A TRANSDUCER TO REGULATE THE INK/WATER BALANCE IN AN OFFSET MACHINE

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ABSTRACT :

In offset, the printing plate is the element to be controlled, most particularly the ink/water distribution which constitutes an image that can be analyzed. A transducer that measures ink/water balance has been designed. This sensor provides an evaluation of the image that represents the ink/water distribution on the offset plate. Evaluation of the image quality permits a closed loop regulation of the offset process. The process model derives from the Takahashi phenomenological analysis of ink transfer. The Takahashi model was extended to design a sensor capable of analysing such an image. The integral of the transfer function of the process responsible for the image represents an efficient quality index for the image. And the main thing is to choose the optimal transfer function for the ink/water distribution on the offset plate. For that, the sensor has a laser and a lens that optically produces the Fourier transform.

Press runs performed with a prototype instrument led to the development the optical model for ink/water distribution. The behavior of the optical transducer was evaluated during these press runs. The model showed good sensitivity between actual press command and press performance. It also made it possible to study of other parameters and theoretically explained observations made during press run.

The transducer can also measure the dynamic response of the machine. The responses were used to calculate the transfer function corresponding to each command in order to design a closed loop control. Computer simulations illustrate the interest of such a transducer for different closed loops.

1. PRINCIPALS OF MEASURE

We intended to produce a transducer in order to regulate an offset machine. Obviously one can regulate a lot of parameters in an offset machine : speed, temperature and composition of the dampening solution etc...), but there is still an unsolved task : the ink/water balance and its action on image quality.

The ink/water balance and the image quality are own subject of interest. Previous studies had pointed out the interested of using the Fourier methods in order to produce the transfer function of a printing medium /1/.

A description of the offset machine as a linear system points out 3 transfers (Fig 1) and if we consider them as a linear system, the corresponding Transfer Function must be multiplied to obtain the global Function. This is the limit of the global approach of printing quality by measuring the Transfer Function of the medium.

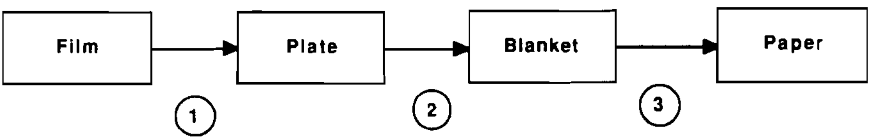


Figure 1

The literature is not rich on the subject of the physics of each transfer. We need some knowledge about each transfer and particularly which is the limiting step or the bad one considering the transfer function.

The work of Takahashi /2/ gave us what we needed : a physical description of the phenomena for each step of transfer. He also pointed out the limiting step as the plate to blanket transfer.

A theoretical study /3/ on how to represent physically the phenomena described by Takahashi, leads to a model of ink/water balance measured on the offset plate. This study shows that a measurement (which is defined as the integral of the frequency analysis of the ink/water repartition on the plate), is sensitive with the halftone dot surface and also the state of dampening solution on the plate. This measure is /4/ very well connected with an objective measure of image quality.

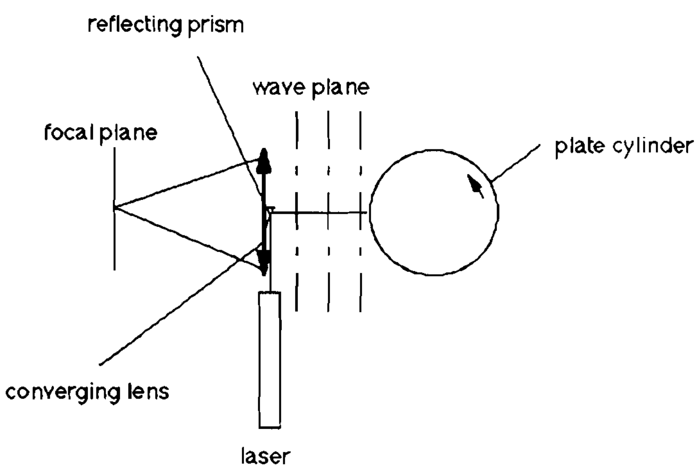
How to realize the transducer is now the question.

2. REALISATION OF THE TRANSDUCER

The problem of the transducer is to realize the Fourier Transform of a wave plane reflected by the surface of a running plate and to produce the integral of this Fourier Transform.

We use the lens properties regarding light waves and a photosensitive cell to realize the integral. The remaining problem is to design a geometry which can easily emit a laser beam (the wave plane) an receive the reflected laser without being too sensitive to the geometrical defect of the machine

After testing some geometries based on the same principles, we concluded with a compromise between fidelity and sensitivity; the principals being described in Figure 2



Principals of the transducer
Figure 2

This transducer must be easily positioned and attached relatively to the machine. For this we use a goniometrical disposal and an optical stand figure 3.

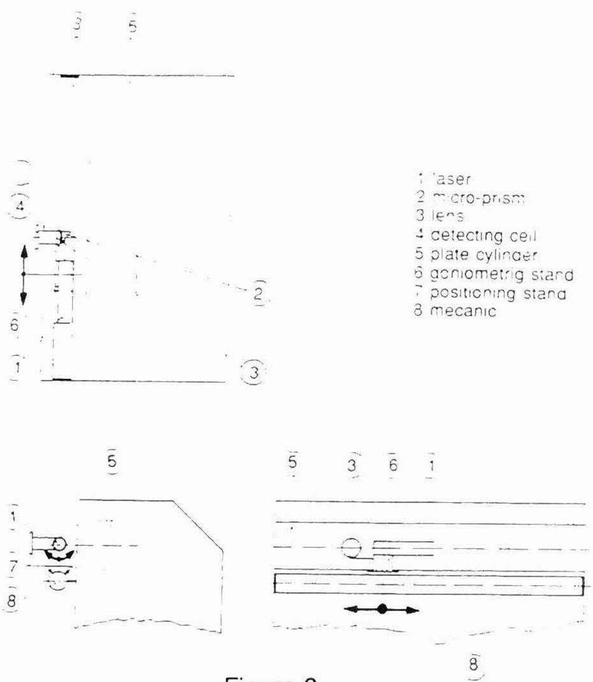


Figure 3

3. EXPERIMENTS/TRIALS

The first aim of these experiment was to check that the theoretical aspect of this transducer and the model used to explain its behavior was good. So a first serie of trials was done in order to test the gain and sensitivities of the transducer.

To record and to memorize numeric data, we had to build the interface (software and hardware) between the transducer and the offset process. To test the behavior of the process, we had to record the command actions and the response of the transducer. Another point is to trigger the measurement capture with the revolution of the plate cylinder, this general context is presented in Figure 4.

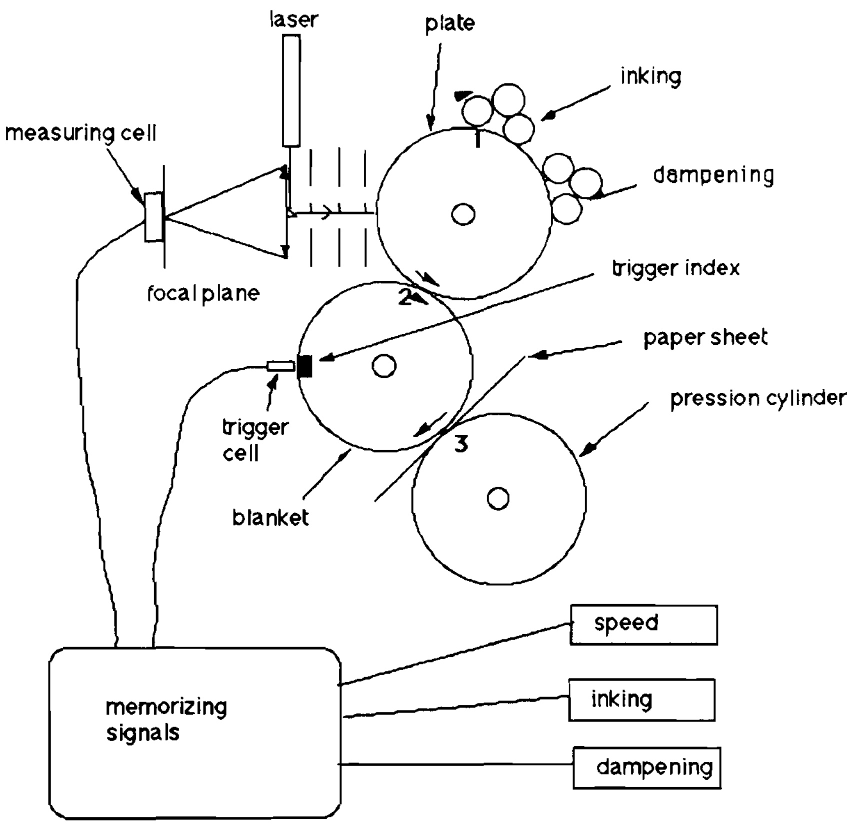
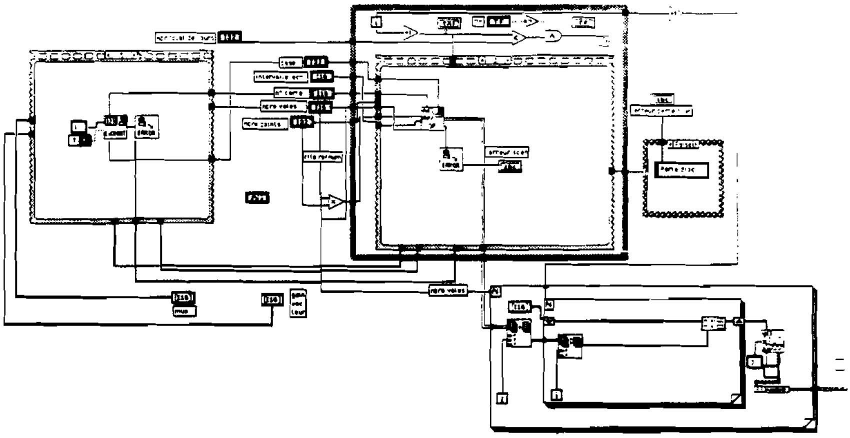


Figure 4

The architecture of the electronics is based on Machintosh II with an acquisition multi-function board plugged into it. The software is entirely realized in G language (LabView™ National Instrument) which greatly improved our productivity and the versatility of this acquisition package (Figure 5).



The G program

Figure5

We first measure the "static gains" of this transducer : the relation between a level of command and this level of the transducer's response. This measurement is made for example on a halftone of 30 % coverage (Figure 6).

We saw that our transducer has quite a good response particularly around the static point.

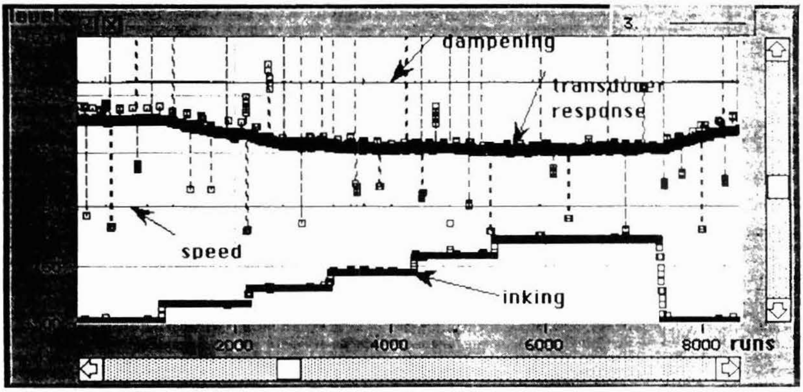
These measurements are made in typically stationary condition the machine is balanced for each couple of commands (inking ; dampening) by at least 250 sheets of paper.

The machine used is a sheet-fed Roland Favorit with a R.C.I. device.

After verifying the stationary gains, we intend to evaluate the dynamic responses of the transducer, the running point (the couple of command to obtain the best result).

The protocol to observe the dynamic responses where the following : on a halftone zone of 60 % coverage, the machine stabilized by at least 200 sheets, the operator had to give a series of commands ; inking command or dampening command.

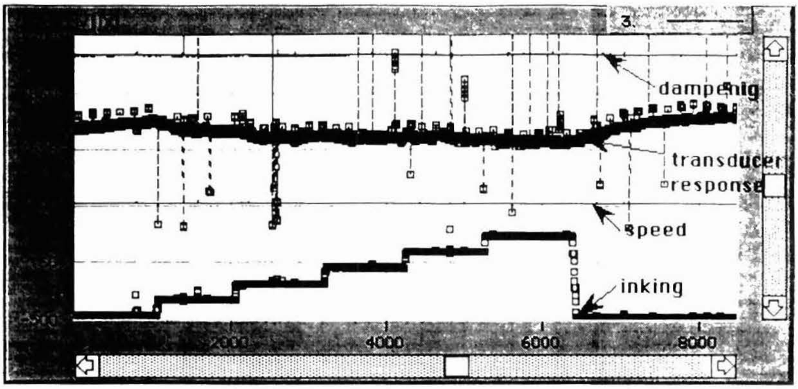
An example of theses trials, for a dampening level of 70%, a speed of 6000 rph and a level of inking from 0% to 100%, is shown by Figure 6.



Halftone 60%, speed 6000 rph dampening 70%

Figure 6

Another example is showed by figure 7: halftone 60% and dampening 90%



Halftone 60%, speed 6000 rph dampening 90%

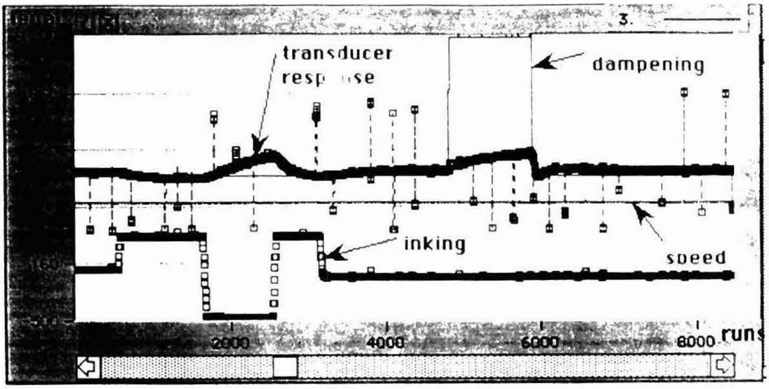
Figure 7

Other series of trials have been made in order to verify the behavior of the model explaining the ink/water distribution on the plate and the measurement provided by the transducer

We verify 3 points :

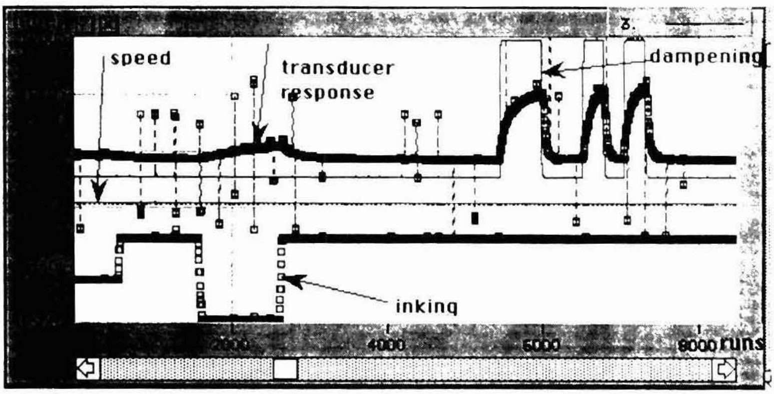
- the sensitivity with the coverage on a halftone zone
- the sensitivity with the dampening command or (level)
- the sensitivity with the inking command or (level)

Theses three verifications, instationary conditons, were sufficient to try to observe the dynamic behavior. Two examples of dynamic responses are shown on figures 8 and 9. They both show a good response with inking and dampening commands. The rates of the responses are connected with the ratio of ink coverage on the plate.



Dynamic response of halftone 60%

Figure 8



Dynamic response of halftone 30%

Figure 9

4. IDENTIFICATION AND REGULATION OF THE MACHINE

The numerical data of figure 6 are used to identify the temporal transfer function of the offset machine. These data are processed by a programs CASTOR™ and ACSYDE™ which are typically designed to effect the numerical identification and the simulation of this kind.

We have to choose the structure of the model representing the machine. We choose the structure Figure 8, which is the simplest, to start this study It assumes the independency between the two commands of inking and dampening.

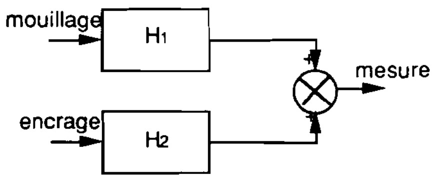


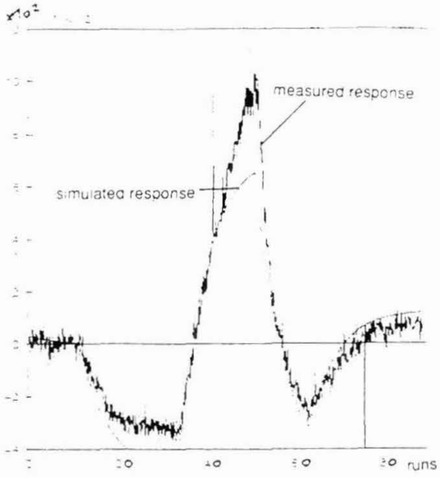
figure 10

The numerical identification of the temporal transfer functions leads to the expressions H1 for the inking and H2 for the dampening :

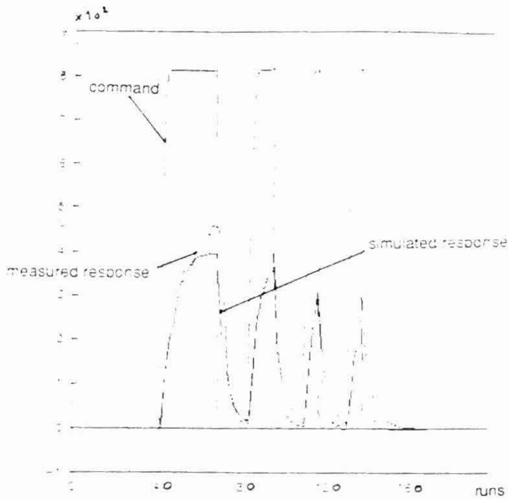
$$H_1(z)=\frac{z^{-1}\left(0{,}126 - 0{,}092\ z^{-1}\right)}{1-1{,}40\ z^{-1} + 0{,}4692\ z^{-2}}$$

$$H_2(z)=\frac{-0{,}003\ z^{-1}}{1 - 0{,}975\ z^{-1}}$$

The graphic simulations are shown in Figure 10 and Figure 11. This simulation shows a relatively good linearization of the process : the simulated curve fits quite good to the measured one.



Function H1(t)
Figure 10



Function H2(t)
Figure 11

The last step to regulate the machine would be to introduce correctors and actuators for reacting to the machine. This work is under development now the electronic modifications that we have to make with the machine are not very easy and are a bit dangerous for the machine. So the design of the actuators is under development by simulations.

5. CONCLUSION

It is obvious that the need for a transducer which allows a regulation of the printed image's quality is essential for the future of the offset process.

Our work is a possible way to find a solution for the regulation of the machine. This project is to be placed in the context of total automation and automatic command of an offset machine. In this context there are three big questions to answer :

1) The definition of the best running state (or running point) of an offset machine in terms of a reliable measured index. The connection of this or theses indexes to the corresponding command variables.

2) The best way to get to this running point. That is to say, the speediest method which reaches the running point without causing disturbances or rupture of ink/water balance.

3) When the best running point is attein, it is time to regulate it.

For these three points of total automation of a machine, the transducer we designed can be a good tool of investigation and we will use it to bring some solution.

Bibliography

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