Innovations for automotive and appliance glass

Dedication to researching and developing new technology, as well as responding to customers' requests for lower priced, high performance equipment has driven machinery manufacturer AISA along the path of innovation. Over the past four years, the company has expanded its production range by upgrading existing models and introducing new ones. Amongst its newest innovations stand a screen printer for automotive glass, and a printer for domestic appliance glass which is considered the quickest on the world market.

Giovanni Patrini*

AISA

Fig. 1
A complete printing and drying line at AISA's new plant

Background

AISA was founded in 1977 and started manufacturing robots and industrial automation systems tailored to suit specific customer requirements. The company soon dedicated itself to the flat glass processing field, cooperating in research and development with major companies. Today, AISA is able to satisfy the demands of different business sectors with designs which carry the company's hallmark of quality and originality.

Other fields in which AISA operates are:

- complete lines for colour TV tubes processing and handling;
- valve assembly, calibration and testing lines;
- gasket manufacturing equipment.

Due to its work, the company has acquired extensive technological experience and employs highly-skilled staff. The combination of these two factors has enabled AISA to develop screen printing lines of the highest quality.

AISA offers complete glass processing lines for automotive, architectural and decorative glass, with different handling and process machinery, before or after the bending or tempering lehr. These products include corner grinding machines, screen printing machines, IR or UV dryers and coolers for ink curing, inspection systems, registration devices, automatic loading/unloading systems, and packing systems.

AISA has a new, fully operational production plant in Ticengo, near Cremona (northern Italy) which, together with its long-established Cumignano sul Naviglio (Cremona) plant, will provide a further boost to the company's increasing production needs. Its total production space now amounts to 5,000 square metres.

ISO certification procedures have been started by the company, which has implemented a Quality Assurance System. The firm's goal is to achieve certification by 1998.

In recent years, the company has seen considerable sales of its latest screen printing machines and IR paint dryers. Net sales have risen approximately 40 per cent annually during the last couple of years and annual turnover is expected to top US$ 9 million in 1996. A considerable amount is set aside for research and development.

Screen printers

Since 1992, AISA has been producing screen printer model *GHS17* with numerical control. This model is capable of printing windshields and backlights in 9 seconds, with excellent precision and repeatability results (Cp greater than 6). All glass registration and printing parameters are stored in the memory of the PLC (or PC), so when a changeover is required the operator need only to select the new part number on the PC display. These screen printers can be changed over in approximately 5 minutes from the last painted glass of a former part number to the first painted glass (which meets the customer's quality requirement) of a new part number, provided the "off-line screen alignment table" is used.

Fig. 2
The GHS 19-2 IR paint dryer

The speed and precision achieved is the result of technology acquired by AISA over the years in constructing robotic equipment although it is mainly due to the new design and manufacturing concept, which considers the screen printer as a machine tool. For each movement, high quality components like prismatic guides with recirculating ball sliding units and brushless motors are used, and in

general, the machines are sturdily constructed to facilitate high working speeds without vibrations.

Furthermore, AISA has done a detailed analysis of the screen printing process and identified the basic parameters of the process itself. This was done to reduce operator intervention and eliminate the possibility of error. Operation of AISA machines does not require an expert. After detailed study of all changeover procedures, the screen printing machine was engineered to keep the time of these procedures as short as possible.

New products

A wide range of equipment has been introduced into AISA's production over the past four years. All screen printing machines have been upgraded due to new concepts (patent pending), and new models have been launched on the market to cover the entire range of glass sizes and thicknesses.

A special screen printer has been developed for printing on two glass sheets for automotive windscreens; the printing is done on the smaller piece of two glass sheets, which is placed on the larger one. (This model will be exhibited at Glastec '96.)

Trademark printing machines have also been developed, in different configurations: off-line, with manual loading and unloading table, on-line with an autocentring table to print, for instance, the bus bar on backlights before entering the tempering furnace.

The UV paint dryer has also been updated and engineered for cost-efficiency. An IR dryer has been designed and developed, which is now available in different versions. New developments for glass cooling are being studied to obtain a shorter equipment length - compared to standard systems available on the market - as well as to achieve savings in running costs.

A powdering machine that deposits wet powder on the outer glass of windshields is the latest product which will be added to the windshield pre-processing line. Thus, AISA is now able to supply a complete system, starting from the washing machine exit to automatic loading of the paired windshield into the bending furnace.

In addition, a new pairing and palletising system for windshields, which uses no separator between the pairs of inner glass (painted) and outer glass, was developed. The system runs at a cycle of 13 seconds and has a minimum changeover time of about 2 minutes.

Fig. 3
The fully automatic GHS 31-S with PLC display

Machine performance

The demand of flat glass processing companies for higher productivity levels to fully exploit modern tempering furnaces currently on the market has led AISA to study the development of new machinery.

One of the engineered results of its study is screen printer *GHS31-S*. This screen printer model is the fastest on the world market for household appliance glass. It can print on glass sheets with maximum dimensions of 800 mm x 600 mm with a cycle time of 4.5 seconds down to a minimum size of 200 m x 200 mm with a cycle time of 3.8 seconds!

Another new project under way will produce a machine capable of printing sidelights and quarterlights up to the very edge of the glass with an operating time of 6.5 seconds. This will allow the customer to continuously feed a tempering furnace with two glass sheets every 7 seconds, and to have extra time for screen cleaning and servicing on the printer, using in-line the accumulator model *GHS27*.

Changeover times

Since four years ago, AISA has developed the *Off-Line Screen Alignment Process* which is now extensively used by the company's customers. The system is based on the adoption of a screen holder (master frame) on which the

screen frame is mounted. The master frame is suited for every screen frame size in the machine range. When the master frame is positioned on the alignment table, the operator has only to align the screen with two fiducials and lock the screen in position on the master frame. Then, the latter can be re-inserted with the screen on the printer and the machine is ready to produce. The screen alignment procedure is, therefore, simpler, more practical, and not time-consuming because it can be done off-line while the printer continues working. This feature, added to other AISA-installed features, allows a total changeover time between 5 and 7 minutes.

Fig. 4 The GHS 37-T with visual inspection station

Costs

Requests from customers for lower-priced equipment with manual set-up and quality performance within certain specifications led AISA to study and develop new automation concepts for printing equipment - which are now being patented. AISA has engineered different screen printing models suitable for different glass sizes, ranging from 100 mm x 250 mm to 2,500 mm x 1,500 mm. The prices of these new models are lower and market response has been positive; many machines have already been sold in the automotive glass and household appliance glass sectors.

The requisite of short cycle time is fully maintained by AISA's new screen printing machines. For instance, model *GHS37*, which can print on a maximum glass size of 1,200 mm x 2,000 mm, runs with a cycle time of between 10 and 13 seconds.

The glass registration system is completely new and automatic. First, it operates with six rollers made of hard plastic and does not require registration templates for windscreens and backlights (templates are necessary only for very asymmetrical sidelights and quarterlights). Second, the system is autocentring: it permits minimising the glass cutting tolerances which affect screen printing precision, and helps eliminate any eventual slack generated by wear. Lastly, slight errors regarding the glass position can be corrected with three mechanical X-X-Y knobs with digital read-out, positioned on the operator side. The knobs are set in a zero position to register the glass in a pre-set position, which corresponds exactly to the position of the screen as registered in the master frame on the off-line pre-alignment table. This is more practical and allows the screen set-up time to be saved.

Moreover, the new registration system guarantees high precision within the strictest requirements in the automotive field. Model GHS17 has four or five NC axes to register the glass and reaches standard deviation error on final glass positioning of less than one hundredth of a millimetre with a Cp (process capability) greater than six. The new model GHS37 has no numerical axis, but the result for standard deviation is less than three hundredths of a millimetre with a Cp greater than two. This result is better than what the automotive companies require.

Thus, AISA has achieved its goal of drastically reducing the cost of the equipment, while adhering to the same requirements, and obtaining almost the same machine performance.

Safety

All AISA machines are designed and built in compliance with EU (European Union) rules and safety standards.

A noteworthy example is the new design of the screen printing machines (patent pending), which has eliminated the printing head lifting

movement. (This movement would allow the operator to enter under the printing head for screen cleaning or servicing, in a space of 400 or 500 mm, and would, therefore, be very dangerous.) In the new AISA machines, the screen moves up and down for glass feeding clearance, but the printing head is fixed. This new concept also guarantees more rigidity and as a result, higher precision.

A new system has been developed in order to allow the screen to be cleaned or inspected. The screen is mounted in a special master frame. Every time the machine needs service on the screen, the operator extracts sidewise the screen fastened to the master frame at the height of about 1,100 mm from floor level. After cleaning, the screen fastened to the master frame can be re-inserted in the same reference position with high repeatability.

This new design has also contributed to reduced equipment cost.

Modular design

Since 1994 all AISA screen printers (suitable for different glass sizes) have been offered in the same basic design (patent pending). The same applies to UV and IR paint dryers and coolers, which are available in different widths, according to the glass size. Two versions have been engineered for the glass transport: with a glass-fibre Teflon coated belt (only for IR dryers), or with Teflon rollers. Temperature feedback for control of the IR emitters can be done in different ways, and an automatic set-up using a PC or a PLC (with display) is also available. The UV dryer can have two, three or four lamps depending on the operating conditions. The IR dryer is available in different combinations of zones which are 1.5 metres or 2 metres long, with medium of short wavelength lamps, depending on customer requirements. The cooler can be constructed with two or three zones (2-metre long), with or without a chiller. As well, a platform can be supplied to install all fans, the chiller and the electrical cabinet on the top of the IR dryer and cooler in order to save space in the production plant.

The vertical buffer, AISA GHS27, which is telescopic and does not need a pit in the floor, has been redesigned and now is capable of accumulating different glass sizes, from windscreens and backlights to small sidelights and vents. Only the number of glass supporting bars varies according to glass size and thickness. The storage capacity of the buffer is suited to the customer's requirements.

Fig. 5 Another view of the line in Fig. 1

Another example of the versatility of AISA equipment is screen printer *GHS37/T/N*, which can print glass sizes ranging from 300 mm x 300 mm (vents) to 2,000 mm x 1,200 mm (windshields or backlights). If asymmetrical sidelights or vents are to be printed, two autocentring glass registration units can be shut off and the third can mount templates. The changeover procedure is very simple and fast. In this model, a screen registration system is also provided on the machine.

Automation

All screen printers are offered at different levels of automation. Some or all printing parameters can be provided with numerical control and automatic set-up. In this way, the changeover time can be very short: the printing parameters for each part number are stored in a software database, allowing setting of parameters to be done in a matter of seconds. In the new machines, the parameters can include:

- the stroke of the squeegee and of the flood coater;
- the speed of the squeegee;
- the speed of the flood coater;
- the starting point of the peel-off during the squeegee stroke;
- the speed of the peel-off.

At the Glastec exhibition, AISA will present a breakthrough system (patent pending) to register the screen on the machine when a changeover is needed. This new system works

together with the AISA glass registration system with automatic set-up (NC adjustment of the autocentring units.) In short, two cameras read the position of the motif on the screen and a PC, where the glass contour data is stored, automatically adjusts the glass registration device in such a way that the glasses of the new part number are registered automatically in relation to the motif on the corresponding screen. Thus, the screen is always in a fixed position and only the registration system is adapted to the new part number to be processed. If the screen loses its proper tension, thus causing the motif on the screen to be shifted, the cameras automatically read the error and the system will automatically correct the glass registration in such a way that the incoming glass is printed consistently.

Labour savings

Over the last year, AISA has studied different loading and unloading systems for bending and tempering furnaces. In particular, two projects have been subject to intensive study. The first is the automatic loading of windshields into bending furnaces. Typically the bending furnace presents the operator with a template (a skeleton) for windshield loading. The automatic system will be able to automatically identify the position of the skeleton and load the paired windshield onto the skeleton with a robot. The system will also have automatic identification of the skeleton model and/or automatic checking of windshield dimensions, for furnaces which work with specific sequences of different skeleton models.

The second project regards high speed robotic loading of the tempering furnace: the aim is to load four sidelights (two couples) in two steps with a total time of 14 seconds, with high precision and repeatability. The loading orientation of the two sidelights in a couple will be different, and will have the ability to be remote-controlled at the furnace exit to correct the drift of the tempering system. A solution has been studied to guarantee that no mechanical or electronic set-up is needed by the operator. The loading and registration parameters are stored in a PC according to the glass part to be processed; the line supervisor has only to choose the part number when a changeover is necessary.

Conclusion

From the overview above, AISA has clearly shown a dedication leading into the future of studying and developing new equipment. Nearly 100 patents, issued or pending, reflect the hard work of the company's engineering team, as well as the innovative spirit of Mr. Barozzi, the firm's general manager. Many technical developments made by AISA have become landmarks for the competition.

In fact, AISA's investment in research and development is one of the real reasons for the good results in machine performance, technology and reliability. It is equally clear that this investment has influenced selling prices, when one makes a comparison with those of companies which make no investments in research. The reliability of AISA machines, which are guaranteed for high performance, efficiency and state-of-the-art technology, has caused them to become increasingly popular with the most demanding clients.

The scenario today is no longer a matter of choosing an attractive machine that does its job. Nowadays, numerical controls, sophisticated software and line supervision are the trend and customers tend to choose a partner with real expertise in modern advanced technology, and one that can offer all round technical assistance. AISA fully recognises these facts and advises potential customers to look beyond the product itself, and to consider the soundness of the manufacturing firm. Above all, we suggest to customers that they reflect on the future value of a used machine.

**Assistant to General Manager*
AISA Spa - Italy