

MDM Metrosoft S.a.s.
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USERS GUIDE

Metropatch

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INTRODUCTION

METROPATCH is a software that, using the points properly probed by CATRIM, calculates the geometric characteristics of a physical surface having a generic form. Using an universally accepted terminology, we can state that a measurement properly executed by CATRIM, allows METROPATCH to calculate the **MATHEMATICAL MODEL** of UNDEFINED GEOMETRY SURFACES .

The **MATHEMATICAL MODEL** derived from METROPATCH could be used in CAD / CAM programs becoming a remarkable aid for model & mould performers.

In the realization of the **MATHEMATICAL MODEL** we underline the following phases:

1. "MANUAL" MEASUREMENT POINTS SURFACE

We mean, in this case, the procedure executed using MIX with :

⇒ a manual CATRIM

⇒ a CNC CATRIM driven manually through joystick

for probing points of single splines on the surface; the coordinates of these points will be memorized into Files.

2. "AUTOMATIC" MEASUREMENT POINTS SURFACE

We mean, in this case, the procedure executed with a CNC CATRIM using the dedicated software AUTORIL for probing "in automatic" points splines on the surface; the coordinates of these points will be memorized into Files.

3. SURFACE MATHEMATICAL MODEL CALCULATION

Points memorized with procedure N. 1 or procedure N. 2 will be utilized for the calculation of the mathematical model of the surface.

4. DIFFERENT UTILITIES

⇒ Conversion of the Mathematical Model into different Graphics Exchange Specifications interpretable from CAD/ CAM Systems.

⇒ Conversion from the Mathematical Model in a program for CNC machine tools.

⇒ Modification of the Mathematical Model (factors of multiple scale, local offset).

SOFTWARE PRESENTATION AND UTILIZATION

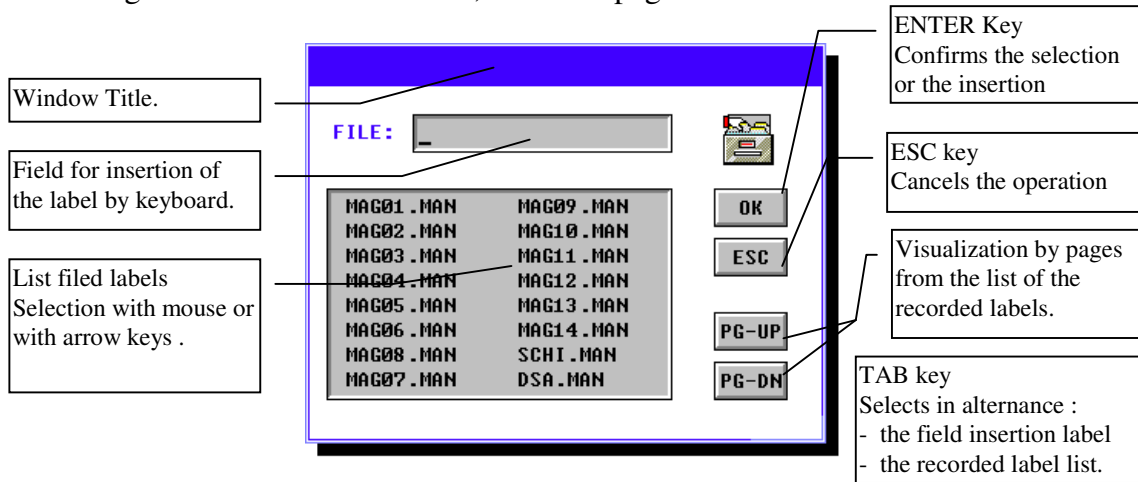
The modalities of presentation of METROPATCH and AUTORIL are similar to those of MIX; we suggest to read MIX User's Guide (September 1995 Edition), and in particular :

- WARNING WINDOWS (Page 8 MIX User's Guide)
- HOW TO SELECT DIFFERENT OPTIONS (Page 9 MIX User's Guide)

FILE RECORD

In different phases it will be necessary to save Files.

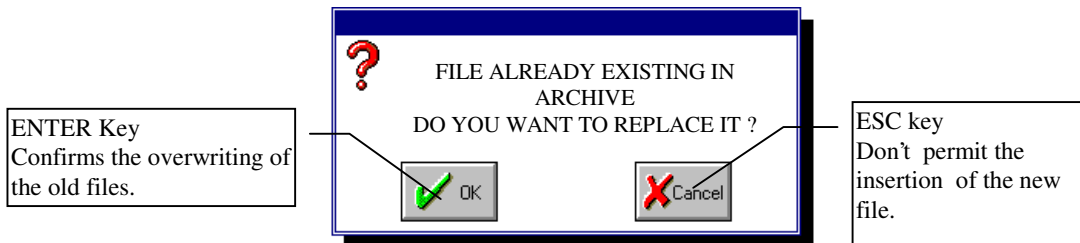
In these cases at the center of the video it will appear a **FOR SELECTING RECORD** containing the list of the saved Files, listed for pages.



RECORD OF A NEW FILE

The label of a file that we want record can be typed only through keyboard.

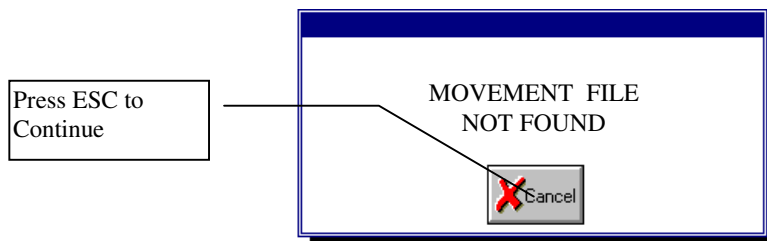
If it will be typed a just recorded label, it will be displayed the following **Warning Window** :



LOADING OF A SAVED FILE

Using the just explained commands from Keyboard or from Mouse, it will be possible to load a saved File.

If the label of the File typed from keyboard would not be present in the list of previously saved files, the following **Warning Window** will be displayed:



SURFACE LOFTING

We suggest the operator, to get an easier measurements execution, to perform by pencil or brush a "lofting" on the surface to probe.

The procedures for the execution of these lofting will be suitable in future, for the "manual" and "automatic" measurement.

With some practice, nevertheless, the operator will individuate, in function of the type of surface to probe, the best method.

1. "MANUAL" MEASUREMENT

1.1. LOFTING

It is necessary to perform a lofting through "longitudinal" lines covering appropriately the shape to probe; we will call these lines "longitudinal Splines".

On every Longitudinal Spline will be drawn points; the rule to select the number of these points is this:

- ⇒ number of points is high when the radius of curvature of the Spline is small (the limit case is represented from a cusp, where must be selected many points).
- ⇒ number of points is low when the radius of curvature of the Spline is large (the limit case is represented from a straight line, where can be selected few points).

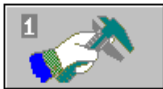
The number of the points doesn't must necessarily be the same for all the Longitudinal Splines; but we suggest, for the best individuation of the surface, to choose the same number of points.

With this procedure we will have performed a "grid" lofting composed by a double Spline series :

- ⇒ Longitudinal Splines, in the number of L ($L \geq 5$)
- ⇒ Transversal Splines, in the number of T ($T \geq 5$)

Longitudinal Splines intersect Transversals Splines in corrispondance of points called "knots" The number of knots is $K = L * T$.

1.2. MEASUREMENT OPERATIONS



It is used MIX, in the M / 1 operating mode, selecting in the General menu of MIX (Page 3 MIX User's Guide) the option N. 1. With this selection it will be displayed the Main menu (Page 28 MIX User's Guide).



It is required to verify that the memorized calibration corresponds to the existing configuration of the installed probes.

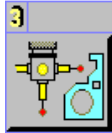
If necessary, it is required to proceed at a new calibration through the option N 1 (Page 29 MIX User's Guide) of the main menu



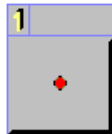
Is opportune, first of all, to fix & measure a reference system connected with the shape that we want to probe, using the option N.2 (Page 32 MIX User's Guide) of the main menu.

After the execution of the operations of calibration and of reference system measurement, must be probed points of the surface.

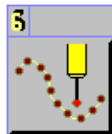
The operator will follow, from main menu, this sequence :



N.3 PROBED GEOMETRIC ENTITIES MENU
(See Page 37 MIX User's Guide).



N.1 PROBED POINT
(See Page 37 MIX User's Guide).



N.6 MULTIPLE PROBED POINTS
(See Page 39 MIX User's Guide).
This option is available in the MIX configuration coupled with METROPATCH and METROSPLINE software.

Performing the above choices, on the monitor will be displayed this Window :

XYZ coordinates display referred to the activated reference system and the addressed probe.

List of memorized points

K = 245.5304		12	274.254	176.082	116.633	
V = 189.6990		13	267.814	178.219	116.633	
Z = 116.6339		14	262.364	183.357	116.631	
		15	259.861	189.699	116.633	
		16	245.538	189.699	116.633	

Last probed point blanking

End of Spline measurement

Configuration of calibrated and usable probes/sensors by MIX.

 Key F3 Allows to select the probe/sensor (among the calibrated ones) with which to probe points.

View plane selection:
 F2 = plane X - Y
 F3 = plane X - Z
 F4 = plane Y - Z

Visualization of the probed points, referred to the selected view plane.

Points of each longitudinal Spline must then be probed; it is necessary to probe the Splines in the same direction.

During the Spline's point measurement a control system will verify that the sequence of the probed points is correct.

If this control system will find a not correct sequence, the program will display a **Warning Window** with the message :

WRONG POINT !!!
DO YOU WANT TO CANCEL IT ?

The operator will be enabled to cancel the wrong point.

At the end of the single spline measurement (Option F4), the points will be saved in a File, in the directory created during the installation of METROPATCH.

It is suggested to adopt for the File of the Spline a common part followed by a progressive 2 characters number.

Since Files under DOS may have a maximum of 8 characters, the common part will be composed by a maximum of 6 characters.

(I.e. FORMAX01...FORMAX99).

2 "AUTOMATIC" MEASUREMENT

For this type of measurement we will use the dedicated program : AUTORIL .

2.1. PRIMARY GRID LOFTING

Let us suppose that previously it has been implemented a "grid" lofting, which we will call "primary grid," composed by a double set of lines.

Every line is a spline; we may have two groupes of splines :

primary "longitudinal" splines

primary "transversal" splines

It is not necessary that the grid is regular and that the splines of every group lie on parallel planes.

The longitudinal splines intersect the transversals ones in corrispondance of points called "primary knots."

The primary grid must :

be sufficiently large meshed, so that it is possible to represent it with few points.

cover sufficiently the shape to be probed.

have at lesat 4 splines, and every spline must have at least 4 points.

The number of the points doesn' t must necessarily be the same for all the splines; but it would be better, for the correct bindividuation of the surface, chose the same number.

2.2. SECONDARY GRID LOFTING

The knowledge of the primary knots permits the calculation of a "secondary grid" small-meshed that covers the shape to be probed with an higer number of knots (secondary knots); this number may be obtained typing through keyboard these parameters :

Number of points for Spline (at least 5)

Number of the Splines (at least 5)

In corrispondence of every secondary knots, CATRIM will probe "in automatic" a point on the real surface.

2.3. PROBED POINTS RECORD

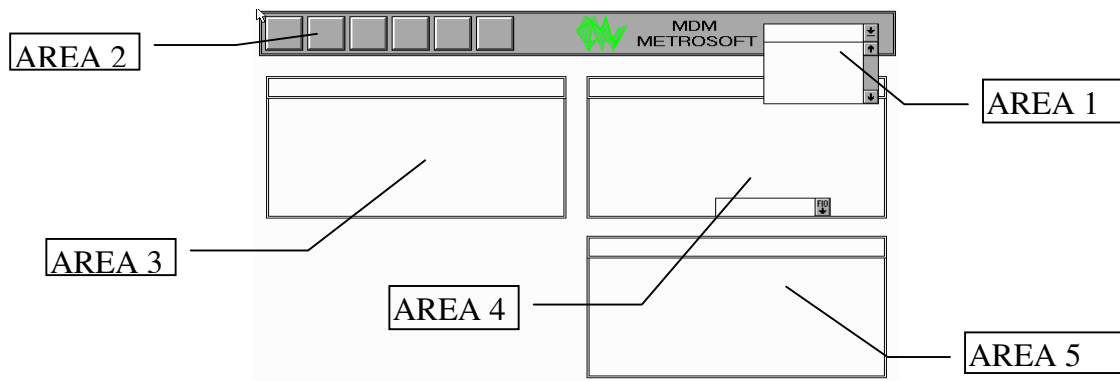
The probed points in corrispondence of the secondary knots are automatically saved in the LINKED FILE.

This FILE will be used later by METROPATCH for the next elaborations.

2.4. MEASUREMENT PROGRAM RUNNING

For running AUTORIL program, type RILP from keyboard and then hit the RETURN key.

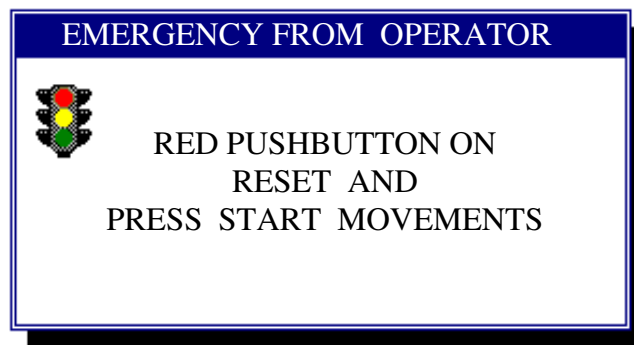
It will be displayed the main menu through this Window.



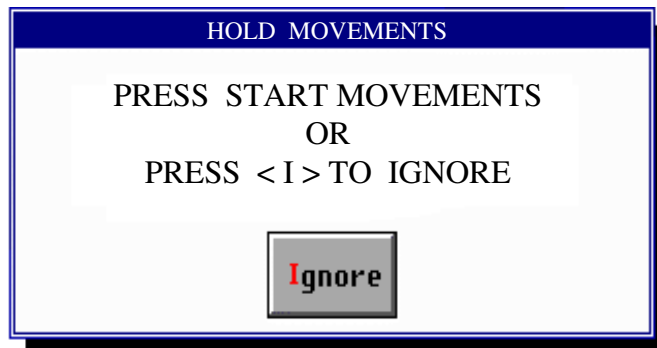
If the <EMERGENCY> push-button is switched-on, will be disabled :

- movement of machine through joy-stick.
- the possibility to choose other options.

It will be displayed a **Warning Window** (Page 8 MIX User'sGuide) of this type:



If <EMERGENCY> push-button is switched-off without having before pressed the START MOVEMENTS push-button, it will be displayed the following **Warning Window** :



- Pressing <START> push-button it will be allowed to move CATRIM “in jog” and to select the different options.
- Pressing <I> key (of Ignore word) it will be interdicted the possibility to move CATRIM “in jog” and it will be allowed to select the different options.

In both these cases it will be available the menu of the Areas 1, 2, 3.

2.4.1. AREA 1

The AUTORIL program could be used, with a proper selection, for the measurement in automatic of :

1. surfaces that will be later processed by METROPATCH program.
2. single profiles that will be later processed by METROSPLINE program.

The following description regards the case 1. .

For selecting this type of functioning, it is necessary to activate the Area 1 menu :

- with Mouse, by "clicking " over the arrow on the right.
- with keyboard, by pushing the combination of keys ALT+ DOWN ARROW.

In both ways it will be displayed the following pull down menu:

3D SURFACE	↓
3D SURFACE	↑
2D SPLINE XY	
2D SPLINE XZ	
2D SPLINE YZ	↓

In the first row it's possible to read the choice previously done.

Using the Mouse or the keyboard it is possible to select the wanted choice.

With this operation the menu will disappear and in the first line will be displayed choosen option .

For selecting the kind of functioning 1. (measurement of surfaces that will be later processed by METROPATCH program), it's necessary to choose the option :

3D SURFACE.

2. 4. 2. AREA 2

Running AUTORIL program, in AREA 2 will be displayed the section N. 1 of the main menu :



AREA 2 - MAIN MENU SECTION N. 1



F1 USE OF MIX program

Performing this choice :

- will be loaded the MIX standard program, in the operating mode M/1.
- will be shown the main menu (Page 28 MIX User's Guide).

It is suggested to follow this procedure :

1. Verify that the stored calibration of heads/sensors is in conformity with the situation of mounted heads/sensors. If this conformity would not exist, it will be necessary to proceed to a new calibration through option N. 1 (Page 29 MIX User's Guide) of the main menu.
2. Fix & measure a reference system connected with the shape that must be probed, through option N. 2 (Page 32 MIX User's Guide) from the main menu.
3. Go back to Main Menu (section N.1) exiting from MIX.

If the probe / sensor for the measurement has been chosen, with the schedule of Area 5 (Page 19) it is possible to verify the correspondence with addressed probe / sensor.

In case this correspondence does not exist, it will be possible address another probe / sensor with the option F1 of Area 2 Main Menu Section N. 2 (Page 14) .



F2 PRIMARY GRID MEASUREMENT

Allows the primary grid knots measurement (See paragraphs 2.1. and 2.2.).

It will be displayed File Recording Window, with which it will be possible to assignee the label to the File with extension **.MAN**.

Then, in correspondence of the Area 2, will be displayed the menu of PRIMARY GRID MEASUREMENT.



F3 SECONDARY GRID AUTOMATIC MEASUREMENT

This option allows to repeat "in automatic" a sequence of measurement following a path previously calculated and stored :

1. just after the primary grid measurement.
2. in a latter time using the option "F4 Path calculation"

Choosing this option it will be displayed a **YES-NO Window**, titled "EXECUTION", with the question "WORKPIECE IN NEW POSITION ?".

This question is asked because after the measurement (See option F2 on Page 11) it had also been stored the reference system used during the measurement and this option allow:

- pressing ESC to confirm this reference system.
- pressing ENTER to use a new reference system, that has previously been probed using MIX.

In the measurement's procedure, probed points are displayed graphically in a window.

At the end of the measurement it appears a **Warning Window** titled "END OF PROBING PROCEDURE".

Press Enter to go back to the Main Menu section N.1

At the same time, the Linked File (See Paragraphs 3. 1. and 3. 2.) will



F4 PATH CALCULATION

This option allows to calculate again in a second time, using a primary grid stored measurement, the automatic path, assigning new values at the parameters:

- Numbers of Spline points (minimum 5)
- Numbers of the Splines (minimum 5)

These numbers will allow, in practice, to locate the knot points of the secondary grid.

Confirmi the selection pressing ESC key.

It will follow the phase of calculation of the secondary grid knot points, their visualization in a **Warning window** titled PATH CALCULATION and, at the end, the storage of Path points and of reference System.

Choosing F4 will be presented an **ARCHIVE Window** containing the list of the saved Files as manual measurement.



F5 N.2 SECTION

Allows to activate, from the Section N. 1, the Section N. 2. Also this menu will be displayed in correspondence of the Area 2.



F6 EXIT

Allows to go out of the program



AREA 2 - PRIMARY GRID MENU

The operator, by Joystick, can begin the measurement of the primary grid; he must drive the probe / sensor to probe, in sequence, primary knots.

It will be displayed a Window with the coordinates, referred to the addressed reference system, of each probed point.

N.	X:	Y:	Z:
1	-249.527	-75.625	331.868
2	-237.876	-68.268	331.870
3	-237.879	-68.275	305.911
4	-221.980	-68.557	305.858
R.T	-221.958	-68.557	305.861

In this phase you can select the following options:



- F1 ERASE POINT**
It allows to erase last probed point.



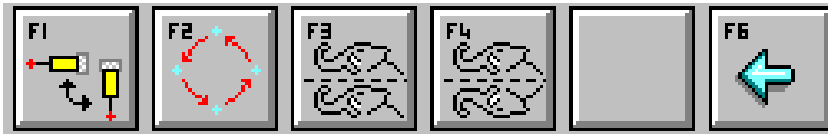
- F2 SPLINE END**
Use this option to end a spline.
The direction of a longitudinal Spline must be inverted compared to the direction of the preceding Spline, in similar manner to a cutter path.



- F6 END OF MEASUREMENT**
During these measurements may be displayed Warning windows, containing various messages like :
- **POINT NUMBER NOT SUFFICIENT**
- **SPLINE NUMBER NOT SUFFICIENT**
If you want to end a measurement, selecting F6 it will be displayed a YES-NO Window titled "END MEASUREMENT". With affirmative answer manual measurement will be ended.

In sequence will start the procedures :

- **F4 PATH CALCULATION**
- **F3 SECONDARY GRID AUTOMATIC MEASUREMENT**



AREA 2 - MAIN MENU SECTION N. 2

**F1 SELECT PROBE**

With this option it will be displayed a **DATA INPUT Window**, titled "SELECT PROBE", that allows to select the right combination of probe / sensor used for the measurement.

The following options F2, F3, F4, allows geometric operations on an automatic path, which we will call "Basic Path".

The options F2 and F3 allow the "MULTIPLE FIGURES SETTING" and are used chiefly for the measurement of single profiles that will be later processed by METROSPLINE program (See Page 10).

**F2 MULTIPLE FIGURES SETTING FOR ROTATION**

This option allows to calculate paths in automatic, rotating the Basic Path around one of the axes of the reference system.

Selecting F2 an INPUT DATA Window titled :

**MULTIPLE FIGURES SETTING
ROTATION ANGLE**

with the request of the following parameters:

- **ROTATION ANGLE**
Write, by keyboard, the value in degrees and thousandth of degree (from 0 to 359.999).
An observer that considers the XY plane from the side of the positive Z, will provide the following signs for the angle:
 - Negative for the clockwise direction.
 - Positive for the counterclockwise direction.
- **AXLE (X = 1, Y = 2, Z = 3)**
Must be assigned with a number (from 1 to 3) corresponding to the axis of the shapes reference system around which rotation is desired.
- **SECURITY POSITION**
Is the distance form the plane XY (from the positive Z side), from a path to the following rotated one.
- **ROTATION NUMBER**
Assign the desired number N of rotations.
First rotation is the Basic Path.
Everyone of others N-1 rotations represent a rotation from the Basic Path around the selected axis of one of the N-1 angles



F3 MULTIPLE FIGURES SETTING FOR TRANSLATION

This option allows to calculate paths in automatic, translating the Basic Path in respect of the X and Y axes of the reference system.

Selecting F3 an INPUT DATA Window titled :

MULTIPLE FIGURES SETTING AXIS OFFSET

with the request of the following parameters :

- **OFFSET X**
Input the value of translation for the Basic Path on the X axle, with value and sign.
- **OFFSET Y**
Input the value of translation for the Basic Path on the Y axle, with value and sign.
- **SECURITY POSITION**
Is the distance form the plane XY (from the positive Z side), from a path to the following translated one.
- **COLUMNS NUMBER**
Fix the number of columns on which you want to do the translation.
First column is the Basic Path.
- **COLUMNS NUMBER**
Fix the number of rows on which you want to do the translation.
First row is the Basic Path.



F4 SPECULAR SHAPES

Basic Path, in respect of one plane This option allows to calculate a path in automatic, specular to the of the reference system.

Will be displayed, in sequence, **Windows** with these titles:

1. "NAME OF THE SOURCE FILES ? "
2. "NAME OF THE DESTINATION FILE? "
3. "SPECULAR DATA "

with the following possibilities of selection :

- **SPEC. PLANE** (1 = YZ, 2 = XZ, 3 = XY)

for the selection, done obviously by means the corresponding number, of the specularity plane referred to the addressed reference system.



F6 SECTION N.1

Allows to go back to section N.1 of the Main Menu, which will always be in correspondence of the Area 2 .

2. 4. 2.1. CONSIDERATIONS ABOUT OPTIONS F2, F3, F4

In the last pages we have done the description of the options F2, F3, F4, and how to use them.

Now we think that it is right to give an explanation about some their modality of operation, to avoid wrong interpretations.

We have already anticipated that these options have sense if it has already been stored a Basic Path connected to a certain reference system.

OPTIONS F2, F3

The options F2 and F3 allow to use this Basic Path to repeat it a certain number of times, in accordance with the selected parameters.

Therefore it won' t be calculated and stored a path for all the multiple shapes and, quitting the program, will be lost the selected parameters for the options realizing **MULTIPLE FIGURES SETTING**.

OPTIONS F4

The option F4 allows, instead, to store a Path specular to the Basic Path.

This path stored will be considered, in a second time, as a Basic Path, that will be executed singularly, or with the **MULTIPLE FIGURES SETTING**.

2. 4. 3. AREA 3

This Area may be selected through :

- the keyboard, using the Alt + C key
 - the mouse, clicking on the first line from the top
- and allows to set these parameters :

ALT + C = PARAMETERS SETUP	
1) SECURITY DISTANCE	: 5.000 (mm)
2) APPROACH DISTANCE	: 3.000 (mm)
3) SEARCHING DISTANCE	: 3.000 (mm)
4) BAUD RATE	: 19.200 (bps)
5) HIGH SPEED	: 8.000 (mm / min')
6) PROBING SPEED	: 200 (mm / min')
7) MODALITY	: NORMAL

On the right hand are written some exemplary values of parameters, with indication of the measurement units.

To give an explanation of the first 3 parameters meaning we will do reference to arguments of paragraphs 2. 1. and 2. 2.

The knowledge of the secondary grid will allow to know the position of the secondary knots and the normal line direction to the surface in correspondence of these knots.

Three points on this normal line, eachone in corrispondence of every secondary knot, are very important; we will give them the numbers that they have in the schedule :

1. The **SECURITY POINT** , located at an opportune distance from the unknown surface, has the job, between a point to probe and another, to hold the probe at a right distance from the surface and to avoid undesired collisions. This distance is called **SAFETY DISTANCE**.
2. The **APPROACH POINT**, that is situated outside the surface, in respect of the corrispondent secondary knot. at the **APPROACH DISTANCE**.
3. The **SEARCHING POINT**, that is situated inside the surface, in respect of the corrispondent secondary knot. at the **SEARCHING DISTANCE**.

For the point 4, 5, 6, is not necessary explanation.

7. MODALITY

It is possible to set two modalities of interpolation axis between consecutive probed points :

- **NORMAL** : Linear Interpolation between the security point.
- **CONTOUR** : Circular Interpolation driven by the security points, without nevertheless that these are reached.

2.4.4. AREA 4

It allows **only the visualization** of the following DATA

PROGRAM STATUS	
1) PROBING TYPE	: SINGLE
2) MODE	: MANUAL
3) FILE NAME	:
4) REFERENCE S.	:

1) PROBING TYPE

- **SINGLE** It highlights that none multiple modality has been selected and, consequently, that the automatic measurement will be performed over the only Basic Path.
- **MULTIPLE (ROTATION / TRASLATION)** . It highlights that a multiple mode has been selected and, consequently, that the automatic measurement will be performed over the Basic Path rotated or traslated in respect of its reference system, according to values setted for the parameters.

2) MODE

- **MANUAL** It highlights that it has been selected option F2 (Primary grid Measurement).
- **AUTOMATIC** It highlights that it has been selected option F3 (Secondary grid Measurement).

3) FILE NAME

- It displays the File name addressed at the moment.

4) REFERENCE S.

- It displays and selects (Key F10) the Reference System addressed at the moment.

2. 4. 5. AREA 5

Allows the only visualization of the following Data:

MACHINE STATUS	
. C. N. C. EMER.	:.....
. ADDRESS. PROBE	:.....
. ADDRESS. SENSOR	:.....
. PROBE STATUS	: PRESENT

1) C. N. C. EMER.

- Signals the operating status of the Numerical Control.

2) ADDRESS. PROBE

- It displays the code number of the addressed probe (the selection of the probe has been done with the F1 option of the section N. 2 of the Main Menu).
- In the configuration for PH9 PH10 this field highlights the angular position taken on from the Alpha & Beta axis

3) ADDRESS. SENSOR

- It displays the code number of the addressed sensor (the selection of the sensor has been done with the F1 option of the section N. 2 of the Main Menu).

4) PROBE STATUS

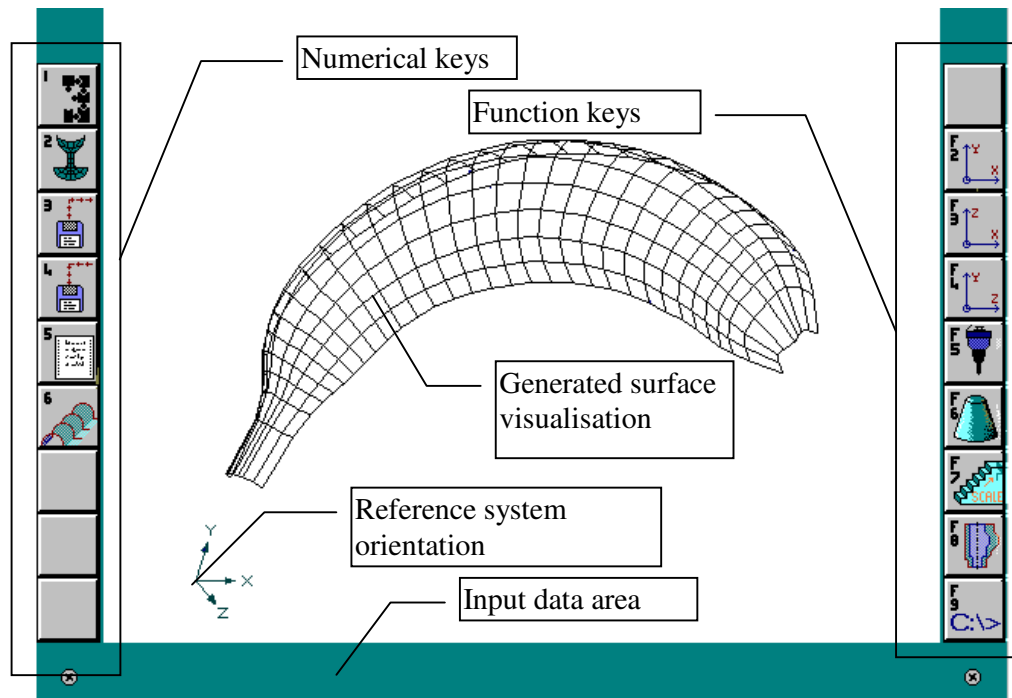
It signals the calibration status of the probe / sensor configuration, displayed in the rows 2) and 3) .

Possible status displayed are :

- **PRESENT** the selected probe / sensor has been previously plugged and calibrated with MIX.
- **ABSENT** the selected probe / sensor has been plugged on the 5 ways block .
- **NOT CALIBRATED** the selected probe / sensor has not been calibrated.

3. METROPATCH.

METROPATCH program main screen:



Let us suppose that we have just done measurements.

For the **MATHEMATICAL MODEL** calculation we need the “LINKED FILE”, that is available in different ways if measurement has been “manual” or “automatic”:

- In case of “manual” measurement (See page 5), this File will be created through “**SPLINE LINKING PROCEDURE**”.
- In case of “automatic” measurement (See page 8), this File is already memorised in archives.

3.1. LINKED FILE CALCULATION FROM MANUAL MEASUREMENT

Must be used the first option of main menu :



Key 1 **SPLINE LINKING PROCEDURE**

This option will be used only when Splines have been probed in "manual mode" and it allows to "connect" the separated Splines on a single LINKED FILE.

3.1.1 LINKED FILE DENOMINATION.

First question regards the name for the surface.

On screen it will be displayed an ARCHIVE Window (see page 3) with this title :
SURFACE NAME ?

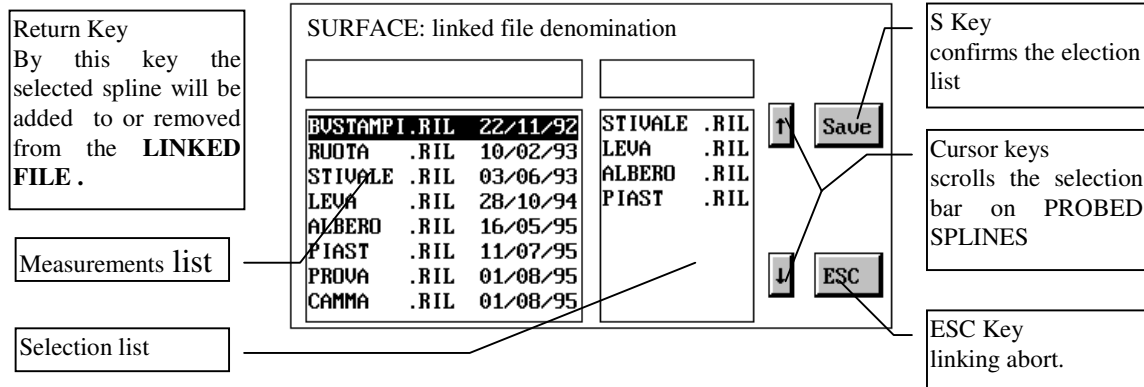
and we will assigne this name, with which it will be memorized the correspondent LINKED FILE.

3.1.2. SPLINES SELECTION FOR LINKED FILE CREATION.

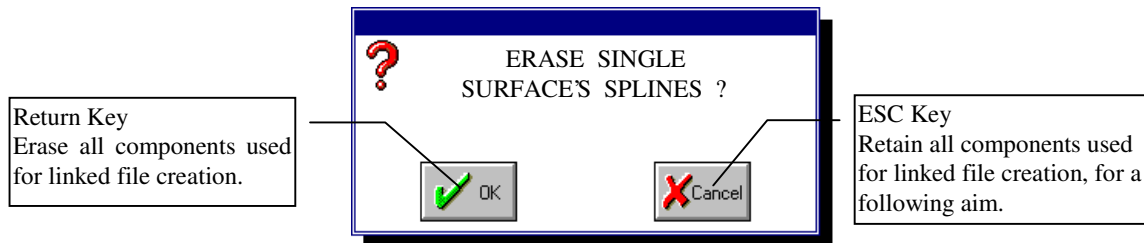
By this selection it will be opened a Window including two separated lists:

- PROBED SPLINES (left) , to display all splines already saved.
- SELECTED SPLINES (right) , to display the splines actually selected.

The job of this selection is to assemble in a geometric sequence the Splines which compose the surface.



After the selection list confirmation, concerning the LINKED FILE, it will be opened the following Window:



3.2. SURFACE MATHEMATIZATION.

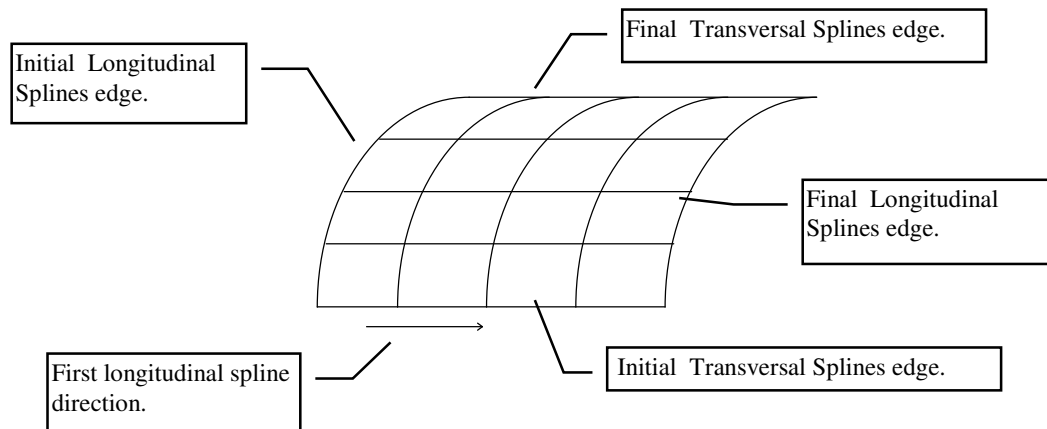
This calculation is done on Linked files from carried out either in "manual " or "automatic" measurement mode.



Key 2 SURFACE ELABORATION.

All points saved in Linked File will be elaborated, to obtain the Surface Mathematical Model.

- A proper Window will be opened for the LINKED FILE selection.
- On "insert data" Area will be requested the following parameters:
 - ⇒ Approximation tolerance; this value sets up the maximum accepted distance from mathematical. surface to probed points.
 - ⇒ Optional values concerning an **Extension edge** of surface contour. Pressing RETURN key in corrispondence of each extension, a null default value will be assigned.



At the end of mathematization process, the computed and simplified surface will be displayed in 3D view.

3.3. SURFACE LOADING FROM ARCHIVE.



Key 3 LOAD SURFACE

This option permits to load from disk the file cotaining the math. model of a saved surface. A graphic rappresentation of this surface will be displayed, with the option to rotate the view.

3.4. FORMAT CONVERSION.



Key 4 FORMAT CONVERSION.

It converts the surface mathematical model to formats directly readable from CAD-CAM packages.

Available formats:

- IGES (5.1 version)
- VDA - VDMA (2.0 version)

Others optional protocols will be available from MDM Metrosoft on request.

3.5. GRAPHIC PRINTING.



Key 5 GRAPHIC PRINTING.

With this option it is possible to print on paper the computed and simplified surface in 3D view . displayed on video

3.6. SPLITTING THE WHOLE SURFACE IN SEPARATED SPLINES.



Key 6 SPLITTING IN SPLINES.

Sometimes the CAD-CAM packages don't recognize the formats seen above; for this reason it is necessary to convert the math. model in a simplified form, for example a series of points, members belonging to isoparametric sections.

IN Data Input Area are requested :

- **Longitudinal Step** (distance in mm. between points along longitudinal Splines).
- **Transversal Step** (distance in mm. between points along ltransversal Splines).

It will also be requested the direction of computed spline:

- **Longitudinal spline direction** (default choice)
- **Transversal spline direction**

In the graphic output reserved area will be displayed a 3D view of splines as selected .

3.7. SELECTION OF VIEW ANGLE.

It is always possible to change the angle of plane of view, concerning the selected surface, by changing the position of this reference system as regards to **screen reference system**.

The **screen reference system** is oriented as follow:

The X axis is parallel to monitor horizontal edge.

The Y axis is parallel to monitor vertical edge.

The Z axis is perpendicular to monitor view plane.

By using the cursor keys is possible to rotate the workpiece reference system as following rules:

Left arrow : rotation over Y axis (screen) on counterclockwise direction.

Right arrow : rotation over Y axis (screen) on clockwise direction.

Down arrow : rotation over X axis (screen) on counterclockwise direction.

Up arrow : rotation over X axis (screen) on clockwise. direction.

PgDn : rotation over Z axis (screen) on counterclockwise direction.

PgUp : rotation over Z axis (screen) on clockwise direction.

The keys from F1 to F4 realize fixed changes of angles between the piece reference system and screen reference system.



Key F1 Rotates the piece reference system of 30 degrees over X and Y axes.



Key F2 Makes the two reference system coinciding.



Key F3 Aligns the piece Z axis to screen Y axis and makes coinciding the X axes of both reference systems.



Key F4 Aligns the piece Z axis to screen X axis and makes coinciding the Y axes of both reference systems.

3.8. MILLING PROGRAM GENERATION.



Key F5 MILLING PATH.

Allows the machining simulation and the creation of a Milling Program, ready to be sent to CNC; this program includes linear interpolations of 3 axes XYZ, with the tool radius offset already computed.

This option requests or displays, in sequence:

- **Longitudinal step** (mm) (distance point to point over the longitudinal splines).
- **Transversal step** (mm) (distance point to point over the transversal splines).
- DATA INPUT Window for selecting, if desired, a program header previously memorized; this program will be added at the beginning of milling program.
- DATA INPUT Window for selecting, if desired, a program end previously memorized; this program will be added at the end of milling program.
- ARCHIVE Window to input the milling file name.
- DATA INPUT Window for selecting these parameters :

CNC PARAMETERS (OPTIONS)	Meaning
Measure Unit <input checked="" type="checkbox"/> mm <input type="checkbox"/> 1/100.mm	Measure unit following the CNC settings.
Decimal number	Sets up the decimal number requested from CNC.
Block ID.	Identifys the start program block number.
Step	Identify the program number step.
Mill <input checked="" type="checkbox"/> Spherical <input type="checkbox"/> Cylindrical	Allows to select the tool type.
Machining allowance	Identify the desired machining allowance quantity.
ID X axis	Character identifying the X axis.
ID Y axis	Character identifying the Y axis.
ID Z axis	Character identifying the Z axis.

- Tool diameter to be used (in mm) . If diameter is assigned without sign, surface will be machined outside; If diameter is assigned with negative sign the surface will be machined inside.
- **CORDAL ERROR TOLERANCE** (mm). This parameter changes according to the kind of machining requested. Using, for the CNC program, all computed points with the machining step selected, the milling tool could vibrate, due to consecutive points too close. In this way the milled surface can be imperfect. To eliminate this problem, all points are "filtered" by an algorithm, called "**cordal error algorithm**", that operates according to a selected tolerance. Normally, by keying in a tolerance of 0.005 mm , may be obtained satisfactory results, without compromise the original shape of probed surface.
- **MILLING DIRECTION**. Referring to direction of Longitudinal and Transversal splines (see paragraph 2.1), which are strictly connected to the sequence selected for points measurement, will be requested wich direction to assign to the milling :
 - ⇒ Longitudinal (default choice)
 - ⇒ Transversal

After these parameters settage, will be computed and then displayed on graphic area:

- a path on skin surface (without tool radius compensation).
- a path containing all mill centers, calculated from preceding path with the tool radius compensation.

3.9. SOLID SURFACE VISUALISATION.



Key F6 SURFACE SHADING.

Allows to display the surface as a real solid, with light effects, texture and two different colors for the inside and outside surfaces. In this way the operator can get a first approximated results of measured form, before its real machining.

3.10. MULTIPLE SCALE COEFFICIENTS.



Key F7 SCALED SURFACE COMPUTATION.

This option was introduced for application in the shoes industry, to generate different sizes starting from a basic size. This option could be used for other industrials sectors, on condition that the surface has these caratheristics :

The reference system used for the form measurement and for the math. model, must be have the origin and at least one of axis included inside the form.

This option requires to fix in the selected form an axis, named **evolving axis** ; according to this axis, may be used scale factors that simultaneously operate on the coordinates of eachone of the three axis, following rules explained later.

With reference to evolving axis, the computed surface will be divided in three different areas, (Area 0, Area 1, Area 2) , on each of which will be applicable separate scale factors.

These three areas will be divided by two intermediate areas, which act as a connection.

The assignment of the scale factors follows the rules contained in this table:

SCALE FACTORS PARAMETERS		
Development : X Y	Requested inputs	ZApplication point
01 LIMFSC Z.....	Upper limit Area 0	Input R and S values
02 LIMFSC Z.....	Lower limit Area 1	Input R and S values
03 LIMFSC Z.....	Upper limit Area 1	Input R and S values
04 LIMFSC Z.....	Lower limit Area 2	Input R and S values
05 LENGHT	Upper limit Area 2	Input R and S values
06 X F0	Any point inside Area 0	Input R and S values
07 X F1	Any point inside Area 1	Input R and S values
08 X F2	Any point inside Area 2	Input R and S values
09 Y F0	Any point inside Area 0	Input R and S values
10 Y F1	Any point inside Area 1	Input R and S values
11 Y F2	Any point inside Area 2	Input R and S values
12 DATA OK		
13 ABORT		
14 LOAD SCALE		
15 SAVE SCALE		

On top left it is possible to select the Development axis.

The table is displayed differently, according to Development axis chosed.

In the case of table seen above was chosed the Z axis of the Surface reference system and the requests sequence will be the following :

- From 01. to 05. scale variation along the Z axis. It will be necessary to provide for each limits the probed value R, and the matching value in scale S that is requested. Please to notice the following:

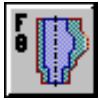
⇒the upper limit for Area 0 corresponds to Z axis origin, so it is not necessary to fix the R and S values for this limit.

⇒the upper limit for Area 2 declared by R and S values, practically is extended to endless.

⇒the connections beetwen the Area 0 / Area 1 and Area 1 / Area 2, which are realised in the two intermediate Areas, follow a linear law.

- From 06. to 08. scale variation along the X axis. It will be necessary to provide for each Areas the value of R, and the matching value in scale S that is requested. This numbers can be interpreted as length, as the case a) or as numbers owning the ratio S / R equal to request scale. The connections Area 0 / Area 1 and Area 1 / Area 2, realised on two intermediate Areas, follows a law which guarantees the continuity of tangency in corrispondence of intermediate limits.
- From 09. to 11. scale variation along the Y axis. As view for values from 06 to 08.
- 12 DATA OK. Option to be used when the parameters are properly defined.
- 13 ABORT. It cancels the scale transformation.
- 14 LOAD SCALE. It allows to load a configuration of parameters previously saved by option n. 15.
- 15 SAVE SCALE It allows to save a defined configuration of parameters.

3.11. USING MULTIPLE THICKNESS COEFFICIENTS.



Key F8 Thickness variation.

This option was introduced, as the F7, for application in the shoes industry, but it could be used for other industrials sectors .

Also in this case it is required to fix an **evolving axis** ; according to this axis may be calculated a surface with desired variable thickness, following a law that will be explained later.

According to development axis, the calculated surface will be divided in four Areas (Area 0, Area 1, Area 2, Area 3), for every Area will be used different thickness.

The four Areas will be divided by three intermediate areas that function as connections.

The assignment of the thickness will follow the rules contained in this table:

THICKNESS PARAMETERS		
Development : X Y Z	Application point	Requested operation
01. LIMFSP	Upper limit Area 0	State end Area 0
02. LIMFSP	Lower limit Area 1	State start Area 1
03. LIMFSP	Upper limit Area 1	State end Area 1
04. LIMFSP	Lower limit Area 2	State start Area 2
05. LIMFSP	Upper limit Area 2	State end Area 2
06. LIMFSP	Lower limit Area 3	State start Area 3
07. S0	The whole Area 0	State thickness Area 0
08. S1	The whole Area 1	State thickness Area 1
09. S2	The whole Area 2	State thickness Area 2
10 S3	The whole Area 3	State thickness Area 3
11 DATA OK		
12 ABORT		

On top left is possible to select the Development axis.

The table will change according to the chosed Development axis.

In the table seen above the Z axis of the Workpiece reference system was chosed and the requests sequence will be the following:

- From 01. to 06. stating the limits Areas according to Z axis origin, so it' s not necessary to state this axis.
 - ⇒The lower limit for Area 0 corresponds to the origin of the Z axis, that' s why is not necessary define it.
 - ⇒The upper limit for Area 3 practically extend to endless.
 - ⇒The connections Area 0 / Area 1, Area 1 / Area 2, Area 2 / Area 3, which are performed in the three intermediate areas, follow a law that guarantees the uninterrupted tangency in corrispondence of intermediate limits.
- From 07. to 10. It provides, for each Area, the value of related thickness (mm).
- 11 DATA OK . Option to be used when the parameters are properly defined.
- 12 ABORT . It cancels the thickness variation.