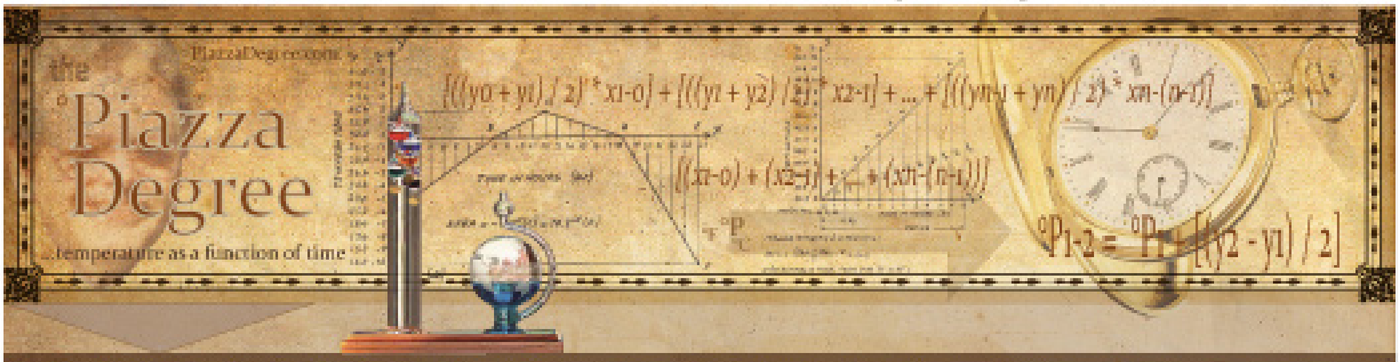

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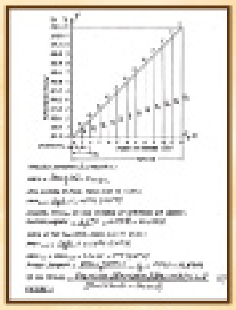


FIGURE 1

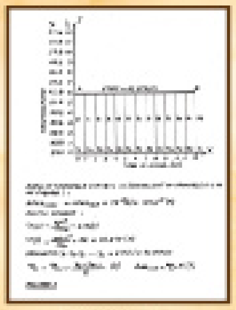


FIGURE 2

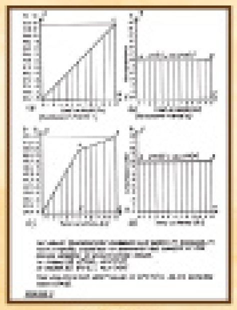


FIGURE 3
(a, b, c, d)

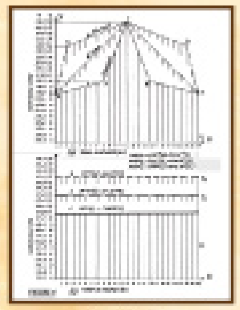


FIGURE 4
(a, b)

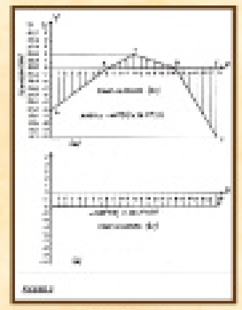


FIGURE 5
(a, b)

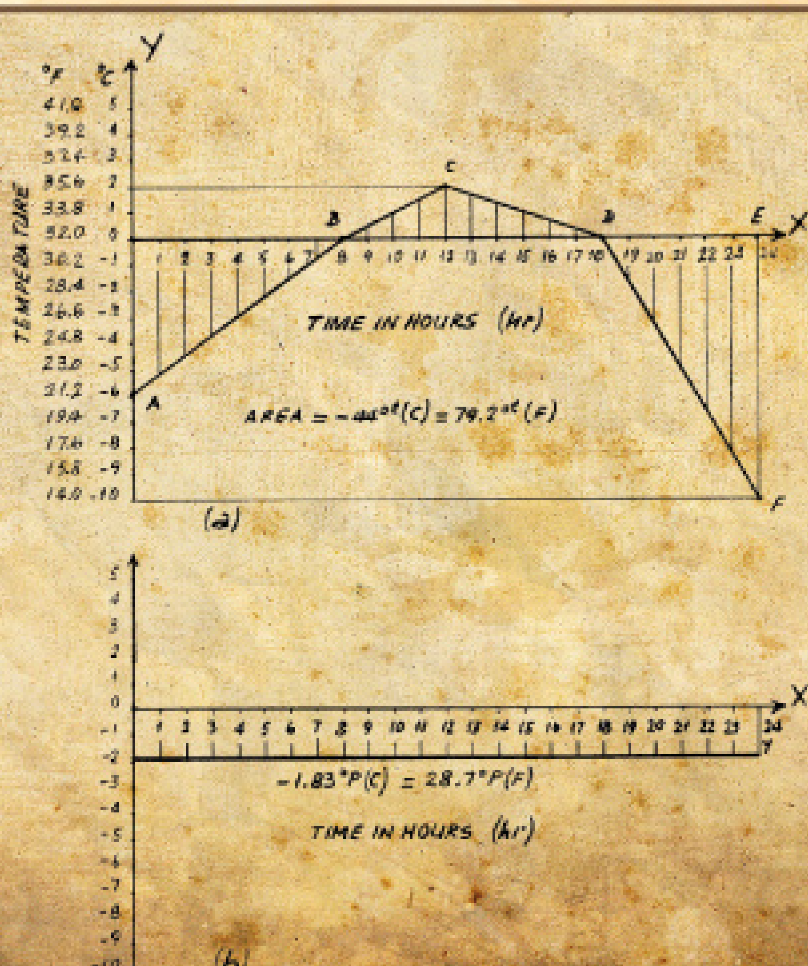
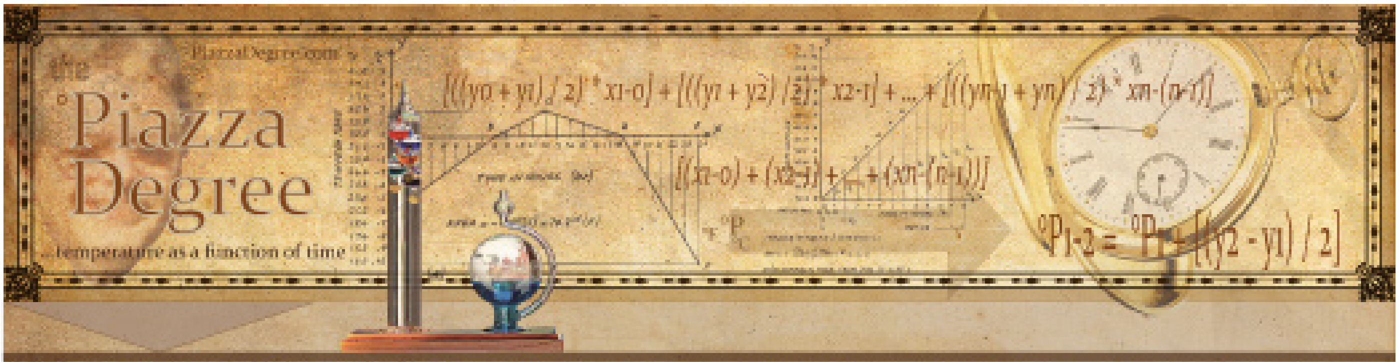


FIGURE 5



GLOSSARY

Cartesian diagram: Cartesius, Latinized form of René Descartes (1596-1650), French mathematician and philosopher, developed the analytic geometry, allowing the reduction of geometric problems into algebraic equations.

Kinematics: study of the motion of bodies without reference to the forces causing the motion or the mass of the bodies.

Velocity: is the time rate of change of displacement, **v = ds/dt**.

Acceleration: is the time rate of change of velocity, that is the increment variation of velocity, therefore the second derivative with respect to displacement (space), **a = dv/dt = d2s/dt2**.

Metrology: the study of measurement in abstract.

Latitude: Palm Coast, FL **29°30'** (Google Map) – Rome, Italy **41°50'** (Google Map) – Prospect, CT **41°30'** (Google Map)

APPLICATIONS

The Piazza Degree finds its origin in the interpretation of weather temperature data, expressed in a quantitative degree-time form, ***a quantitative resolution in place of an indicative resolution***. Forecasting the variation of the temperature in a quantitative form by integrating the periods, where each period is considered a unit. A diagrammatic projection of the tendency of the acceleration of the Piazza Degree ***represents the 'velocity' of the temperature***. It indicates the instantaneous velocity at each point of its trajectory and the relative acceleration, which is the second derivative.

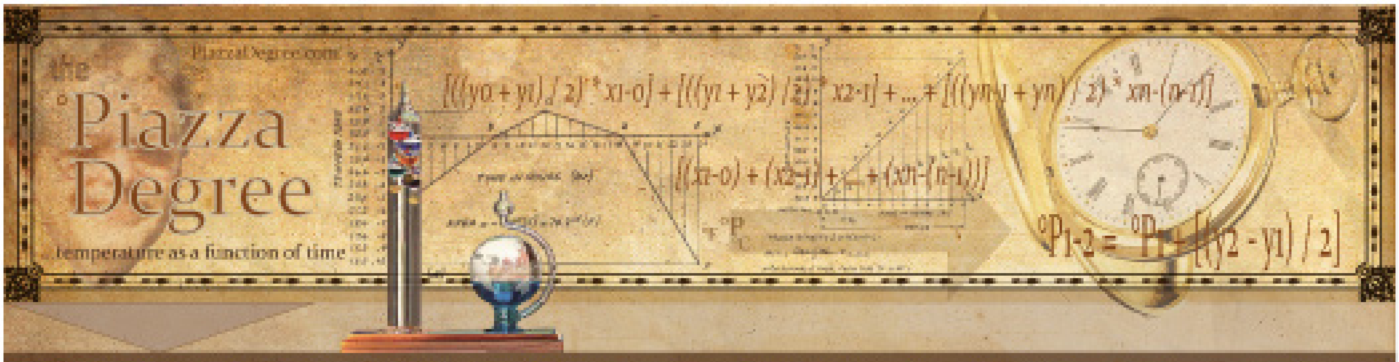
Among the many applications, are the ones related to water systems requiring data for quantitative evaluation. On a large scale the Piazza Degree can be used in the field of load forecasting. At a local level the Piazza Degree may allow management of systems and equipments for heating and cooling with greater efficiency, providing benefits not only in the aspect of economy but also in the impact on the environment. Another aspect is the one related to agriculture, for productivity and quality, particularly for cultivations requiring specific treatments. Applications to medicine are to be studied in different directions; a quantitative form may lead to new horizons.

In conclusion, the Piazza Degree is a leap forward in the interpretation of air temperature. It is a theoretical-practical system used in place of the minima and maxima observations that we are accustomed to. The concept ***temperature-time*** is an innovation in metrology; the Piazza Degree will eventually ordinate, conceptually, the values of the temperature.

R & D

A system with its devices for recording temperature at predetermined regular intervals and to perform calculations for determining the temperature-time and the Piazza Degree, has been studied in a schematic form including structure of instrumentation. Data organized by a central processing unit can be easily extracted and reprocessed in accordance to a specific input. Various formats can be used.

The R&D department layout is designed for developing experimental prototypes leading to manufacture functioning units, including the technical staff and supporting personnel.



AUTHOR

- Pietro Piazza, also known as Piero, or Peter Piazza, is a retired Professional Engineer of Connecticut and Rhode Island, who studied engineering in Italy and in USA.
- Former member of the CT Society of P.E., National Society of P.E., and The American Society of Mechanical Engineers. Honors: U.S. and Italian Patents.
- His spiritual sense of creativity leads him to flourish in the spectrum of intellectual knowledge, from engineering to mathematics, to literature and philosophy.

He is the author of:

The Piazza Degree: Temperature as a function of time - *English and Italian*
Roulette and Craps in Mathematics and in Life - *English and Italian*
The Art of State (How to create a State) - *Italian (English in Dec 2009)*

... additional works will be published in the near future.

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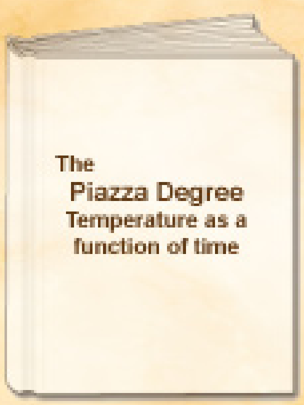
PUBLICATIONS

The following works are available by contacting the author directly



English and Italian
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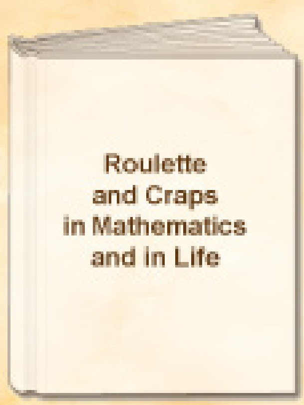

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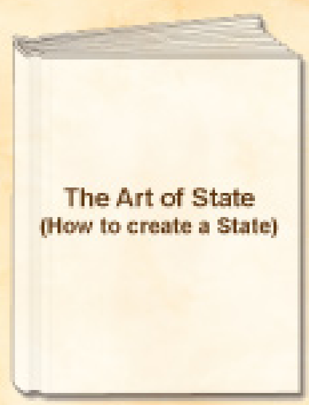

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