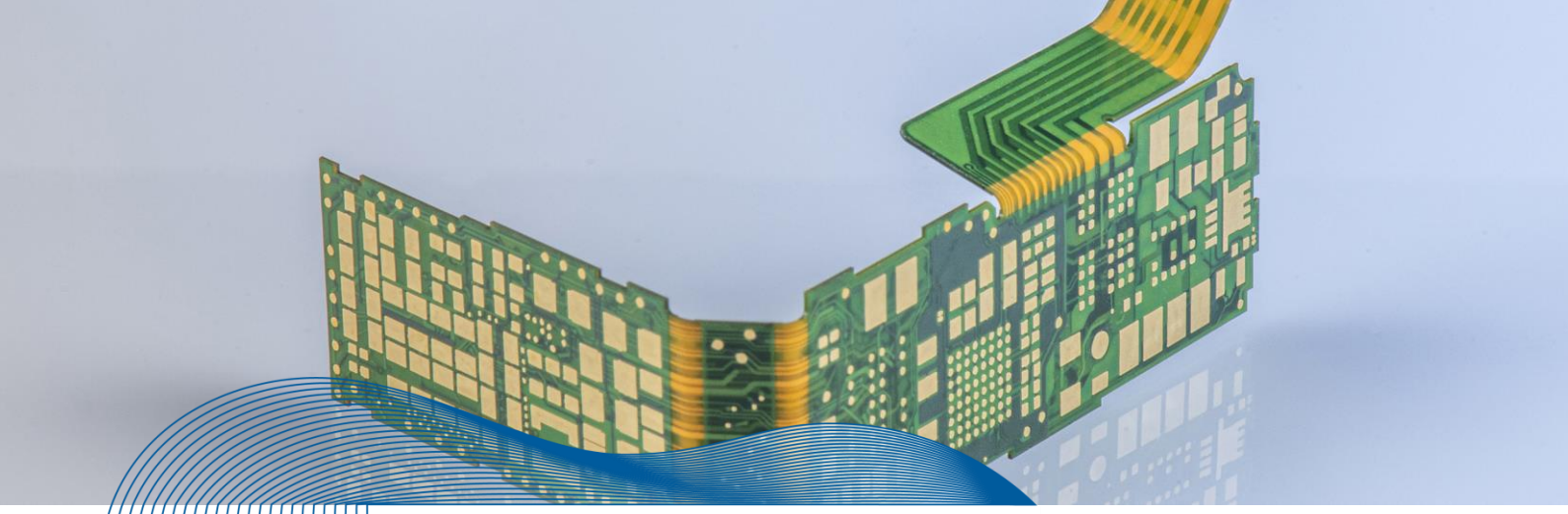

Why Predictability Matters in High End PCB Manufacturing

An advanced approach that delivers predictability, serving as the basis for assuring ongoing reliability.

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SUMMARY

Predictability is essential for PCB manufacturing. Without it, a product's reliability cannot be assured. Conventional approaches to predictability often fall short. Inspection, for example, only reveals superficial flaws. Micro sectioning is destructive in nature and inadequate for complex PCBs with thousands of vias.
DYCONEX has developed a comprehensive inspection and control solution for assuring predictability in the manufacture of high-complexity PCBs. Leveraging its over 50 years' experience in supplying highly complex flexible, rigid-flex, and rigid HDI/microvia circuit boards, LCP and packaging substrate solutions, the DYCONEX solution guarantees better, more reliable PCBs that customers can count on to have the highest quality, every time.

DYCONEX
an MST company

MST
Micro Systems Technologies

Reliability is essential to product success. For some industries, such as medical technology, aerospace and aviation, it's a given. In the medical arena, a device failure may seriously impact the patient, either through improper diagnostics or insufficient therapy. Replacing a failed implanted device is often not an option. In avionics, if a device fails, the lives of many hundreds of people may be endangered. That's why when it comes to printed circuit board (PCB) manufacturing, predictability is so important.

To achieve the highest reliability in the field, processes must be transparent, with all relevant parameters easily accessible. With such data, predictions can be securely made. Unusual behavior related to process parameters or product failures can be quickly assessed and used for product disposition. And, atypical or Maverick products, which are generally the root cause of failure events in the field can be removed from the population.

DYCONEX AG, a Micro Systems Technologies (MST) company, has developed a comprehensive inspection and control solution for assuring predictability in the manufacture of high-complexity PCBs. The solution, the DYCO Integrated Control and Inspection Concept (DYCO IC2), guarantees predictability through measureable reliability, traceability, and reproducibility. In doing so, DYCO IC2 helps to move decision making from a reactive to a proactive approach.

The Case For Predictability

Traditionally, predictability in PCB manufacturing is achieved through inspection. That inspection takes place after the PCBs have been manufactured, with faulty ones simply being thrown out. Even then, only superficial flaws are truly visible. Any process problems relating to vertical interconnects, for example, are invisible. While PCB microsectioning offers a way to find such subsurface defects, the technique is destructive in nature. The biggest drawback, however, is statistics. With up to 5000 microvias per product, inspection of just a few vias per panel in a cross-section is absolutely inadequate. And with relatively low volumes and high product diversity, classical statistical tools fall short. The influence of product-related properties lowers the signal-to-noise ratio dramatically.

One additional problem stems from the late discovery of device failures. When this occurs, other lots may also be affected. Such late-stage failures are often costly and time-consuming to fix.

Charting A Better Path To Predictability

The DYCO IC2 solution succeeds in assuring predictability in the manufacturing of lower volume / high complexity PCBs where the traditional approach falls short. Lower volumes require better and more comprehensive data analysis in order to detect the right signal in the noise. The DYCO IC2 solution is well suited for companies working in industries demanding the highest reliability. When coupled with DYCONEX's manufacturing and testing automation and digitalization, DYCO IC2 allows for comprehensive statistics and contributes to reliability, traceability, reproducibility, and delivery reliability.

At its most basic, DYCO IC2 is centralized storage of all available product, process and machine data. Each machine is programmed individually with an interface that allows all data to be pulled out and loaded into a centralized data warehouse (DWH), as shown in Figure 1.

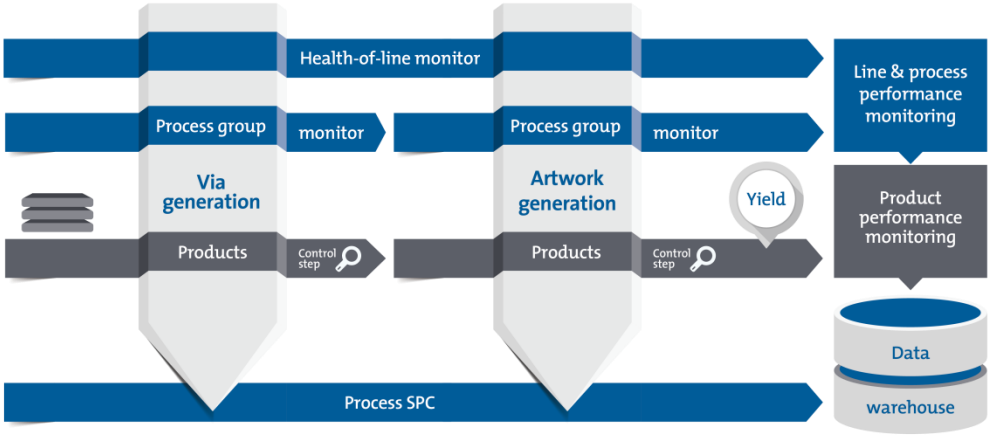

Figure 1. Integrated control and inspection concept (DYCO IC2)

DYCO IC2 goes far beyond just data storage, however. By loading all data into the DWH, and with the right data format, deep analysis can be performed, along with searches for correlations between failures and data collected in the factory that might otherwise be hidden.

Under normal circumstances, such analysis and correlation searches would fail because the data is coming from many different sources and is often not comparable. DYCONEX's data comes from a number of independent sources, including: machines (process data), product specifications (input data), and inspections (output data), all of which equates to billions of data points handled in the DWH, with millions of new data points being loaded and analyzed each week.

DYCONEX overcomes this challenge with data processing in two stages: a pre-staging area, where data is first normalized, followed by staging area where different analyses are performed (Figure 2).

The data analysis capabilities DYCO IC2 enables are critical since it means companies can now move beyond simply finding an issue after manufacturing and responding to it, to predicting issues before they arise and acting to ensure they don't. This is possible because the information DYCO IC2 produces allows abnormalities to be recognized before they can hit products.

Rather than inspection alone, DYCO IC2 controls the critical process input variables: what goes into the processes, into the machines, and what the machines are doing. DYCO IC2 also allows DYCONEX to capture atypical products, such as those with failure codes higher than a product specific limit (Maverick Control Procedure). Having full control of data allows DYCONEX to avoid costly surprises and delays, resulting in better predictability.

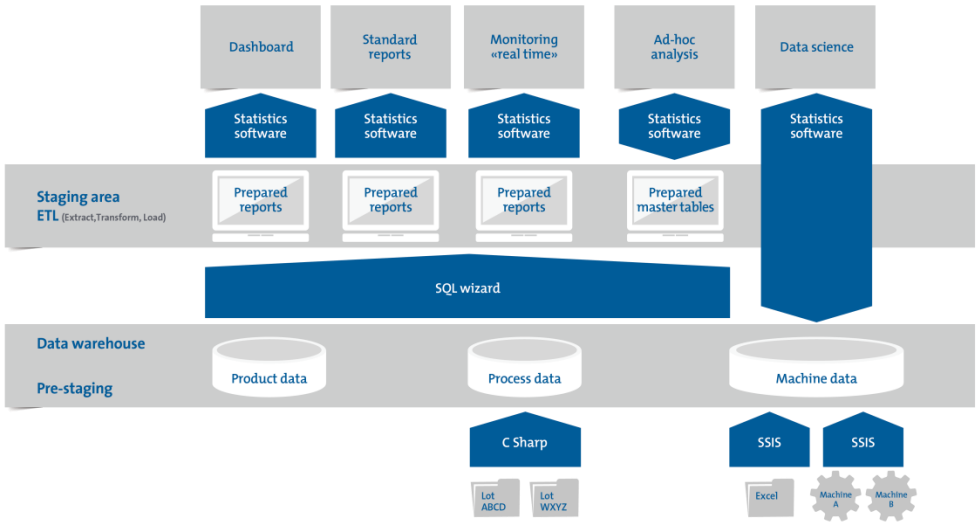

Figure 2. Two-stage DYCO IC2 approach to data processing

DYCO IC2 In Action

To better understand how DYCO IC2 works, let's examine the classical Pareto of failure categories. To address one category, the via fill ratio, further analysis of possible correlations is necessary. Combining product data, it becomes obvious that not all products are affected equally (Figure 3). After combining the failure category with the highest susceptible product, the next parameters can be chosen. In our case, a good correlation was found with the electroplating carrier position (Figure 4). Without filtering the sensitive product in the first place, such correlation would not have been found. Once identified, the reason for the carrier position correlation was quickly found and eliminated.

Figure 3. Combination of data from different sources

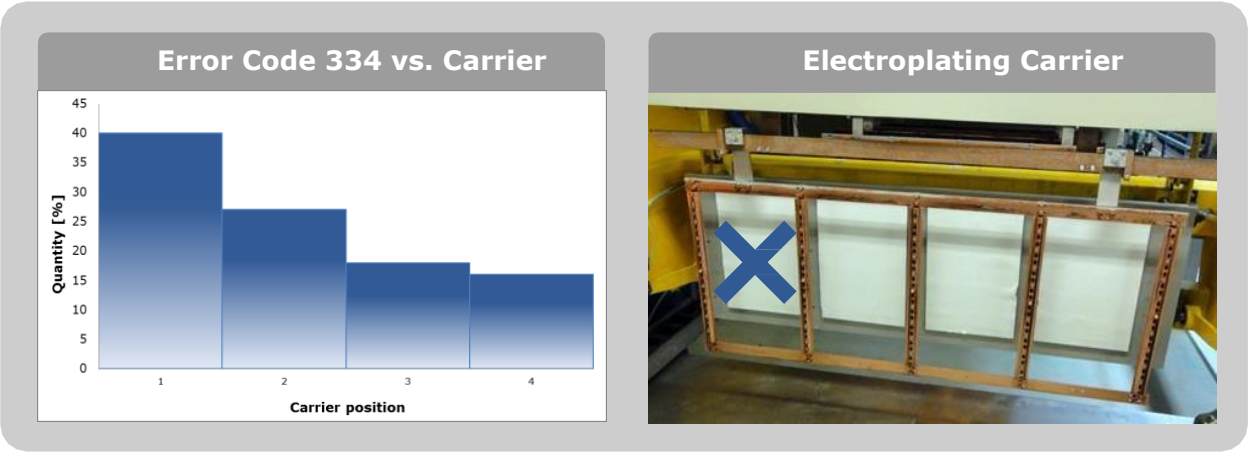

Figure 4. Combining error codes with product related data shows a correlation to the position within the electroplating carrier

Uniquely Suited To Address Predictability In PCB Manufacturing

Predictability is essential to manufacturing PCBs with high product diversity and high complexity. DYCONEX's unique and innovative DYCO IC2 delivers that predictability, serving as the basis for assuring ongoing reliability. With the billions of pieces of data it collects, DYCONEX is able to control the manufacturing processes and continually improve them.

Leveraging over 50 years' experience in the industry, DYCONEX is an international leader in supplying highly complex flexible, rigid-flex, and rigid HDI/microvia circuit boards, LCP and chip packaging substrate solutions. With its emphasis on automated physical and digital factory infrastructure and strong quality control, DYCONEX has a proven track record for manufacturing PCBs used in applications where miniaturization, increased functionality, quality, and the highest level of reliability play a role. While that quality and reliability may come at a premium price, the cost of non-quality in the field would by far, outweigh such costs. DYCO IC2 translates into better, more reliable PCBs that customers can count on to have the highest quality, every time.

About the Authors

Dr. Hans-Peter Klein has studied physics and reached his PhD in metal physics in 1984 at the University of Saarbrücken. Since then he worked in several management positions in the semiconductor industry with Siemens, Infineon and Qimonda in the fields of failure analysis and quality & reliability management. In 2009 he joined DYCONEX AG, a Swiss PCB manufacturer focusing on high complexity, high reliability PCBs predominantly for medical implants. Within DYCONEX he assumes responsibility as the Director of Quality Management.

Uwe Kramer has studied physics with focus on semiconductor and metal physics at the Technical University Dresden, Germany. After working in semiconductor industry for AMD and Infineon for more than 12 years, Uwe joined DYCONEX AG in 2009. At DYCONEX he started as process engineer in the artwork department. Since 2013 Uwe is head of the artwork process module and a senior process engineer. For the DYCO IC2 project he developed the technical specifications and applications for data analysis.

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