KINEMATICS OF WEFT YARN INSERTION ON AIR JET WEAVING MACHINE A COMPUTER MODEL

M.A. El-Messiry and A.B. Mito
Textile Engineering Department, Faculty of Engineering
Alexandria University, Alexandria, Egypt.

ABSTRACT

The profile of the air speed along the width of the weaving machine is determined with the help of a computer program. An equation for the yarn acceleration is developed and through a given data such as weaving machine width, insertion time or no of machine revolution, fiber type and yarn count the kinematics of the weft yarn and the distribution of air velocity along the width of the weaving machine are calculated and plotted.

1. INTRODUCTION

To insert the weft yarn on the air jet loom, where the weft yarn is transmitted along the weaving machine under the action of the air flow, a certain amount of compressed air is required for every pick through the main nozzle and sub-nozzles. A control pressure valve can be adjusted to give the required air pressure for each nozzle. The flow air and the period of its blow should be synchronized with the machine speed. This can be achieved synchronized with the machine speed. This can be achieved through mechanical or electromagnetic units. The amount of compressed air must also suit the material of the weft yarn at minimum energy cost. The minimum air consumption can be only reached when the loom runs without cloth faults or stoppages due to weft yarn.

2. CASE OF PUBLISHED WORKS

In the last years, the scientists have worked intensively on the problems of insertion the weft yarn with the air flow. The theoretical approach to determine the air drag forces acting on the Yarn during the by insertion was studied [1,2,3].

Anderson and Stubbs [1] pointed out the relation between the yarn tension, the air speed, the yarn diameter and the fiber length. Uno [4] determined through a numerous work the force applied along the weft yarn in the air flow as a function of the yarn length. Greenwood and Makki [5] investigated the twist removal in the inserted yarn for a ring and OE yarn before and after weaving. Their experiments were on the yarn inserted on shuttle and air-jet weaving machines. Krause and Kissling [6] studied the use of air jet weaving machines and the amount of air consumed. Kissling [7] and Wahhoud [8] investigated the forces transmitted on the outer yarn surface and the air flow different principles of air jet weaving machine. The behaviour of different yarns as a function of different machine and yarn parameters were, in details, investigated. Wahhoud [8] studied also the physical technological properties of yarns and woven fabrics on the air jet weaving machines. He found that the fabric properties are not affected by the amount of air consumed per pick.

3. COMPUTING THE KINEMATIC VALUES

The equation of motion of the weft yarn can be written as:

$$\frac{d(mV_G)}{dt} = \sum F \qquad (1)$$

where:

m mass per unit length of weft yarn
V_G velocity of weft yarn
$\sum F$ summation of all the forces affecting the yarn in the air flow

Hence these forces are:

transmission forces from the air on the weft yarn as a function from the yarn outer surface and;
the resistance force which affect in the opposite direction of the yarn movement.
Assuming that the resisting, forces are very small, then equation (1) becomes:

$$\frac{d(mV_G)}{dt} = dF \qquad (2)$$

Where:

$$dF = \frac{1}{2}\int_{x=0}^{1} C_f . \pi d . \rho_L . (V_L - V_G)^2 \, dx$$

c_f air drag coefficient
d diameter of weft yarn
ρ_L density of air
V_L velocity of air

On the air jet weaving machines, the machine width and speed are limited when the main nozzle is used. The use of subnozzles makes it possible to create the suitable force required to transmit the weft yarn on a wider loom and at a higher machine speed.

To insert the weft yarn across the shed in predetermined weft insertion time which suits the machine speed, it is required to calculate the distribution of the air velocity.

Assuming that the weft yarn has an acceleration as a function of the distance x as given by

$$a_G = f(x) \qquad (3)$$

Consequently, at any distance the values of VL and V_G can be obtained by solving the equations (2 & 3). A computer program was developed, so that at any point across the shed width (x) the value of t, V_L, V_G can be calculated. However, depending on the value of a_G (x), there are several solutions for different values of yarn kinematic parameters. The following constraints were considered:

$$t = \sum dt = \frac{30}{n} \qquad (4)$$

$$w = \sum_{x=0}^{1} V_L(x) = w \min \qquad (5)$$

Where:
t- total insertion time
n- machine revolution per min.

This leads to one solution which sati[...] minimum air consumption and the time T[...] insertion.

4. CASE STUDIES

In order to verify the above mentioned [...] several conditions were investigated and compa[...] same of the published results. Figure (1) illust[...] values of the yarn velocity, acceleration and t[...] function of the displacement calculated using th[...] mentioned program for a loom width 150 cm[...] weft insertion of 43 msec. of a yarn count 13[...] is clear that the results are conform to that meas[...] Wahhoud [8].

The same situation for the second case Un[...] shown in Figure (2) for a loom of width 225 [...] weft insertion time 63 msec. for the yarn cou[...] tex.

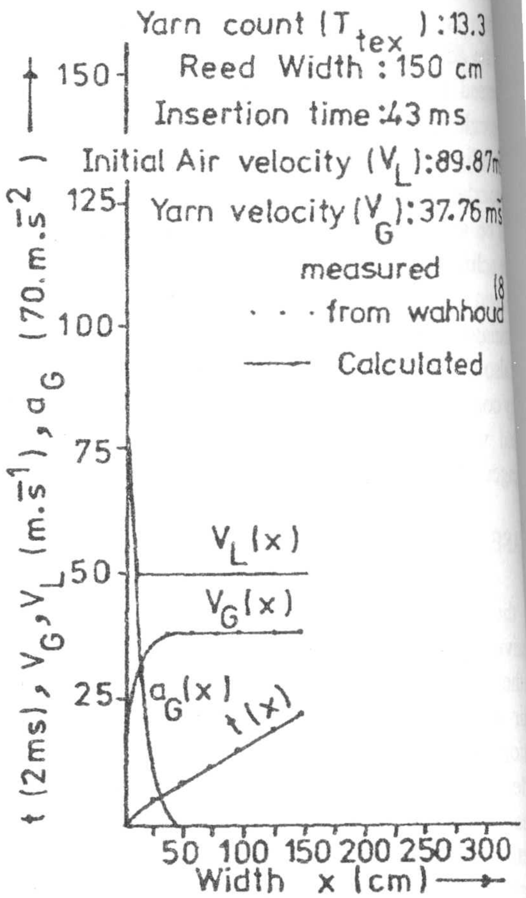

Figure 1. Kinematics of weft yarn for width 150 cm.

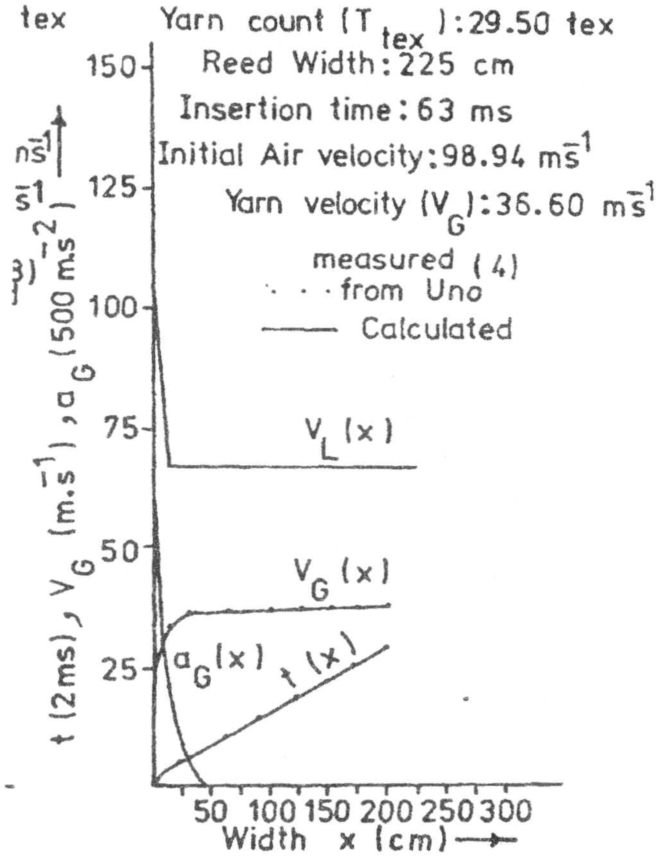

Figure 2. Kinematics of weft yarn for width 225 cm.

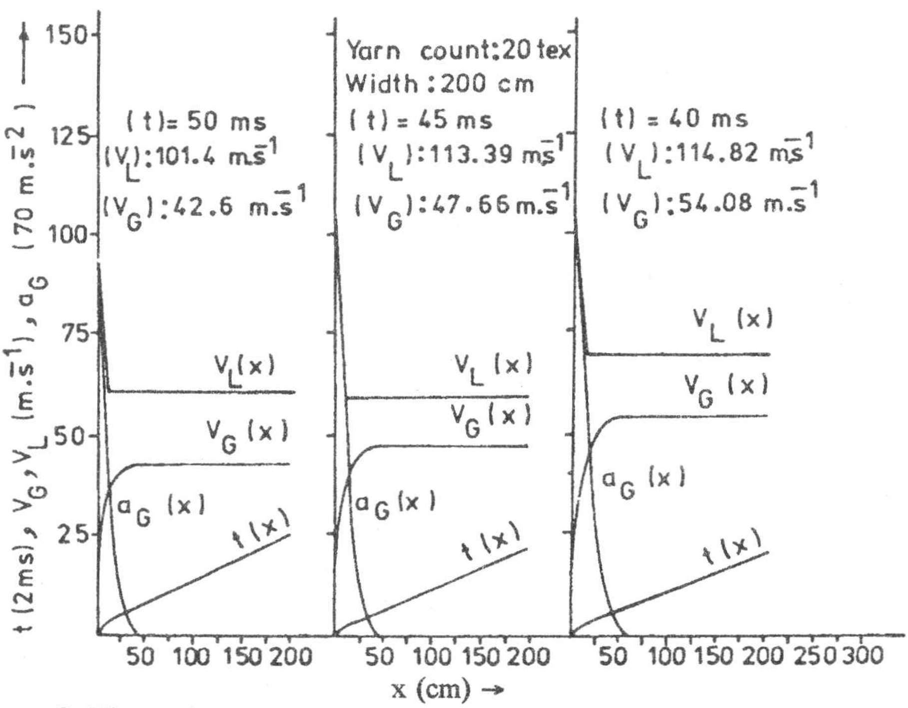

Figure 3. Kinematics of weft yarn by changing machine speed.

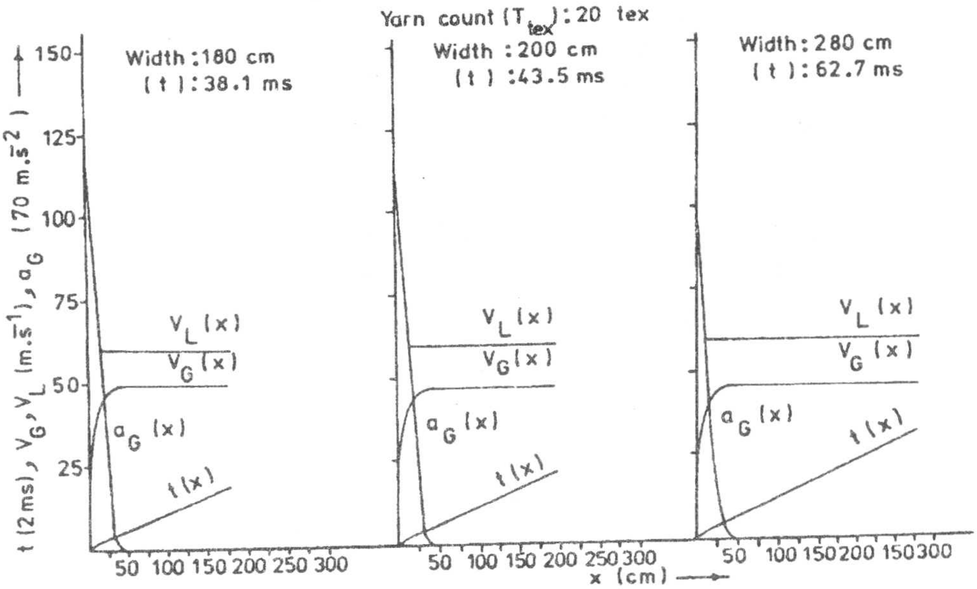

Figure 4-a. Kinematics of yarn by changing machine width with constant weft insertion rate.

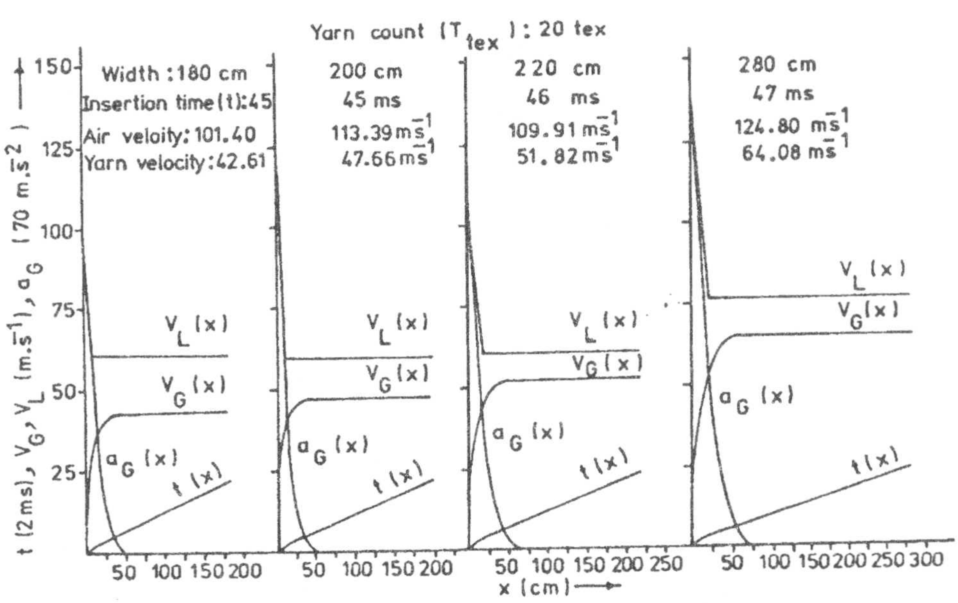

Figure 4-b. Kinematics of weft yarn by changing machine width with constant insertion time.

Using the above approach the effect of both machine and yarn parameters can be investigated. Figure (3) illustrates the kinematics of weft yarn as well as the air velocity by changing the machine speed for the insertion width of 200 cm. The effect of loom width at the same weft insertion rate is shown in Figure Figure (5,6) illustrated the effect of yarn parame such as yarn count (tex), yarn coefficient of air which is a function of the type of yarn material spinning systems.

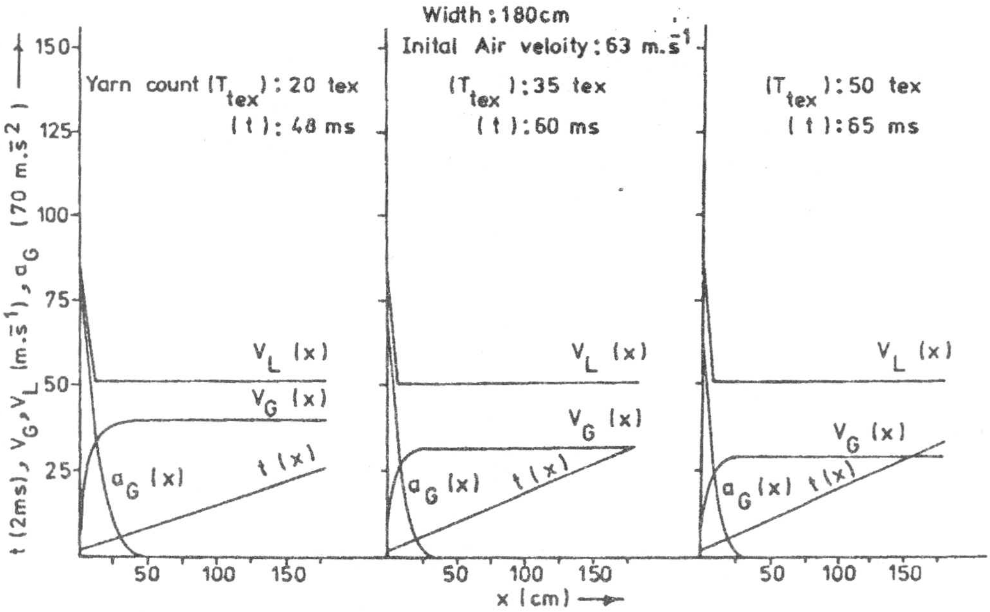

Figure 5-a. Kinematics of weft yarn by changing yarn count.

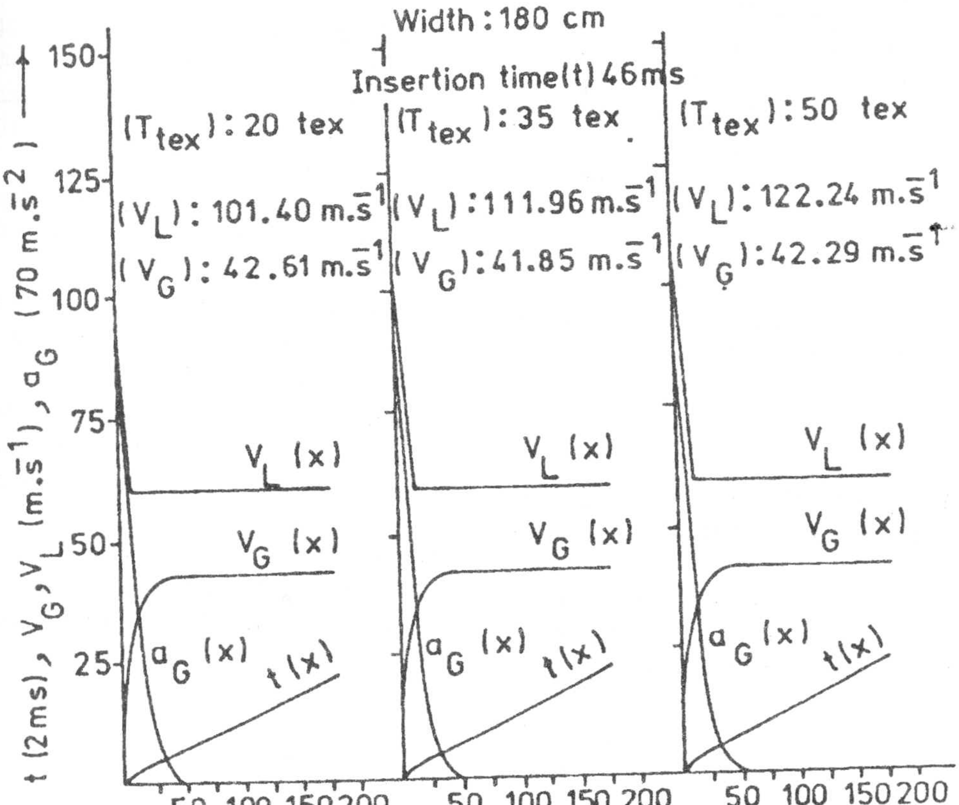

Figure 5-b. Kinematics of weft yarn by changing yarn count with constant insertion time.

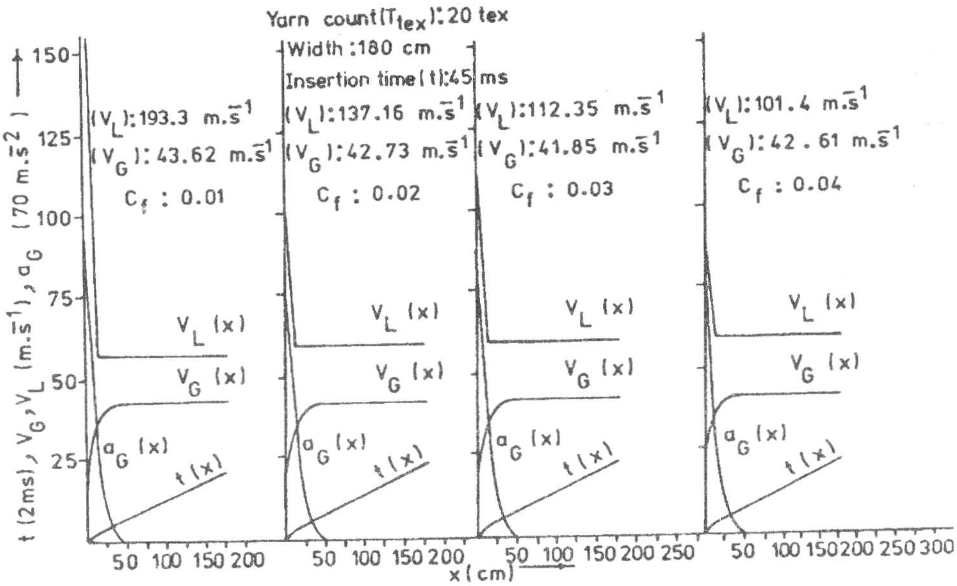

Figure 6. Kinematics of weft yarn by changing air drag coefficient.

5. CONCLUSION

The suggested approach to estimate the kinematics of weft gives the possibility for the loom designer to adjust the air velocity distribution across the insertion width to attain minimum energy consumption to insert the yarn at the proper insertion time.

From the economical point of view, it is useful in practice to determine the minimum required amount of air through the minimum air velocity.

The advantage of the presented program is to save time, experimental materials and cost as well as avoidance of fabric defects and machine stoppages.

REFERENCES

[1] Anderson, A.L., Stubbs, R.: Use of Air-currents for tensioning fibers *Journal of Textile Inst.* 49 T. 53-T 57, 1958.

[2] Duxbury, V., Lord, P.R. Vaswani, T.B: A Study of Some Factors Involved in Pneumatic Weft Propulsion *Journal of Textile Inst.* 50 pp. 558-573. 1959.

[3] Uno, M.: et al.: A Study on Air-jet Looms J. *of Text. Mach. Soc. of Japan* 7. pp. 28-36.

[4] Uno, M.: A Study on Air-jet Looms Substream Added *Journal of Text. Mach. S. Japan* 18. pp. 37-44, 86-92, 106-113,11 135-140. 1972.

[5] Greenwood, K. Makki, B.E.: The Twist Lo and Ring Spun Yarns In Air-Jet Weaving. *Month.* June, pp 56-57. 1981.

[6] Krause, H.W., Kissling, U.: Die Luftwebmas in Parkistischen Einsatz *Melliand Textilberich* pp. 780-784. 1980.

[7] Kissling U.: Experimentelle und theoret Analyse des Schu βeintrags mit spe Berucksichtigung der Hauptduse. *Dissert ETH Zurch.* 1984.

[8] Wahhoud A.: Ein Beitrag Zum Schuβeintragsverha;ten von Garnen im Lufts *Dissertation RWTH* Aachen 1987.