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Mathematical model to estimate the conditioning time of paper for offset printing of books and journals

Modelo matemático para estimar el tiempo de acondicionamiento del papel para la impresión en offset de libros y revistas

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Abstract

Objectives, methodology: Designing a mathematical model to estimate the time of conditioning the paper. From the information available is performed a correlation and regression analysis, we get a mathematical model, determines their validity and is shown by their use in the development of software. With Attribution: Currently for the offset printers, there is no equation available, to estimate the time of conditioning the paper from the temperature difference with respect to the print room and the volume. This work contributes in the professionalization of the graphic arts industry in relation to the development of software, the administration and planning of the production, the plans and programs of study of the career of graphic arts that offer technological universities, as well as in the formation of human resources.

Graphic arts, Software, Conditioning for paper

Resumen

Objetivos, metodología: Diseñar un modelo matemático para estimar el tiempo de acondicionamiento del papel. A partir de la información disponible se realiza un análisis de correlación y regresión, se obtiene un modelo matemático, se determina su validez y se demuestra su uso en el desarrollo del software. Con la atribución: Actualmente para las impresoras offset, no existe una ecuación disponible, para estimar el tiempo de acondicionamiento del papel a partir de la diferencia de temperatura con respecto a la sala de impresión y el volumen. Este trabajo contribuye en la profesionalización de la industria de las artes gráficas en relación con el desarrollo de software, la administración y planificación de la producción, los planes y programas de estudio de la carrera de artes gráficas que ofrecen las universidades tecnológicas, así como en la formación de recursos humanos.

Artes gráficas, Software, Acondicionamiento para papel

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Introduction

The lack of planning and programming (dead time, production overload, production delay, poor production programming) are problems in the production process that the graphic arts sector faces in Mexico. A solution to this problem is proper planning and administration to properly estimate production times (National Chamber of the Graphic Arts Industry-FUNTEC, 2004).

At the Fidel Velázquez Technological University, in the Graphic Arts career, it has been found that the development of projects related to optimization in the use of resources is recurrent (Martínez Barbosa, 2014) (López Aguilar, 2013). There is a shared interest of the graphic arts production chain to establish various technical recommendations for the proper and efficient use of offset paper (Technical Committee for the Standardization of Graphic Arts, 2000).

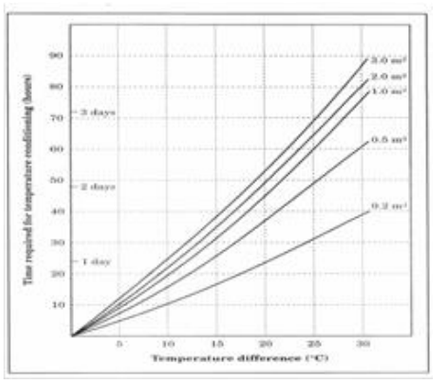
A paper that is cold cools the surrounding air and changes its relative humidity (RH), this change causes the surrounding air to become saturated, which causes condensation, so if it is uncovered, it will become damp and the condensation will produce wavy edges. The opposite situation occurs when a warm paper is brought into a cool press room, the higher temperature of the paper heats the surrounding air, lowers the RH and moves from the substrate into the surrounding air, causing the paper to shrink. and its edges remain "topressed" which could mean printing problems (Wilson, 1998).

Once the paper reaches the press room, it may or may not be the same temperature as the press room, an accurate measurement of the paper temperature can only be obtained by inserting a sword thermometer into the stack. The wrapping of the packages, rolls or boxes must be removed when it has been determined that the temperature of the paper is identical to that of the environment in which it will be processed, for which the paper must be given time to reach the temperature of the newsroom, this time is called paper conditioning time and can take from a few hours to several days.

Graphs or tables can be used to determine the conditioning time of the paper (Breede, 1999).

Model development

A table (Cerrato Escobar, 2004) and a graph (Breede, 1999) were found to estimate conditioning time. It is worth mentioning that according to the bibliography analyzed, the conditioning time does not depend on the type of paper.



Graphic 1 Paper conditioning time
Source: (Breede, 1999)

Graphic 1 is taken as a basis, since it provides visual information about the behavior of the conditioning time as a function of the volume and the temperature difference with respect to the printing room.

If we do:

Now the relationship between the coefficients a and b of the quadratic equations with respect to volume is determined.

X = Value to absolute from the from temperature and between and the paper and the living room of impression.

y = Volume of the sheet or roll in m^3.

z = Conditioning time in hours.

The conditioning time as a function of the temperature difference, keeping the volume fixed, fits well with a quadratic equation that passes through the origin, as shown by the values of R^2 in Table 1, so we can generalize that:

$$z = ax^2 + bx \quad (1)$$

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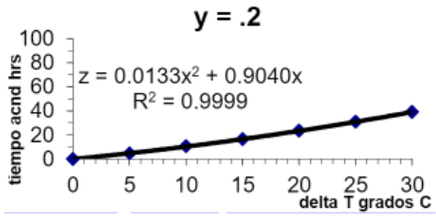
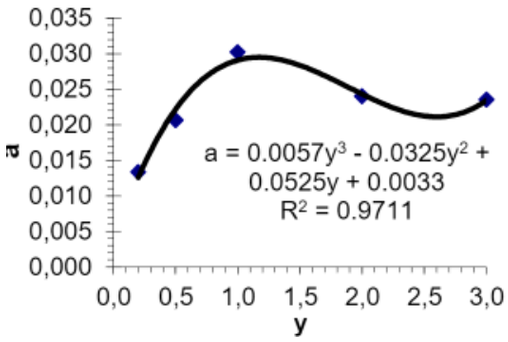


Graphic 2 Conditioning time for a volume of .2 m^3

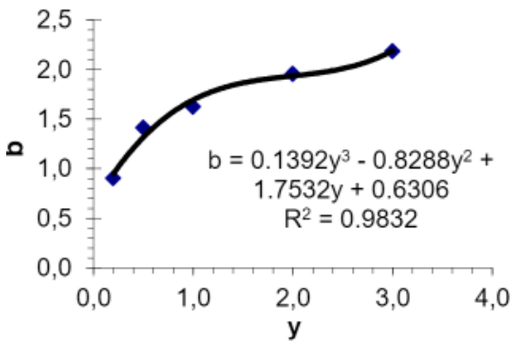
y	a	b	R^2
0.2	0.0133	0.9040	0.9999
0.5	0.0206	1.4145	0.9994
1.0	0.0302	1.6259	1.0000
2.0	0.0240	1.9559	0.9999
3.0	0.0235	2.1865	0.9998

Table 1 Relationship between the coefficients of the quadratic equations and the volume

The relationship between the coefficients a and b of the quadratic equations with respect to the volume is now determined.



Graphic 3 Dependence of the coefficient "a" of the equation(1) with respect to volume



Graphic 4 Dependence of the coefficient "b" of equation (1) with respect to the volume

As can be seen in graphs 3 and 4, if the coefficients a and b are adjusted to polynomials of degree three, values of R^2 greater than 0.9 are obtained, so the mathematical model sought is:

$$z = (0.0057y^3 - 0.0325y^2 + 0.0525y + 0.0033)x^2 + (.1392y^3 - .8288y^2 + 1.7532y + .6306)\,x$$

Where:

x = Absolute value of the temperature difference between the paper and the printing room.

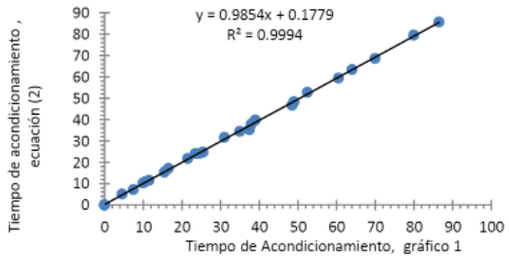
y = Volume of the sheet or roll in m3

z = conditioning time in hours

Model validation

In order to verify the validity of the model, the values obtained between graph 1 and equation (2) are compared, in a temperature difference range of 0 to 30 °C and a volume of 0 to 3 m3, see graph 5.

As can be seen, comparing what is obtained by equation (2) and graph 1, an R2 of 0.9994 is obtained, so the model obtained adequately predicts the conditioning time.



Graphic 5 Validity of the model obtained 3

Application of the model

The results of the execution of two programs, made from the model obtained, are shown below as an example.

HP 48 Series Programmable Calculator Program

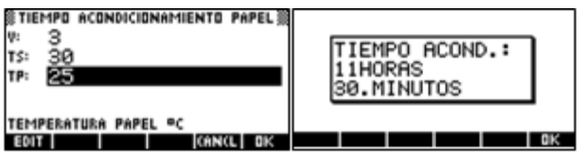


Figure 1 Execution of the program developed for an HP 48 series programmable calculator

Program using the Dev-C++ integrated development environment

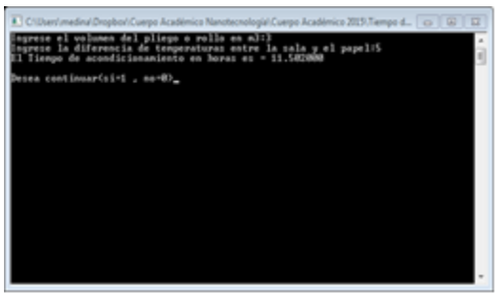


Figure 2 Rresult of the execution of the program developed for the integrated development environment Dev-C++

Conclusions

A mathematical model was obtained that allows estimating the paper conditioning time, which can be used by those interested in managing, planning production and developing software for the graphic sector.

This work serves as an example of the use of logical resolution of problems related to the graphic arts sector, which has traditionally been empirical in Mexico.

This is a multidisciplinary work that was developed for the Academic Division of Productive Processes, Graphic Arts Area, of the Fidel Velázquez Technological University. It seeks to establish, in the future, process simulation projects; The one that currently interests the division the most is related to the simulation of operating conditions of the offset printing system, which would support printers in achieving the fine-tuning of printing presses, flat or roll (rotary), in optimal time.

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