MANUFACTURE OF A COORDINATE TABLE TO ANALYZE THE FORCED CONVECTION

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Abstract. The coordinate table to forced convection analysis, simulating a welding process, consists of two parts: the base with 700 mm in height and length with a width of 400 mm, manufactured using 12 L profile bars with equal tabs united by welding. The second part united with screws is composed by a steel plate, two linear guides four skates, two roller bearings, one spindle, four aluminum bars (forming the support the guides), and a stepper motor 1.6 Nm controlled by computer, responsible for the displacement of the plate on the guides, allowing various options and routines displacement. The equipment has as general characteristics: A maximum path of 300 mm, maximum speed of 5 rps on spindle, generating a maximum speed of 25 mm / s on the table. Therefore this project presents a low-cost solution for building a machine to study convection and simulation of welding processes.

Keywords: Manufacturing; Analysis; Welding; Convection

1. INTRODUCTION

The transmission of heat by convection in the welded joints is usually neglected in computing models due to the low contribution to the energy balance (Guimaraes et al, 2011; Lacoste et al, 2010). Recent studies performed in our laboratory showed that under the action of winds, heat transfer by convection in the weld occurs in turbulent flow and can not be neglected; deserving further analysis (Lessa et al, 2011). To study this mode of heat transfer, harmful to welding processes, a unidirectional coordinate table was developed on which it will be possible to attach a torch able to move at a speed (welding) pre-established. The displacement of the table is made by a computer controlled step motor.

In this equipment will be generated dynamic thermal cycles, where a torch with known calorific power (heat source) produces temperature variations along a line on the surface over which focuses an air flow with a finite speed.

2. SELECTION OF MATERIALS

All metallic materials used in the project were selected based on functionality and endeavors that would have to bear (ASM, 1996). The base of the coordinate table was made with ASTM A36 steel square angles bar of 31.8 mm: four bars of 400 mm, four bars of 640 mm and four bars with 700 mm of length. To sustain the table base on the floor, keeping it flatness, four adjustable supports (fig. 1) were used.

Figure 1. Adjustable support used as table foot.

The support's bench (Fig. 2) is composed by four rectangular aluminum bars (50,80 x 19,10 mm). Two bars of 700 mm and two bars of 360 mm. To join these bars M6 x 25 mm Allen Screws were used. The purchase of the the guides, spindle and stepper motor were made to a commercial provider, using the following criteria:
- Value of products
- Standardization of purchase (the products would be purchased from the same company)
- Recommendation of people in the business.
- Customer service (some of the other companies did not provide budget).

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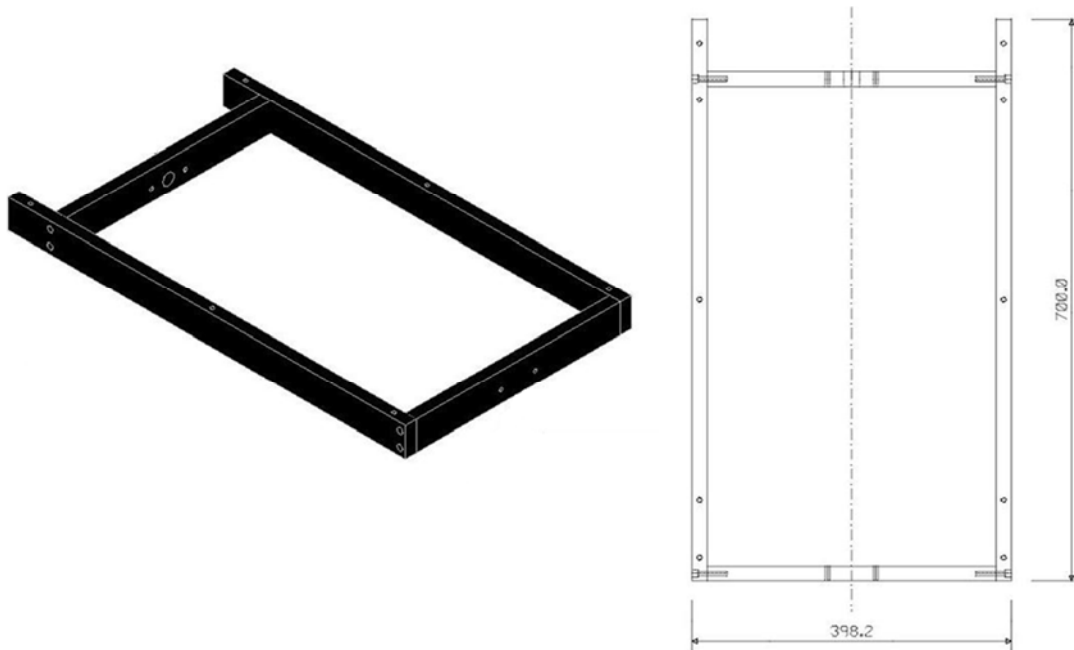MANUFACTURE OF A COORDINATE TABLE TO FORCED CONVECTION ANALYSE

Figure 2. Overview of bench support.

3. MANUFACTURE

The coordinate table was built and assembled following this project. The cutting, folding, welding and machining were supervised by qualified professional which contributed their expertise to the progress of the manufacturing process.

3.1. Base

After the upper and lower components of the base were manufactured, they were welded to the beveled regions. Each bar has top and bottom 45° beveled as shown in figure 3. The base's pieces are joined by butt welding arc electric with a coated electrode AWS E 6013.
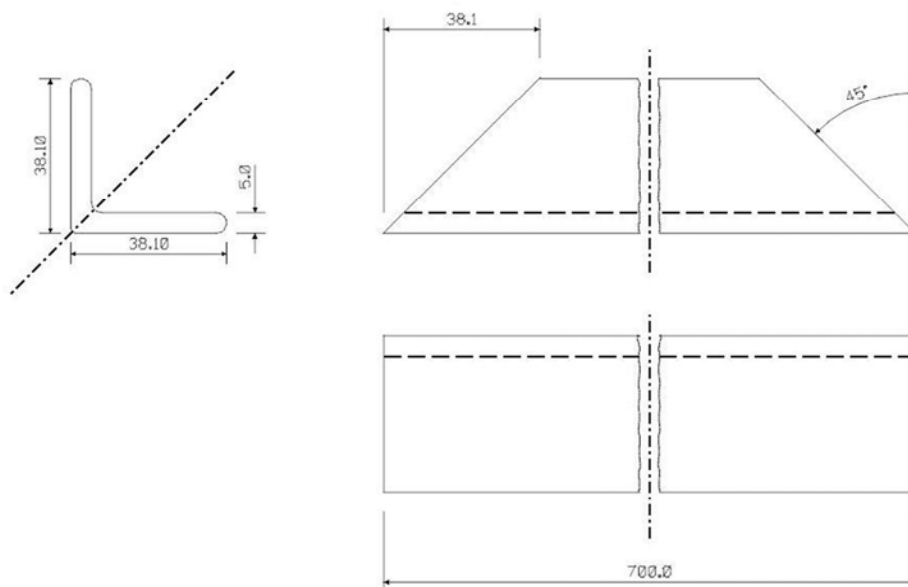

Figure 3. Drawing showing the bevel performed on bars 700 mm and 400 mm (Images out of scale).

Once manufactured, the dimensions of the base were high of 700 mm, width of 400 mm and length of 700 mm. After completion of the base, the holes for mounting the supports are made as shown in figure 1

3.1 Supporters guides

The linear guides supports were fabricated according to figure 5. Eight screws M6 x 25 mm type Allen joined the metallic part of the tab. In support, tabs were also fixed using three screws each in each one. The finished support can also be seen in fugure 5, with the bearings already fixed, the guides fixed with the rollers positioned to receive upper plate which is fixed by M6 x 10 mm Allen screws.

Figure 5. Base, support, guides, bearings and roller set

The shape and union nut Figure 7 were made of aluminum and fixed simultaneously to compesar any irregularity and enable better alignment. The spindle and the nut can be seen in figure. 6. The spindle, as can be seen in Figure 6, was assembled without any special treatment and had to be machined at the edges to receive the bearings, as shown in Figure 8.

Figure 6. Ball screw and nut.

Figure 7. Bottom view of the bench with the spindle and the chestnut of the base of the table.

In this assembly of coordinate table base (fig. 7), the spindle and chesnut can be seen in a rectangular base responsible for uniting these components.. The detailed schematic of the bearing assembly is shown in Figure 8

d	A	E	B	F	G
20	15	15	14.3	11	1

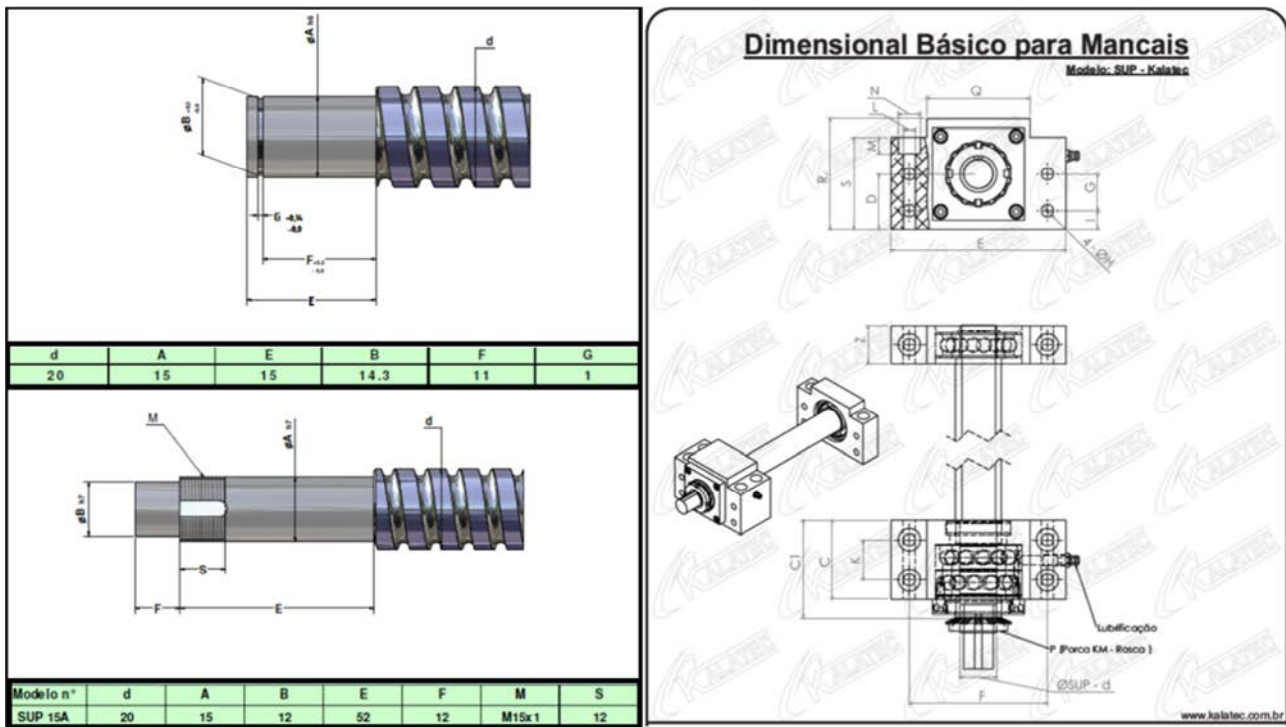| Modelo n°	d	A	B	E	F	M	S
SUP 15A	20	15	12	52	12	M15x1	12

Figure 8. Schematic drawing showing the adjustment (Courtesy KALATEC)

3.2. Final Adjustments

To mount the engine the use of a non designed component was required. Because the weight of the engine (15N) could flex shaft too much, the engine cannot be suspended as provided by the project. Thus, a sheet was adapted and fixed through two holes existing on the guides (Fig. 9).

Figure 9. Motor has fixed the table with the finishing

Finally, the engine and drive source are set on the basis of the table of coordinates. The motor shaft is coupled to the ball screw, ending the manufacture of the table, the result of which can be seen in Figures 9 and 10.
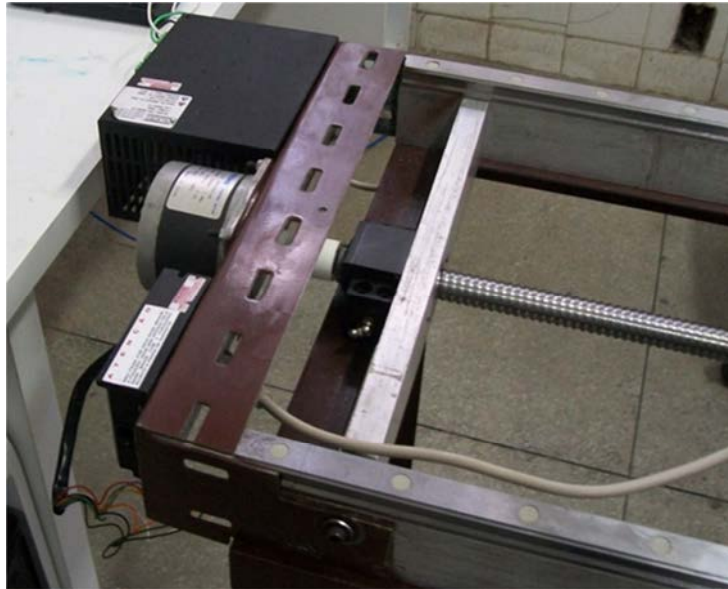

Figure 10. Table with drive, power supply and motor fixed.

4. COMPUTATIONAL CONTROL

Operational control of the table is done with software provided by QProgramer Kalatec Automation. Through this change of software routines required the analysis can be established (Kalatec, Host_Command_Reference).

The main commands are applicable:

- VE: sets the rotation speed in revolutions per second. It's vital set this value before any move make. Not setting this value the motor will move at full speed causing equipment damage. In our case 4rps speeds is the limit.
- AC: sets the rotation acceleration in revolutions per second per second. No setting this value the table move with zero acceleration, so this parameter should only be set if accelerate the shift table is desired.
- DC: analogous to the previous command. Slows the acceleration of the table.
- DI: indicates the direction of travel and how the table will move. Positive and negative values are acceptable.
- FL: This command closes the program starting the movement.

A basic example of programming can be seen below:

```
DI5000      <ENTER>
VE1         <ENTER>
FL          <ENTER>
```

Thus, the table will move 1mm forward at a speed of 5 mm/s at zero acceleration.

```
DI-5000     <ENTER>
VE1         <ENTER>
FL          <ENTER>
```

Thus, the table will move backwards 1 mm at a speed of 5 mm/s at zero acceleration.

These values are explained as follows:

- The 20 mm axis diameter and 5 mm pitch. The command VE1 (Indicates the motor axis rotate 360° in 1s, causing the shape advance or retreat the corresponding value, 5 mm in one second).
- Informing the value 5000 (Indicates the motor axis rotate 1/5) making shift the table 1mm.

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The table has a maximum displacement of 1.5 million (300 mm). This value must never be exceeded. If slippage occurs outside of the guides may occur losses sphere. If the tablet is in central position, the maximum displacement is 750.000 (150 mm).

To establish a routine, commands must be executed using the window of Fig. 11. This window will be used only columns "Cmd" and "Program1", where the first column indicates the command and the second column reports the parameter of this command.
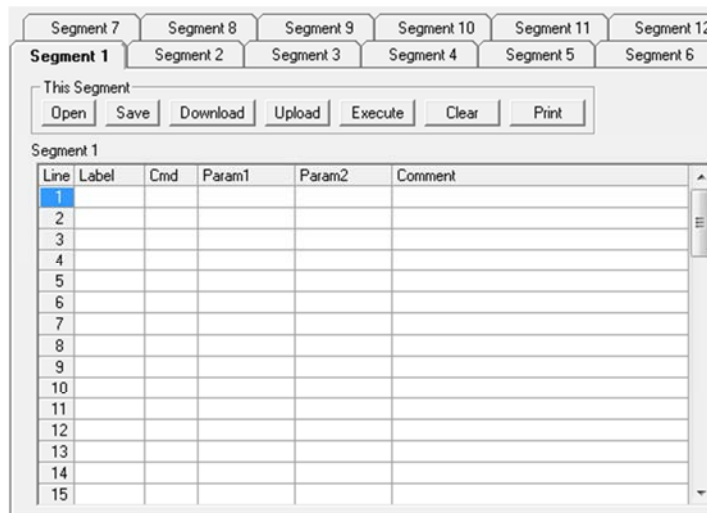

Figure 11. Window where the routines are typed

To enter a command in "cmd" click with the left mouse button on the desired cell and then, there is a button with an ellipsis figure (Fig. 12 left). Click again with the left button of the ellipses will appear the window with the command options (Fig. 12 right). Although the commands may be entered directly, the above procedure avoids the memorization of commands by the user, avoiding the wrong control information, and therefore the use of the table.
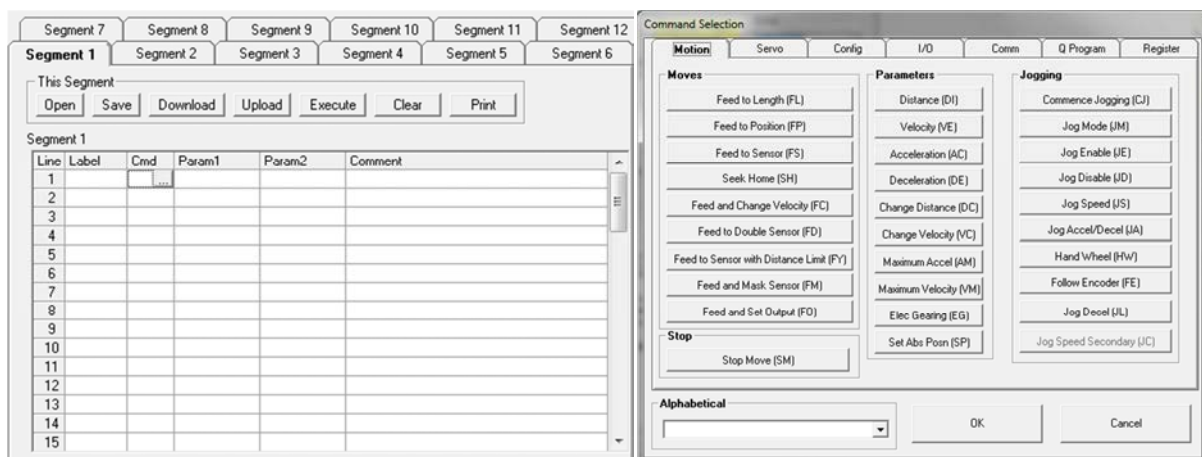

Figure 12: Detail of the button to the command (window left) with command options (window right)

To add any command simply click the left mouse button on the desired command and it will appear in the selected cell.

The commands shown in Fig.12 (right) are not the only options. Each flap contains a specific command list.

In Figure 13, there is an example of a programming routine use very practical in the table. The routine shown in this figure considers the table at the start of your route, so it should not be used if the table you find yourself in the position of center. There are many other scheduling options available which can be found at reference (Host Command).

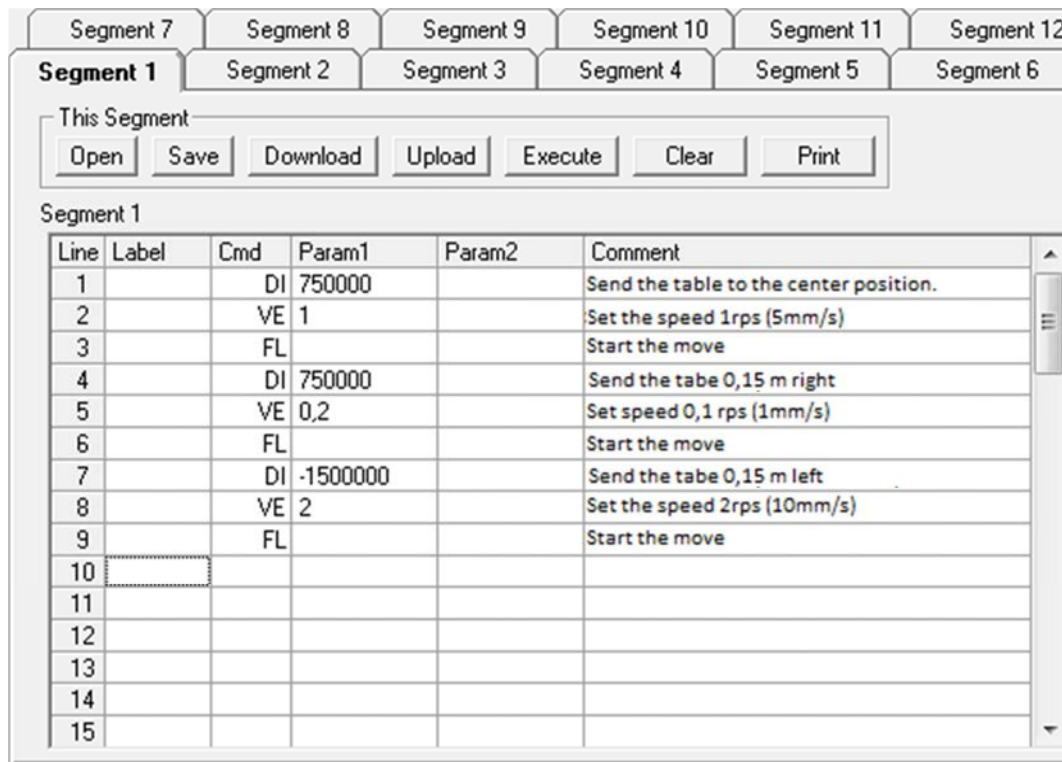| Line	Label	Cmd	Param1	Param2	Comment
1		DI	750000		Send the table to the center position.
2		VE	1		Set the speed 1rps (5mm/s)
3		FL			Start the move
4		DI	750000		Send the tabe 0,15 m right
5		VE	0,2		Set speed 0,1 rps (1mm/s)
6		FL			Start the move
7		DI	-1500000		Send the tabe 0,15 m left
8		VE	2		Set the speed 2rps (10mm/s)
9		FL			Start the move
10					
11					
12					
13					
14					
15					

Figure 13: Example of a basic list of commands.

After typing the command, the left mouse button must click to download to the commands being sent to the drive, and then run the string to be executed. If you do not use the list command, you must click with the left mouse button on "clear" to clear the memory unit on the table. If this procedure is not performed when the unit is restored, the command will be automatically run.

Once you have completed all operations with the table (and wiped the memory unit) turns off the power. If the table is not in the center position should use the command "FP" with parameter "0", regardless of the position in which the table stopped that it returns to the starting position

5. ACKNOWLEDGEMENTS

6. REFERENCES

A_Analog-positioning-using-Q-program. http://www.kalatec.com.br, 31 July 2012

ASM - Selections of Materials, Metals Handbook, 1996

Host Command Reference. http://www.kalatec.com.br, 31 July 2012

DANIS, Y.; LACOSTE, E.; ARVIEU, C, *Numerical modeling of inconel 738LC deposition welding: Prediction of residual stress induced cracking*. Journal of Materials Processing Technology**.** vol 210, p. 2053-2061, 2010

GUIMARAES, P. B.; PEDROSA, P. M. A. ; YADAVA, Y. P. ; ANDRADE BARBOSA, J. M. ; SIQUEIRA FILHO, A. V. ; SANGUINETTI FERREIRA, R. A.. Determination of Residual Stresses Numerically Obtained in ASTM AH36 Steel Welded by TIG Process. Materials Sciences and Applications, v. 04, p. 268-274, 2013.

LESSA, R. M. A. ; YADAVA, Y. P. ; GAMA, J. L. L. ; SANGUINETTI FERREIRA, R. A**.** . Mechanical Properties of Welding Joints of AH 36 Steel Processed Under Different Wind Actions. In: 21st Brazilian Congress of Mechanical Engineering, Proceedings of COBEM 2011. Rio de Janeiro: ABCM, 2011. v. CD ROM. p. 1-11.

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