Freeing up technicians to build an aircraft

A TE Connectivity Technical Article

Using high-performance customized labels to identify components in airframe manufacture instead of engraved metal plates can save time and complexity.

by: Philippe Contri, global product manager for TE's label products, Grenoble

While it's essential to apply long-lasting and legible identification markers to aircraft components and electrical terminations, it can be time-consuming. The trend towards more electric aircraft means that the number of electric devices and connections is growing and identification is taking more time. In response, airframe manufacturers are adopting new materials and techniques to optimize production.

In this white paper, Philippe Contri, Global Product Manager for identification labels, explains how airframers can adopt high-performance and highly customized labels such as TE's HPR100 labels in pre-designed and printed shipsets to simplify their production flow.

Identification in aerospace

Identification markers are essential in the aerospace industry. Every aircraft carries many thousands of markers, each of which carries part numbers, batch numbers and rating data for individual components, terminals, wires and cables, switches and indicators.

Such markers are used during every inspection, maintenance operation, repair, refit and refurbishment over the life of the aircraft. Fast turnaround times are only possible when identification markers are in place to give maintenance operators and technicians the confidence that they have tested and inspected the right circuits or replaced the correct spares.

The price of poor labelling is grounded craft, disappointed passengers and delayed operations.

To avoid this, identification markers must stay in place and legible for as long as they are needed. For many components or terminal points, this will be the lifetime of the aircraft.

Shift towards more electric aircraft

As the aerospace industry shifts towards more electric aircraft, manufacturers are installing more electric motors, actuators, control systems, sensors, diagnostics and electronic systems. These are driving adoption of additional cabling, as well as electrical and data terminations.

In turn, the need for identification is growing rapidly – both in terms of volume of markers and their importance to effective operation and maintenance during the lifetime of aircraft.

In the light of this, it is essential that manufacturers find new and more efficient ways to manage identification – and TE's HPR100 labels can support this.

The traditional approach: engraved metal plates

Traditionally, airframers have used engraved metal plates as identification markers. They are tough, durable and have a proven ability to withstand extreme heat, cold and the aggressive fluids such as Skydrol, jet fuel, water and cleaning fluids that may be encountered in aviation.

However, engraved metal plates have a significant drawback as they add time and complexity to the production process.

After engraving the plates, technicians must then apply them with adhesives and wait up to 24 hours for drying before returning to apply a layer of varnish and more drying time.

The application and drying makes this process time-consuming, therefore TE saw the potential for a more straightforward alternative.

Speeding up production time

TE developed the HPR100 label to enable aircraft manufacturers to replace traditional engraved plates with high-performance pressure-sensitive labels that can withstand the rigors of aerospace.

The logic is that labels are significantly faster to produce and to apply than metal plates. Printing takes half as long as engraving, saving technicians' time.

However, labels also save time during production by eliminating the application and drying times required for the gluing and varnishing of engraved plates. A self-adhesive label will just stick in place, so when a typical aircraft wing might have 2,000 components to identify, the time saving adds up quickly.

Labels are a "fit and forget" option – by eliminating the process steps, they not only save time and effort but can also speed up production flow.

Formats and practicalities

Standard formats

In their basic form, HPR100 labels are white labels that are purchased in rolls that are up to 200 mm wide and 150 m in length. They can be supplied as a continuous product or die-cut into standards sizes.

When a technician needs to identify components, he or she can print identification codes straight onto labels from a computer aided design (CAD) package before taking them to the production line and applying them.

Identification marks can include alphanumeric codes from any language or alphabet, bar codes and images.

The value of customization

Airframe manufacturers are always looking for new ways to optimize their own production, as well as to help their customers to deliver maintenance and operational activities more effectively.

Customizing identification labels is one tactic to help achieve this.

At the simple end of the scale, purchasers can order bespoke sizes and colors, or labels that are die-cut into specific shapes.

Alternatively, they can opt for labels that are pre-printed with a combination of images, bar codes, QR codes and alphanumeric identification codes in multiple alphabets.

As customization becomes more sophisticated, TE can work with manufacturers to learn how labels are applied and apply this knowledge to develop more ergonomically efficient labelling solutions.

One potential example is creating right and left-handed sets of labels to help technicians when they are applying labels in awkward spaces.

Ultimately, customization can help to control costs by simplifying installation on the production line.

The philosophy is that customized labels can help technicians to focus on quality, delivery and safety, rather than the detail of printing and applying identification codes to components.

While sheets of highly customized pre-printed and pre-cut labels cost significantly more than unformatted product, they unlock value on the production line.

Case study: Customized labels for Airbus fleet

Wing Manufacturing

TE worked with Airbus to develop highly customized sets of HPR100 label sheets for the A319 to A380 range of passenger aircraft and the A400M military transport.

Airbus wanted to take a visual and intuitive approach for labelling of complex subsystems and assemblies in its aircraft wings, with the goal of helping its technicians to position identification labels quickly and accurately.

Engineers and manufacturing specialists from TE and Airbus worked together over a six-month period to develop highly customized label sheets. Each individual sheet design contains a complete shipset of labels for a specific subsystem.

Before the new labels were introduced, technicians would produce batches of printed labels by downloading component identification codes from the CAD system and printing them onto plain, low-cost and unformatted labels.

Airbus turned the approach on its head after recognizing that pre-printed sheets would save time and help technicians focus on other aspects of production.

It worked with TE over a period of six months, to develop highly customized sets of HPR100 sheets, each of which contains a complete shipset of labels for a specific subsystem or assembly.

TE's material and production specialists visited the Airbus production facility to gain a full understanding of how its technicians apply identification markers. The teams then co-operated to develop drawings and prototypes for testing and refinement.

Visual and intuitive

Label sheets for complex subsystems use a visual approach. In these cases, the label sheets are dominated by an isometric sketch of the subsystem. The identification labels themselves feature only short alphanumeric codes and are positioned in the white spaces around the image. Clear lines connect the label with the isometric view to show the technician the exact position of each label.

This arrangement avoids the need to check drawings. The label sheet contains all the information the technician will need to apply the labels.

Being pre-printed and pre-cut, the labels peel off easily and the technician can see at a glance whether they've used all the labels and completed the set.

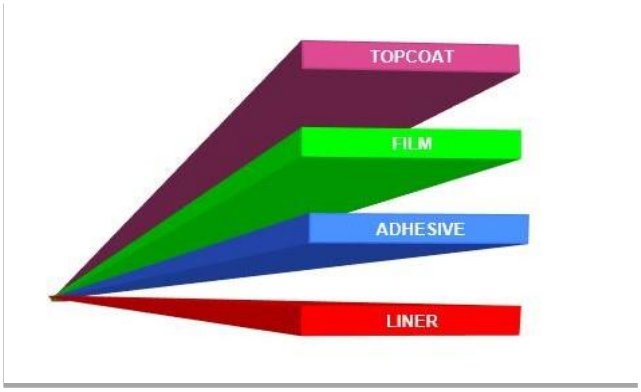
Other types of sheets have also been developed for subsystems where labelling is more straightforward. These lay out labels in logical rows and columns in the correct arrangement for technicians to pick and place labels.

Since developing the labels, Airbus has now integrated them into its manufacturing processes and inventory systems, so that technicians can equip themselves with a full set of all the required labels, along with all the other materials and tooling at the start of the job.

Developing labels for aerospace

Labels are made up of three layers, with a top coat being printable and providing protection, a central film for stability and structure and a bottom adhesive layer.

These are supplied on paper or polymer liner sheets and are often die-cut into pre-determined sizes on sheets or rolls, although some labels are available in a continuous format.



Labels are made up of three layers mounted on a liner

When developing new types of label, TE's material scientists select from a range of possible materials for each of the layers, depending on the application and the performance required.

In the case of identifying components and subsystems in the wings of aircraft, it's important that labels must be able to resist a wide range of temperatures and chemicals, as well as be able to stick efficiently to surfaces.

Temperature

In terms of temperature, a label in an unheated space in the wing may be exposed to widely cycling temperatures from ambient conditions on the ground to extreme cold at high altitudes or northern climates. In contrast, a label identifying a termination point on the engine will need to withstand extreme heat.

If the adhesive, film or top coat can't withstand cold, the label may become brittle and fall apart. However, in extreme heat the adhesive may become tacky or the material may melt or stretch, allowing the label to slip out of place.

As a result, the pressure-sensitive adhesive used to mount HPR100 labels has been selected for its retention in temperatures from -40 to 135 degrees Celsius and even withstand heat of up to 150 degrees Celsius over a period of several hours.

Chemical resistance

The other important variable for the adhesive used in HPR100 is the ability to withstand the different solvents and fluids that are found in aerospace.

Resistance to fluids is also an important factor for the top layer of the label.

As a result, HPR100 labels have been tested extensively with water, Skydrol, different grades of aviation fuel, oil, glass cleaner and isopropyl alcohol, which is a common industrial solvent.

Both the adhesive layer and the top coat are tested by immersion in the fluids for one hour or three days.

The staying power of the mark on the top coat is tested by a combination of immersion in fluids, as well as rubbing or brushing.

Surface energy

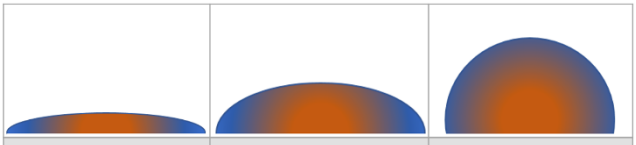
An important consideration for the adhesive layer is the surface energy of the components and materials that will be labelled. Surface energy describes how readily a material will accept adhesives. It is often measured in the unit of dyne per centimeter (dyne/cm), with a dyne being a unit of force equivalent to 10 micronewtons.

Surface energy can be visualised with the behavior of water on a material's surface. On a material with high surface energy, drops of water spread into a wide and thin layer. However, on low surface energy surfaces, water droplets will keep their shape.

Adhesives behave in a similar way to water, by adhering easily to materials with high surface energy. Special adhesives must be used to ensure long-term adhesion to low surface energy materials and textured surfaces.

Airframes typically contain components with a wide variety of surface finishes and surface energies, such as aluminum, steel, PVC and other polymers, carbon fiber and an assortment of coatings and paints.

This represents a challenge in aerospace, where airframe components and subsystems use a wide variety of materials.



High surface energy		Medium surface energy		Low surface enery	
Copper	1,100	Nylon	46	Polystyrene	36
Aluminium	840	Polyester	43	Polyethylene	31
Steel	526	Polycarbonate	42	Powder coatings	
Glass	250-500	PVC	39	Teflon™	18

A water droplet indicates the surface energy of materials, which is measured in Dyne/cm

Qualification

The aerospace environment remains the same no matter what processes and procedures are used to test the products that are adopted on board aircraft.

However, different airframe companies follow different sets of international standards. In addition, manufacturers qualify materials and products against their own in-house specifications and standards.

TE's HPR100 labels meet the standards used in aerospace, industrial, defense and marine applications.

Manufacturing engineers and technicians can only source components and materials that are supplied by approved suppliers and that have demonstrated their suitability through rigorous testing and qualification.

While many low-cost alternatives exist, the qualification process exists to protect the safety and reputation of aviation and aerospace. Only high-quality components from trusted suppliers can be used on aircraft.

System approach

Once in operation, labels will need to stay intact, in place and readable for decades. Testing and qualification is one way to gain confidence in the lifetime performance of labels – but it's not possible to test every label to destruction against all the variables it may encounter.

Instead, TE takes a system approach to give its customers the confidence that labels will stand the test of time. This system approach is based on end-to-end control and consistency at every stage of manufacture, printing and application.

It starts with sourcing of high quality raw materials in a consistent grade and format.

Batches of polymer are then produced under tightly controlled conditions. Many variables during manufacture can influence the end quality of the polymers that form the different layers – and the ultimate performance of the labels.

For labels that are printed by customers, it is also important to ensure consistent printing. It's important to remember when print permanence of a label is tested, it has only been qualified when printed with the recommended printer, print ribbon, print settings and software.

Therefore, it is only possible to achieve consistent performance by adopting a system approach.

About the author

Philippe Contri is global product manager for TE's label products. Based in Grenoble, he oversees the development of labels for customers who want to identify products and components in the electrical, electronic, aerospace and defense, marine, rail and industrial sectors. He has long experience in industrial marking systems and labelling materials.

About TE Connectivity

TE Connectivity is a technology leader that designs and manufactures the electronic connectors, components and systems inside the products that are changing the world – making them smarter, safer, greener and more connected. With 78,000 employees, including more than 7,000 engineers, working alongside customers in nearly 150 countries, TE ensures that EVERY CONNECTION COUNTS. Learn more at www.te.com and on LinkedIn, Facebook, WeChat and Twitter.

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