

# **ROBOformER**

## **Salvagnini Automated Bending Cell**

**Request No. WB\_7/04**  
**February 23, 2004**

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The Salvagnini Group, with its great proven experience in the design and production of flexible systems for machining sheet metal, is pleased to present you with a worldwide exclusive: the automatic bending cell

## **ROBOformER**

As long ago as 1977 the Salvagnini Group had become the unchallenged leader in sheet metal automatic bending with its P4 automatic Panel Benders, which, with their wide range of models and configurations, can satisfy a vast range of applications.

Since 1997 the Salvagnini Group has further completed its range of automatic connections for automatic loading and unloading, using completely integrated robots. The first applications of robots were for feeding and unloading P4 automatic Panel Benders, but within two years this technology was already being applied to other Group products too, such as the S4 automatic punching and shearing centers and the L2 laser cutting system.

**ROBOformER** has sprung from the success of these experiences, from careful analysis of the end products studied to date, and from the assessment of the needs of our customers. It is an automatic bending cell composed of a press brake, a robot, and panel handling and regripping stations, which are completely integrated with each other.

When creating **ROBOformER**, the Salvagnini Group did not limit itself to the mechanical aspects of the cell but developed an innovative control and programming system, which makes it a truly automatic and flexible installation. A single and complete work program is created starting from a drawing of the panel in 3D format, drawn up in the office with the exclusive CAMformER package, and can be used immediately by the **ROBOformER** cell.

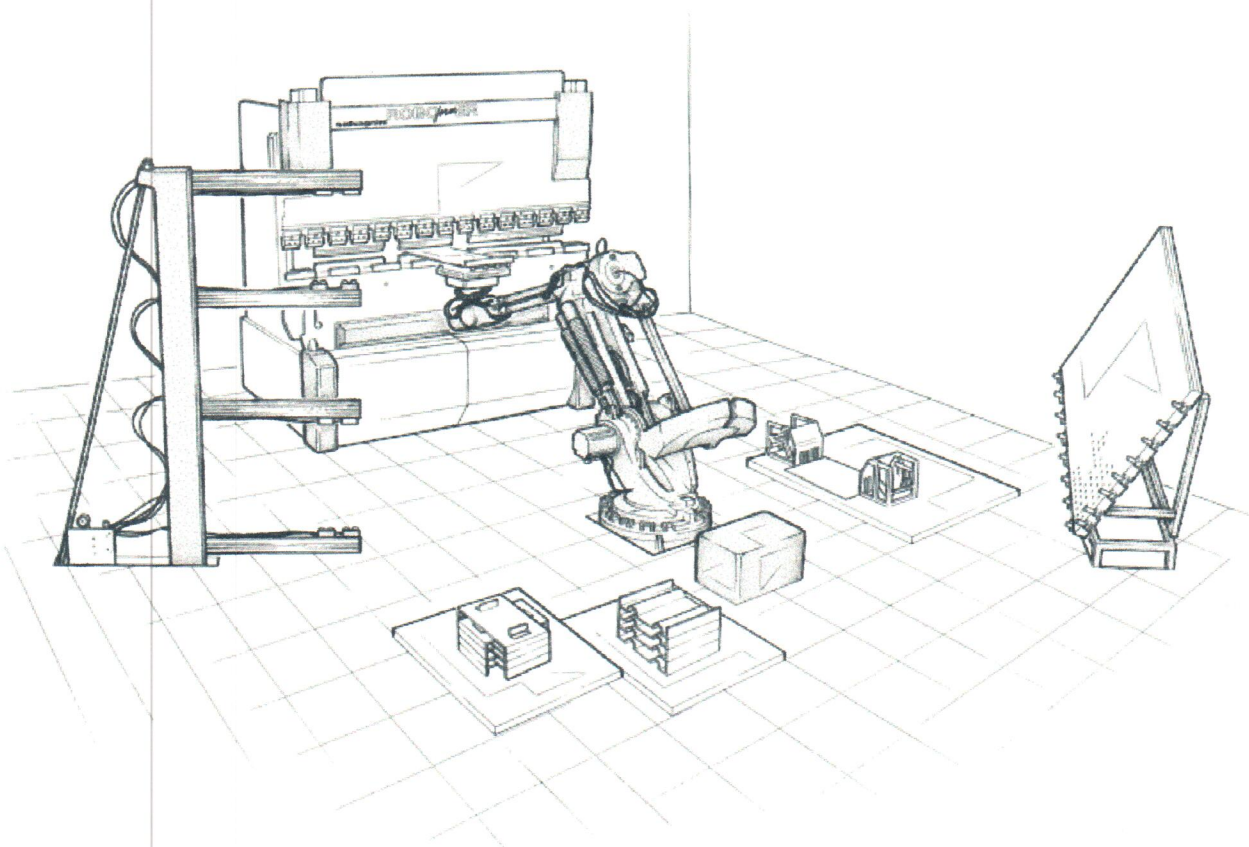
## OPERATING PRINCIPLE

### **ROBOformER**

### SALVAGNINI AUTOMATED BENDING CELL

The ROBOformER bending cell is protected by international patents and comprises the following main components:

- CAMformER + **ROBOformER**OFFICE Programming Package
- MMACHNT Control System
- Press Brake
- 6-Axis Robot
- JOB**ROBOformER**.MAINTMGR
- Stations for inputting materials, centering, and panel regripping and unloading.





## **GENERAL DESIGN**

### **ROBOformER**

### **Salvagnini Automated Bending Cell**

Basically, only two operations are required to make a new panel with the **ROBOformER**:

- 'Off-line' elaboration of the panel with CAMFORMER and transmission of the work program to the **ROBOformER** control unit;
- Set-up, where applicable, of the bending and gripping organs and start of panel production on the **ROBOformER**.

CAMFORMER does not require specific programming for the various cell components but only definition of the geometry of the product (drawing in 3D SAT format), and the panel bending and gripping tools. In particular, no teaching is required for the robot as all the trajectories are calculated in a completely automatic and exhaustive manner by CAMFORMER with precise anti-collision control.

Thanks to the completeness of the program generated with CAMFORMER, the **ROBOformER** possesses all the data needed to carry out the machining cycle phases automatically or to carry out the following cycles in an automatically calculated and completely synchronized sequence:

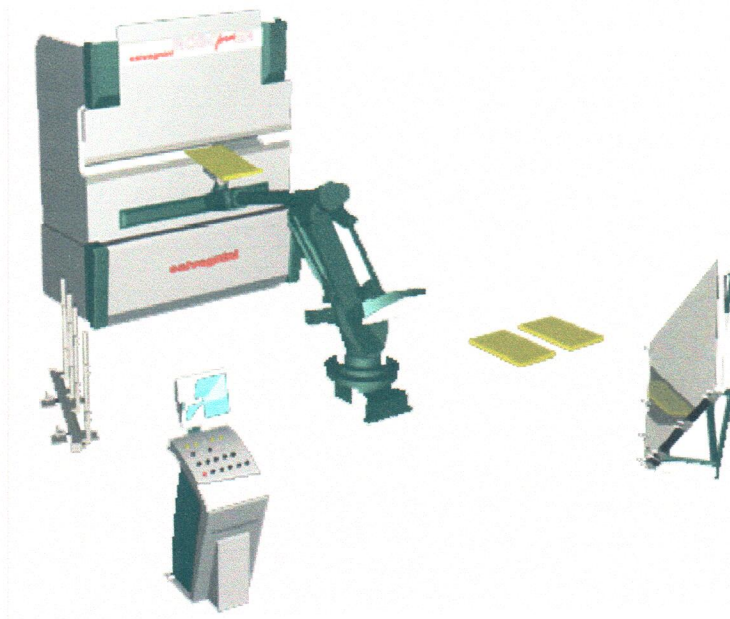
- Sheet pick-up cycle: the robot takes the sheet to be machined from the pack on the feeding station; the cycle contains all the controls required to guarantee that the robot picks up a single sheet;
- Sheet centering cycle: the robot places the sheet on the centering station in such a way that it assumes a well-defined geometrical position;
- Bending cycle: during the bending cycle, the sheet is held by the robot which acts as manipulator; the bending press carries out all the actions specific to bending such as reference positioning and ram descent; during this cycle, the robot and the bending press work in a completely synchronized manner in accordance with a strategy of reciprocal positioning optimized by the elaboration process; the 'edge guiding' cycle is particularly effective and is realized by means of automatic adjustment in real time of the descent of the ram with respect to the robot movement speed (and vice versa); this cycle makes it possible to carry out the bend without producing undesired counter-bends;
- Sheet regripping cycle: the robot places the sheet on the panel support station outside the bending press; this cycle makes it possible to change the robot's grip on both faces of the panel;
- Panel stacking cycle: the robot stacks the panels in accordance with the procedure decided by the programmer when creating the program.

It is obvious that the operating principle of **ROBOformER** is particularly efficient and advantageous as:

- The programmer does not need specific knowledge of handling by robot;
- The programmer is able to produce complete machining programs without needing the bending press to be available;
- The programmer is able to estimate the costs of the machining cycle;
- A single control cell, MMACHNT, guarantees the repetition of the machining cycle and therefore the consistency of the product.

## TECHNICAL SPECIFICATIONS OF THE **ROBOformER** Salvagnini Automated Bending Cell

**Configuration:**  
**ROBOformER+CAMformER+SAFETY GUARDS**



### **CAMformER Programming Package**

The CAMformER off-line programming package, along with the MMACHNT control unit, is one of the most distinctive features of **ROBOformER**.

The CAMformER package is able to generate all the necessary bending program data, starting from a model of the panel in 3D SAT format, in an automatic and correct manner.

None of the functions of **ROBOformER** are overlooked: the calculation procedure includes all the panel manipulation operations such as feeding/centering, robot trajectories, press brake actions, and unloading the finished product.

Functionally, the package can be divided into the following modules:

- Drawing import and export module;
- Drawing module;
- Module for the graphic definition of the bending tools and panel gripping devices;
- Module for program elaboration and analysis;
- Machining cycle simulation module.



### ***Drawing import and export module***

CAMformER can import and export drawings in 3D SAT format (this format is necessary for elaborating the panels) and drawings in 2D dxf or dwg format (a useful format for importing bending tool sections). File importation takes place in a guided manner and can be actuated simply by using the mouse ('drag & drop').

### ***Drawing module***

CAMformER makes it possible to modify or create 3D models and has all the main drawing functions required for creating sheet metal panels. The module also makes 2D drawing functions available.

### ***Module for the graphic definition of the bending tools and panel gripping devices***

CAMformER manages a series of libraries (databases), which contain all the information required for describing the bending tools/dies and the panel gripping tools.

The library of tools/dies is populated with 2D drawings (dxf or dwg) of their sections. A further function makes it possible to define the various tool/die set-ups on the bending press in a guided manner, and these set-ups are then saved in a special library.

In the library of panel gripping devices, on the other hand, the representations are in 3D SAT format.

Both representations (2D for tools, 3D for gripping devices) can be created using the specific design functions of CAMformER itself.

### ***Module for program elaboration and analysis***

Programmers who want to generate programs are basically asked to provide the 3D SAT drawing of the panel, and decide on the type of tool set-up and gripping device. CAMformER automatically analyzes and calculates the following in successive steps:

- Type of bending requested; for example, it is able to break down a high-radius bend into a series of bends close together;
- Selection of the tool and positioning of the most suitable bend;
- Selection of the bending sequence;
- Position of the bending press references;
- Centering position;
- Calculation of the robot trajectory from feeding the sheet to unloading the finished panel;
- All the different panel gripping positions during the machining cycle;
- Check of the clearance between the panel and the **ROBOformER** structure to prevent collisions;
- Estimation of the duration of the forming cycle ( $\pm 10\%$ ).

The elaboration module has been optimised in such a way as to select the best forming strategy rapidly and is able to provide results quickly, within minutes. It is also provided with powerful diagnostics so that, if a panel cannot be solved automatically, it reports the reasons to the programmer.

### ***Machining cycle simulation module***

CAMformER is provided with a high-fidelity animated machining cycle simulation system. No phase of the process is excluded from the simulation and the operator has various degrees of representations available with tools such as zoom, hold image, and save to animation file in AVI format.

## **ROBOformEROFFICE – Software application**

Software application for classifying, filing and transferring bending programs, in the office auxiliary workstation. Based on a window graphic interface, it makes the remote maintenance activity of the **ROBOformER** programs easier and more efficient.

## **MMACHNT control system**

**ROBOformER** uses the MMACHNT control system, which has been already successfully adopted in all Salvagnini's product range.

In the case of ROBOformER a single MMACHNT control manages all the components of the cell: press brake, 6-axis robot, auxiliary stations.

High performance control system distributed on 3 levels.

- Elaboration unit for managing and supervising the machine. The unit is composed of a COMPAQ workstation with Windows 2000 operation system equipped with an UltraSCSI hard disk and two



ETHERNET TCP/IP thin net BNC RJ58 network cards (RJ 45 available only for outside networks): one for the connection to the “real-time” control and the other for the connection to any programming office workstation.

- Proprietary real-time control unit, which communicates with the interface section through a high-performance VME bus.
- Interface section towards peripheral devices such as hydraulic motors, solenoid valves, sensors .etc.

The MMACHNT control system allows the operator to use the main functions for managing the system swiftly and intuitively by means of a specially created graphic interface.

*The MMACHNT system includes the following applications:*

- *Machine diary, which records the number of movements made by machine parts;*
- *Graphic diagnostic on monitor, which indicates operation anomalies and indications on the solution of the problem;*
- *Analog modem that permits a fast information exchange between the machine and various Salvagnini depts. such as Service, Automation, Studies & Applications.*

## **6-Axis Robot**

The 6-axis robot completely carries out panel handling inside the cell during the entire machining process.

During the machining cycle, a gripping device fitted with suction cups, which can have different dimensions and geometry depending on the product to make, supports the panel.

The gripping device is mounted on the innovative **Soft-Link** system, by means of a fast manual coupling system. The **Soft-Link** system is mounted on the wrist of the robot and makes it possible to detach the gripping device while the panel approaches the bending press reference system. When detached, the panel assumes the correct position with respect to the references in conditions free from mechanical stresses. When referencing has been completed,

**Soft-Link** stiffens the robot wrist and gripping device, without changing the position assumed by the panel.

Thanks to the **Soft-Link** system, **ROBOformER** is able to carry out machining operations with very high precision and consistency, especially if compared with the characteristics of bends made by bending presses.

The robot is able to manipulate panels with a maximum weight of 55 Kg.

## **JOBROBOformER.MAINTMGR - Software for the automatic management of batch sequences and for saving system data.**

Software package, installed in all Salvagnini systems, for the automatic management of the production of sequence of batches - if equipped with a sheet automatic feeding system - and for saving data and movements of system components.

The sequence of batches is contained in a list manually prepared by the operator. The batches - that differ from one another in the program, the type and/or the thickness of material – must be produced with the same arrangement of the tooling; otherwise, separated lists must be prepared. The final destinations of the single parts produced are automatically assigned according to the configuration of the connections placed downstream of the system. The operator can modify these destinations before starting production. It is possible to interrupt the input sequence and then to re-start it from where it was interrupted, even if in the meantime other parts have been produced.

## **Stations for inputting materials, centering, panel regripping and unloading**

The basic configuration of **ROBOformER** is fitted with the auxiliary stations listed below. **ROBOformER** is however designed for integration with automatic systems for the supply of the materials to be machined (for example, Salvagnini MV sheet metal pack stores) or machined panel storage systems (for example, Salvagnini ASR automatic roller table systems).

### **Material input station**

This is composed of a table on the ground on which packs of metal sheet to be machined are deposited and a sheet separation system with manual positioning.

The sheet separation system is provided with permanent magnets, blown air and an automatic thickness control device.

### **Centering station**

This consists of an inclined table on which reference pegs are fixed along two orthogonal axes.

The control system automatically calculates the ideal orientation of the sheet for centering.

The panel is placed on the table by the robot and goes to rest on the reference pegs as an effect of its weight, assuming a known position for the subsequent machining operations. Micro switches check that the panel is positioned correctly.

*Dimensions of the centering station: 1500 x 1500 mm.*

**Panel regripping station**

The panel regripping station permits positioning of the gripping device on both faces of the panel so that it is possible to make both upward and downward bends. It consists of a strong frame and a set of panel support arms, each of which is easy to position manually. There is a set of suction cups on each support arm capable of supporting the panel in a vertical position.

*Length of the regripping station: 1900 mm.*

**Panel unloading station**

In the simplest version the panels are unloaded unto flat containers or crates located in defined areas on the ground.

# **TECHNICAL SPECIFICATIONS** **ROBOformER Cell Components** **(CPR105-3000.CP200)**

**Hydraulic Press Brake**  
**6-Axis Robot**  
**Material Handling Stations**  
**Software and CNC Control**  
**Safety Guards**  
**Maximum Length of Incoming Sheet = 120"**  
**Maximum Width of Incoming Sheet = 60"**

➤ Press Brake, with 5-Axis Back Gage	
Down Acting Press Brake with Synchronized Cylinders	Standard
Automatic Slide Lubrication	Standard
Automatic Bed Crowning	Standard
Pneumatic Tool Clamping	Standard
"Promecam" Style Tool Mounting	Standard
Maximum Tonnage	117 Ton (US)
Bending Length – Overall	122 in.
Bending Length – Between Housings	102 in.
Stroke	8 in.
Throat	14 in.
Open Height	15 in.
Ram Approach Speed	472 in./min.
Return Speed (Max)	401 in./min.
Bending Speed (Max)	47 in./min.
Ram Positioning	+/- .0004 in.
Ram Repeatability	+/- .0002 in.
Main Motor	15 HP
Machine Weight (Approx)	16,100 lbs.
➤ 5-Axis Back Gage	
X-Travel (Depth) – Max/Min	23.5 / 0.0 in.
Z-Travel (Width) – Max/Min	84.0 / 3.0 in.
R-Travel (Elevation)	7.5 in.
Offset (Maximum)	7.875 in.
Position Speed	520-X, 105-R in./min.
Positioning	+/- .004-X, +/- .008-R in.
Repeatability	+/- .002-X, +/- .004-R in.



## TECHNICAL SPECIFICATIONS, continued

➤ Robot	
6-Axis, Articulated Arm Robot	Included
Maximum Capacity	176 lbs.
Maximum Capacity of Sheet Metal Panel	120 lbs.
Positioning Accuracy	+/- .004 in.
Robot Base	Included
Robot Pendant	Included
Quick Change Vacuum End-effector	(1) Included
<i>Soft-Link</i>	Included
<p>During the forming cycle the gripping device, fitted with suction cups, supports the panel. The gripping device is mounted on the innovative <i>Soft-Link</i> system, by means of a quick-change manual coupling system. The <i>Soft-Link</i> system is mounted on the wrist of the robot and makes it possible to “float” the panel into position on the press brake. As an effect of the “float”, the panel assumes the correct position with respect to the gages free from mechanical stresses. When referencing has been completed, <i>Soft-Link</i> stiffens the robot wrist and gripping device, without changing the position of the panel. The system is able to carry out forming operations with high precision and consistency.</p>	
➤ Software and CNC Cell Controller	
CAMformER (Automatic program generation from 3D model)	Included
TOOLformER (Tool Library)	Included
RDE (Data Elaboration)	Included
MMACHNT with Windows 2000 (CNC Cell Controller)	Included
➤ Safety Guarding, with Interlocks	Included
➤ Material Handling Stations	Included
<p>The basic configuration is listed below. <b>ROBOformER</b> is also designed for integration with automated storage and retrieval systems, and automatic roller table panel storage systems.</p>	
<p><u>Material Input Station, One (1) Included:</u> This is composed of a table on which the stack of material to be formed is positioned and of a sheet separation system with manual positioning. The sheet separation system is provided with permanent magnets, air blower, and double sheet thickness detection.</p>	
<p><u>Centering Station, One (1) Included:</u> This consists of an inclined table on which reference pegs are fixed along two perpendicular axes. The control system automatically calculates the ideal orientation of the sheet for centering. The panel is placed on the centering station by the robot, rests against the reference pegs, and as a result creates a known position for the subsequent forming operations. Micro switches check that the panel is positioned correctly.</p>	
<p><u>Panel Regripping Station, One (1) Included:</u> The panel regripping station permits positioning of the gripping device on both faces of the panel so that it is possible to make both upward and downward bends. It consists of a strong frame and a set of panel support arms, each of which is easy to position manually. There is a set of suction cups on each support arm capable of supporting the panel in a vertical position.</p>	
<p><u>Panel Unloading Station, Cell Defined, and Customer Supplied:</u> In the simplest version the formed panels are unloaded to customer supplied flat containers or crates located within the defined area of the cell.</p>	