TANNING INDUSTRIAL REVOLUTION HIGH FLEXIBILITY ROBOTIC SOLUTION FOR THE AUTOMATIC LOADING OF TANNING PRODUCTION LINES

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ABSTRACT

The tanning process is a very complex and specialized system that requires experienced and high-level manpower in specific skills.

Although craftsmanship is fundamental, there are some phases in which labor is superfluous because the operator simply performs a purely manual function, feeding the process lines with the leather, taking it from the pallets, trolleys or air hangers. Where the skill is essential is at the end of the line where is performed the quality inspection as well as the handling and manipulation of the leather.

We have invented and patented various robotic and automatic systems where the unskilled manpower is superfluous and non-essential, achieving the result of reducing fixed costs and mobilizing the role of operators in tanneries, avoiding difficult and unsatisfactory work.

From an idea that seemed impossible and visionary, a new BRS (Barnini - Robot System Automation) brand was born, created for the most skeptical, created for those who say that it is impossible, created for those who cannot see the future and are satisfied with knowledge of the present.

Three different solutions have been created, all patented and operating in two relevant tanneries in Tuscany and in our internal research & development laboratory.

Here, today, we are the architects of the tanning industrial revolution.

The year 2022 represents the turning point of the beliefs and traditions of the sector.

1. State of the art, process and specs

Currently the tanning industry is full of systems and automatic machines to perform various processes. Barnini, which has always been a leader and specialized in automatic process lines for single or multi-stage spray finishing ofleather with associated thermal treatments.

Typically, the lines are developed on wire belts (different materials for different processes).

The width of the inlet belt can be of variable size according to the type ofleather and/ or the process methods used. The same goes for the speed of advancement of the product on the belts.

The part is moved on the conveyor and sprayed by a rotary, alternating or parallel system.

The lines can be made on sets of widths suitable for the products to be treated, starting from useful widths of 1500 mm up to 3800 mm, and calibrated for product feed speeds which can vary from 5 to 25 meters/ min. Currently there are and are marketed systems for collecting the hides coming out of the machines, based on conveyor belts.

On the outfeed belt, using centrifugal rotary systems that allow the passage from the wire belt to the belt, the leathers are transported and with simple kinematics "stacked" and palletized. The same technology is also used to feed airways lines on hangers.

Currently, no anthropomorphic robot or "full automation" technology, therefore based on the concept of "NOT SURVEILLED", is **instead applied to the loading of the product at the beginning of the phase.**

The main issues are:

- Variability of shapes and sizes of the product to be handled (eg half calves, calves, sheep and goats)
- Variability of thickness and type ofleather (eg. From 0.5 to 2mm, including breathable product)
- Variability of the support materials to be taken from (eg pallets, by air, "horses", drying racks).
- Process speed. A speed of 15 mt / ruin presupposes a feeding with a cycle time that varies between 6 and 10 seconds depending on the size of the product.
- Loading methods. In many cases the products to be handled do not arrive in a precise order, but for process reasons they can be stored with the finished faces in contact or in opposition (flesh/ flesh - finished/ finished). This assumes that the loading system also has the ability to overturn the pieces (meat-> finished and vice versa)

Focusing on the intention to automate for the Automotive tannery project, we have summarized the specifications and input data as follows:

1. Belt to be interlocked with maximum useful width of3800 mm
2. The leather must be picked up from trolley
3. The part to be loaded will be for the maximum size of 3200x3000mm, up to 28 kg weight

Focusing on the intention to automate the air chain for the shoe upper and leather goods tannery project, we have summarized the specifications and input data as follows:

1. The leather can be picked up by air transport conveyors with variable geometry and size according to the layout of the leather goods
2. The part to be loaded will be for the maximum size of 2500x2000mm, up to 18 kg weight or an half cow

For both solutions:

3. Maximum production speed requested 15 mt/min
4. Total integration with spray line including the status and logic operation synchronization

In all the tanneries there are people dedicated to load and manipulate leather into the spraying lines. The number of operators depends from the product.

For small part, goat or half cow could be enough just one, from bigger or faster line, 2 are the minimum. All of this works in a very non-ergonomic condition, picking from the ground in case of pallet stack with a continuous 180° rotation for the bust and up and down grab.

Similar for the air conveyor, where the operator must drop down from the hangers.

The impossibility to stop the line for the process needs a continuous job, making it very stressful. In many countries this operator must be rotated during the shift.

In big production operation 3 shifts are used.

The impact of **unqualified** manpower to make the job is 3 to 6 per day.

2. Technology implemented

Real tests on pallets unloading have shown the need to "help" the deposition on the main process belt with devices that help to remove wrinkles and "stretch" the leather to make it flat.

This can be performed using a movement in opposite directions (eg robot in a positive direction, belt in a negative direction).

Based on these experimental tests, the project idea is conceived as follows (Fig. 1, 2):

1. Introduction of an *anthropomorphic industrial robot with various degrees of freedom* installed on a rigid and stable basement

2. Manipulation "tool" ("robot end effector")

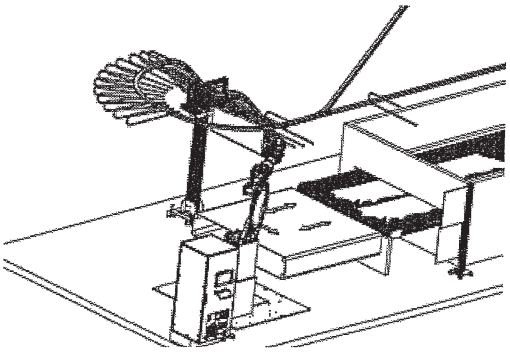


Figure 1 - Air Conveyor

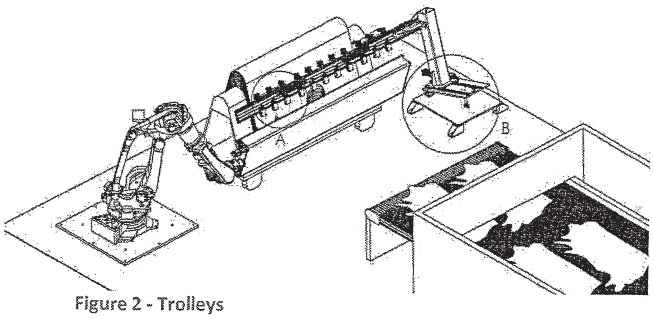


Figure 2 - Trolleys

Two possible solutions have been identified, both of which involves the manipulation of the leather using a special mechanical system based on friction.

The options can also integrated and assembled together in an **hvbrid svstem.**

a) High friction conveyor belt.

It was hypothesized to develop a motorized belt from the robot wrist axis direction. This allows you to manipulate the leather from the unfinished side (flesh) and use the high friction belt in combination with the movement of the anthropomorphic robot to unload it on the final working belt or on a pre-belt (functional to the removal of folds and wrinkles).

The conveyor installed directly on the robot wrist is controlled by a brushless motor, to have enough flexibility in the speed, orientation and interpolation with the robot movement.

It can be installed on 2 different version, small and big accordingly to the kind of product. The small version has a length of 2 mt (Fig.3), the big of 3,4 mt (Fig. 4) (half or full cow).

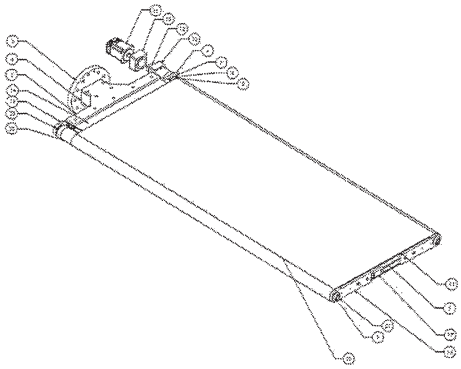


Figure 3 - H.F. Conveyor Belt (Small)

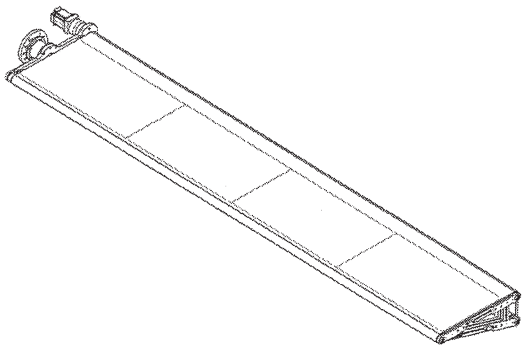


Figure 4 - H.F. Conveyor Belt (Big)

b) Head with multi grippers. Conceptually like the previous one, but it uses mechanical pincers to be able to manipulate and translate the part.

c) **Separation device.**

To facilitate manipulation from the robot, in both cases (removal from a stand or from a hanger) a separating and widening device is provided that allows the end effector of the robot to have sufficient space to enter and extract the leather. This designed device can be a simple rod in a linear pneumatic actuator (Fig. 5), or a system equipped with suction cups.

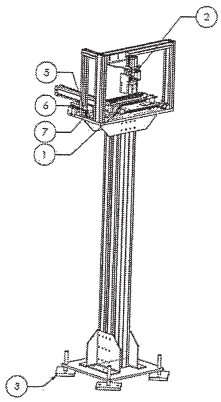
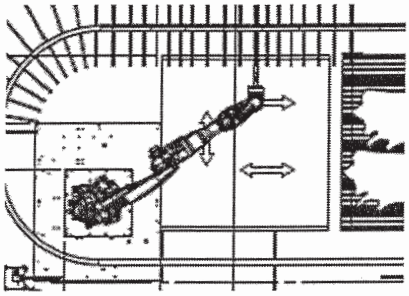


Figure 5 - Linear Rod

d) Omnidirectional belt.

The experimental tests highlighted the need to ensure the correct stretching of the leather (absence of folds and wrinkles) that a progressive and "soft" movement profiting of the friction of the support itself (e.g. belt that moves in the opposite direction to the direction of relaxation) helps in the quality of final placing.

We hypothesized to use a customized belt that can be made to manage movements in opposite directions in the same conveyor belt (Fig. 6).


Figure 6 - Onmi directional Belt

This type of construction make a various advantages:

1. The belt, being able to advance in two opposite directions, can help the stretching movement of the leather, and then in the opposite direction load the process line

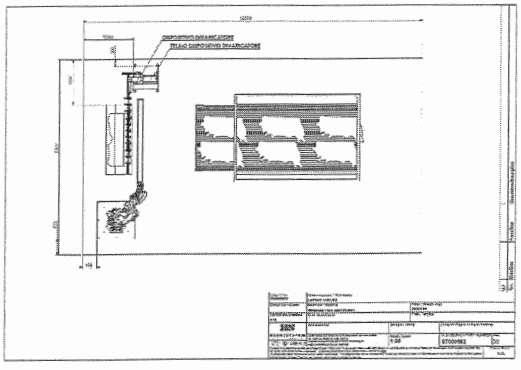
2. Using the two opposite directions at the same time, rotate the leather.

3. Simplify the handling movement, moving the leathers on parallel rows, making the robot unloading point unique and reducing the cycle time

4. Simplify and reduce the layout footprint

3. Layout

Layout for an integration on spraying line, 3,4 mt wide sprayer, unloading from trolleys.


Figure 7 - Layout Trolley Unloading

Layout for unloading air conveyor

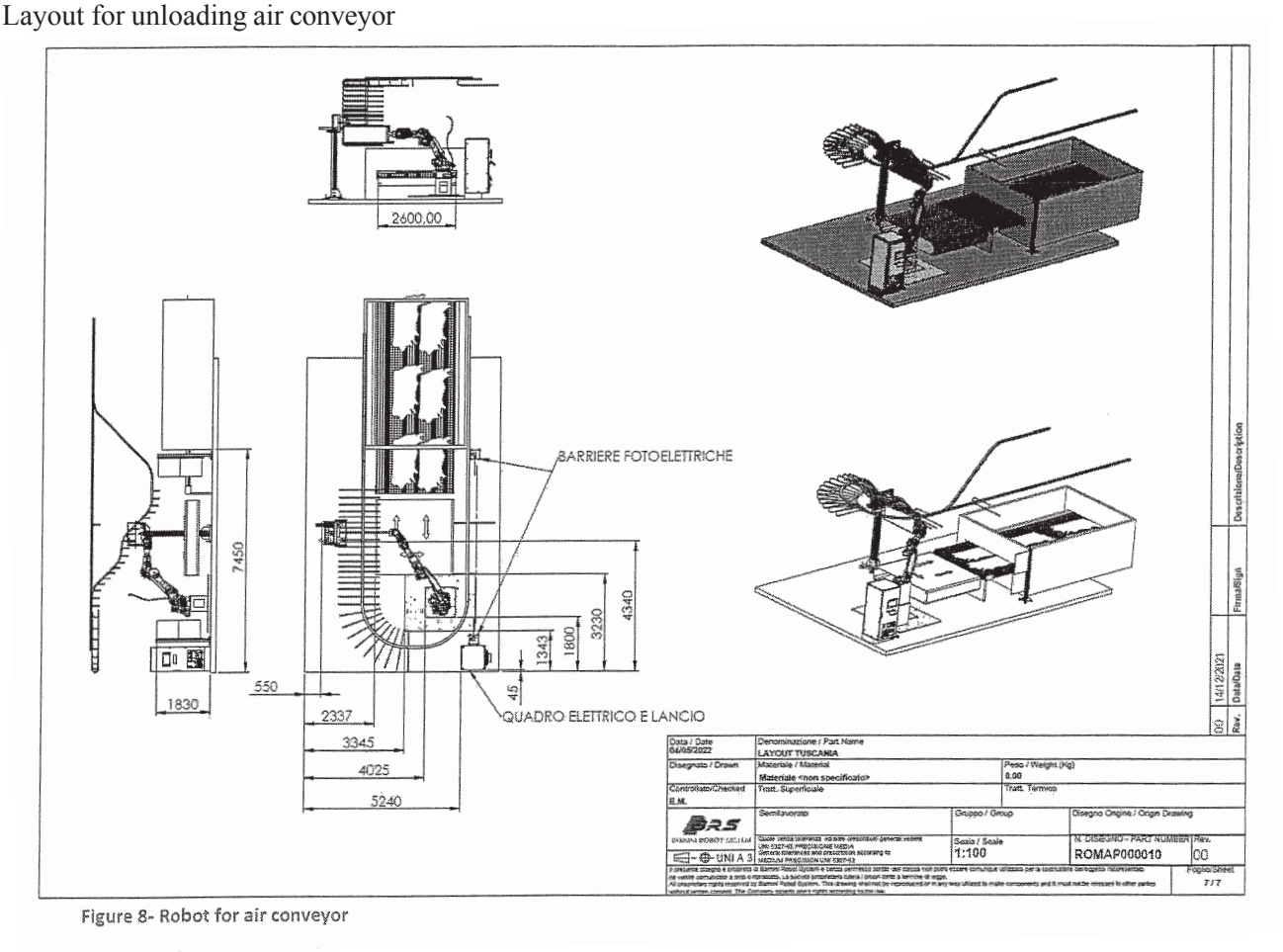


Figure 8- Robot for air conveyor

4. Conclusion

At the end the robotization of the loading process into finishing line is useful to reduce cost, improve the consistency in production saving human mistake and allow to the company to evolves the quality of manpower not having to invest in unqualified peoples.

The robot can work 24h for 365 days in any environment condition guaranteeing a continuous feed of the lines, maximizing the production, saving all the manpower dedicated to manipulation.

It **can works moving from pallet, trolleys or hangers.**

It can load the lines in multiples orientation according to the production using the 6 axis robot capabilities and the ball conveyor.

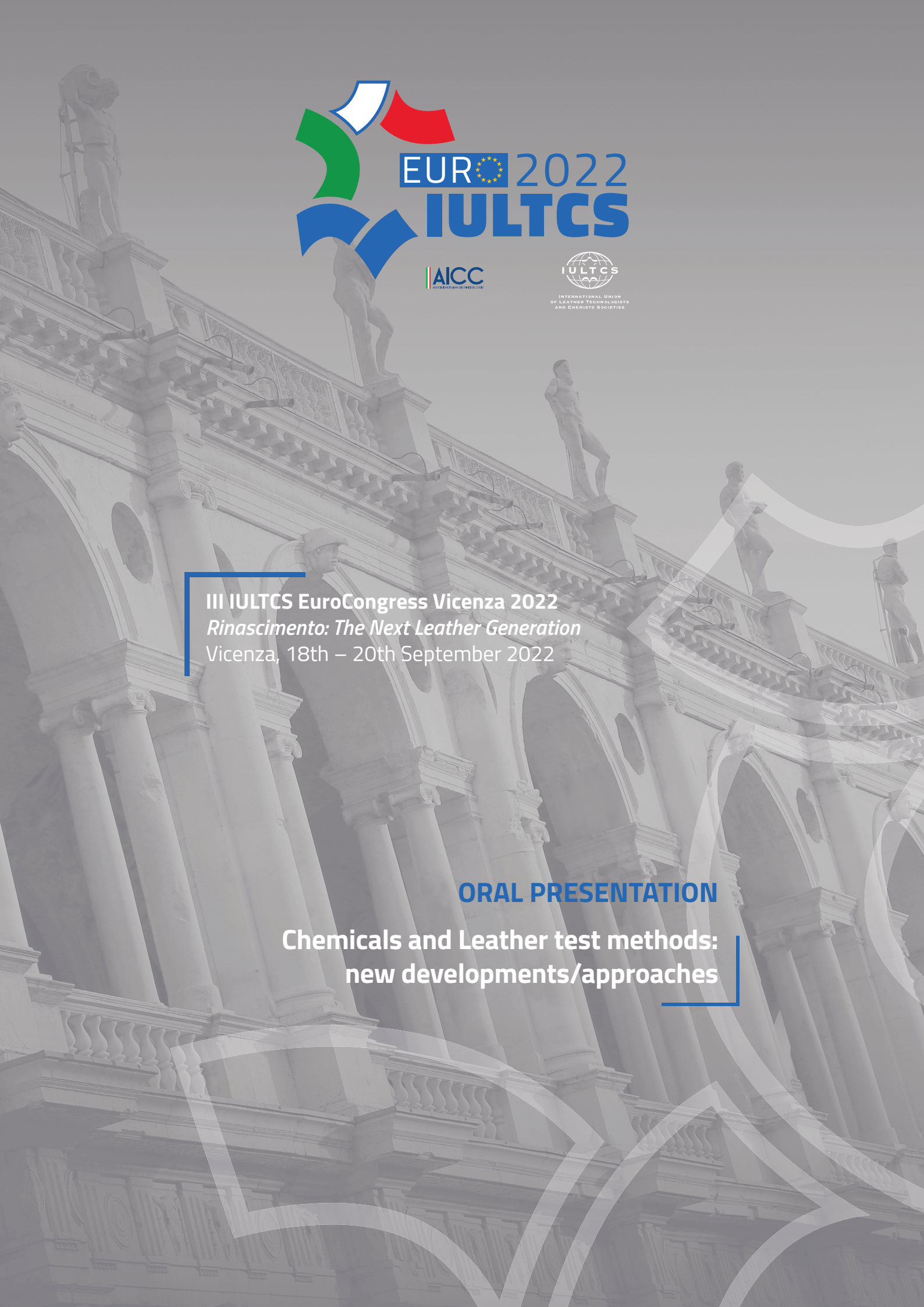
The system can be integrated in all the existent lines, and the space for an operator in case of robot malfunction or special order (for example samples) is still existent.

Additionally, the IT could be interconnected with the automatic solution to control and manage the production from the officed and have a real time visualization of the state of the production line.

References

PATENT 102021000022235 - PATENT 102022000004319

Note



III IULTCS EuroCongress Vicenza 2022
Rinascimento: The Next Leather Generation
Vicenza, 18th – 20th September 2022

ORAL PRESENTATION

Chemicals and Leather test methods: new developments/approaches