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Automation Solutions

Manufacturing case study:
Online inspection delivers picture perfect products every time

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An online vision system is at the heart of a new fully-automated production line for the volume manufacture of optical tiles that can be joined together to create video walls and advertising displays without visible joins or image variations. The new machine builds eight high performance tiles at once, each with 31,000 individually moulded light channels or pixels. It is 10 times faster than the previously developed semi-automated machines and requires just one part-time operator.

The vision system - comprising two line scan cameras, two high speed matrix LEDs, simple mirrors and an image processor - has proved essential in helping control the tile assembly process, while at the same time significantly improving yield and cutting costs.

Each tile is built up from 152 rows of angled, moulded light channels that need to be precisely positioned with the glue accommodating tolerance variations in the mouldings. The tiles work by projecting and magnifying an image input from the back to their front surface; with the quality of displayed image relying on the precise registration of the tile's light guides with pixels in the source image. As expected, registration accuracy and ultimately tile performance depends on three factors: the location, uniformity and thickness of glue dispensed; the precision of the thermoforming process to shape the fibre optic channels without damage; and the repeatability of placement of the parts relative to each other.

The complex, multi-stage assembly process starts with rows of 204 fibres each needing to be locally heated to around 170° C before being accurately shaped to stay within 0.5 mm of the true position after cooling. Each row has a different offset and is bent on demand. A precisely positioned thin bead of specially developed UV-curable glue, just 80 microns thick, is applied to the top surface before adding in the next row. And while precision glue dispensing is technically challenging enough, in this case the material's properties were also highly temperature dependant which added another layer of complexity for the system control and visual inspection.

The glue can only be partially cured by a UV light system: too much damages the fibres, whereas too little causes insufficient curing to retain the parts in position. Two further processing steps – a sawing operation to remove excess fibre material from the new row plus laser cutting and positioning of interlayer tapes – can both cause potential damaged to the newly added light guides.

The previously semi-automated, proof of principle (POP) machines were developed in parallel with the customer's development of the product and highlighted a problem with variation in the quality of the moulded optical fibres. In a very small number of cases this variance caused the light guides to suffer minor internal cracking during or post thermoforming. These superficial cracks resulted in attenuation of the input signal; in effect causing dimmed or even missing pixels. Similarly glue variations and interlayer strip contact to the glue could also cause image variations across a finished tile.

Please note this article was first published in "Engineering" magazine, Nov 2009

One of the key challenges for Innomech in automating any existing process is to identify and control risk factors and potential failure modes early enough to ensure projects run to time and budget. Risk analysis is on-going during machine development but in this case there were two major factors to resolve to improve production speed and yield. The POP process relied on the operator identifying problems: some too subtle to be seen in an unfinished tile but still rendering a complete finished tile as scrap. If the defects could be identified during assembly, the tile could be removed for re-work or the process adjusted. And although it was possible to significantly improve the thermoforming process to virtually remove the risk of internal cracking, there was still the theoretical possibility of a dark or misaligned pixel becoming incorporated into the final tile. One faulty pixel amongst 31,000 would mean the finished tile was scrap. An in-depth analysis highlighted the critical role online inspection could play in guaranteeing final product quality and increasing yield.

The vision system in the inspection station scans and validates the integrity of all pixels in the newly added row before the part-assembled tile moves on to have the next row added. The LEDs, cameras and mirrors are arranged in a horse-shoe shape and check the row from both directions: one measuring light transmission from back to front and the other from front to back, whilst a servo moves the cameras along the product.

Simultaneously the system checks individual pixel orientation in the new row relative to its neighbours on either side and below – in other words, measuring the pixel to pixel distance plus the glue gap - and to highlight over-height, wrongly positioned or missing elements. It 'looks' for dark pixels or damaged fibres by measuring light transmission. All tests are carried out in just under 20 seconds which is the dwell time set by other processes, and if any tile fails it can be automatically sent for rework by removing the faulty row.

Tiles are tracked using RFID tags on each pallet linked to the control system and eight part-built tiles, which may be at very different row numbers, are moving around the production line at any one time. The high-speed process is under complete computer control with multiple diagnostic and self-correction routines to minimise the need for operator intervention. The new production line includes four ASi networks to control its 26 drives, two inverters, a robot and three programmable logic controllers managing multiple inputs and outputs but it needs just one operator to oversee production.

Innomech's software team has also created an integrated suite of software tools accessible via a touch-screen control panel to allow users to make easy, fast adjustments as required.

The client is delighted with the speed improvements and by completely automating a part-manual operation can now secure the full commercial benefits of improved productivity, consistency and cost effectiveness; aided in no small part by the vision system which allows the manufacturing line to generate pixel perfect products every time.

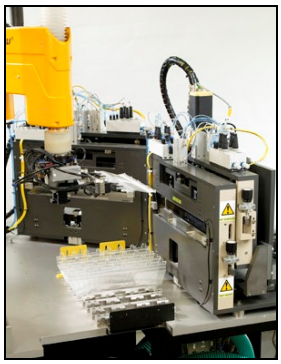

Fig 1 - Tile assembly starts with rows of optical light guides being thermoformed in the 'bending station'.

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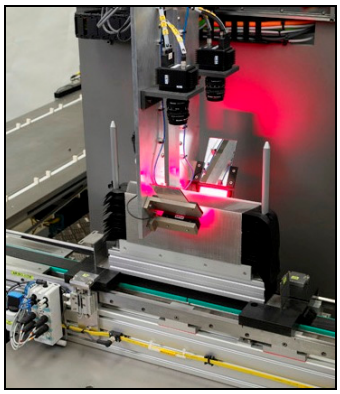

Fig 2 - The cameras, LED matrices and mirrors in the inspection station scan the newly added row of light guides from the back to front face of the tile and *vice versa* to check for damaged, wrongly positioned or missing pixels.

About GB Innomech

GB Innomech (Innomech) specialises in automating highly complex and labour-intensive manufacturing processes to maximise outputs, improve product quality and boost business performance. The company works with major international manufacturers in sectors such as pharmaceuticals, medical devices and environmental, as well as earlier-stage businesses looking to bring breakthrough technologies or products to market.

All projects from initial feasibility studies through to building production-scale machines are conducted to high specification pharmaceutical industry standards and designed to comply with GAMP5, FDA and other international standards. The company was founded in 1990, is based at The Innovation Centre, north of Cambridge and was awarded The Queen's Award for Enterprise 2009 to recognise its sustained growth in international markets.

For more information please visit www.innomech.co.uk

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