Digital twins: double power for AOI

Besides AI, the use of digital twins is no less important when it comes to efficiency. In interaction with the use of AOI systems, this technology can be used in different ways: For example, a virtual offline programming station can be used to create a digital image of the AOI system used, in which all parameters from the real world are included.
Another very interesting area of application for the digital twin is the modeling of the PCB-A, which does not yet physically exist, but is soon to be produced and tested (Fig. 1).

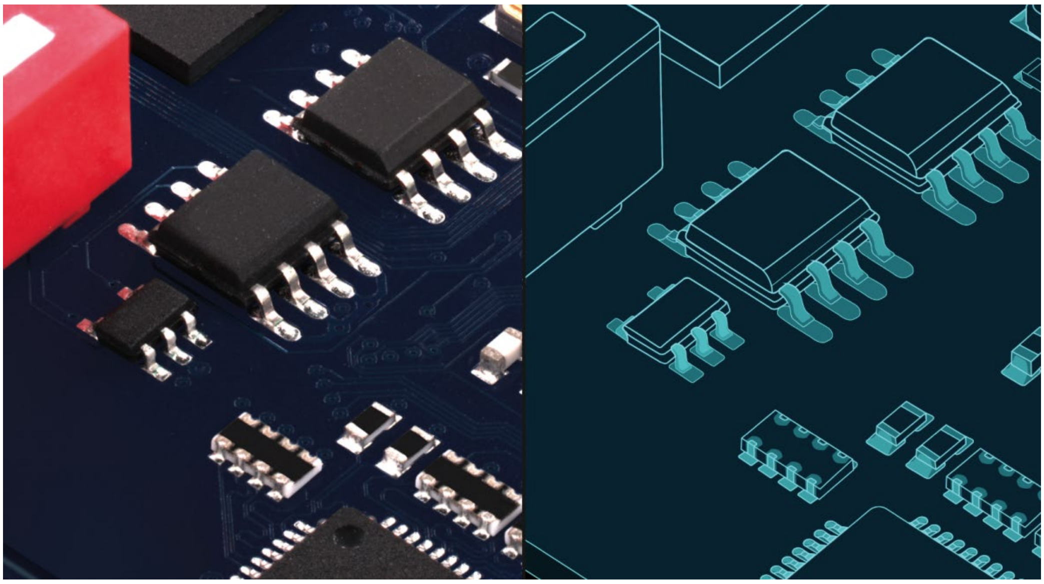

Figure 1: Digital twin of an electronic PCB

With well-prepared CAD data, a great deal of helpful information is already available for creating an AOI test programme; however, there are still a number of gaps for comprehensive parameterisation.

The following article takes up these two use cases for the digital twin and explains their advantages and possibilities in more detail.

Especially in the case of mounted PCBs that are only produced in small quantities, a fast test programme generation and a minimal debug effort are of enormous importance. The information available for this is generally based on production data. Commonly used are the centre coordinates of the components and Gerber data for the layout of the PCB. It is often a bit more difficult when manufacturing service providers want to access ODB++ data, which typically contain additional information for AOI program generation. However, significant specifications for AOI test functions are not available even with this format. This concerns, for example, information on the geometry of the

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pins and their contact area on the pads. Unfortunately, dimensional data on the component height or the expansions of the body are also not available with this database.
Thus, for the parameterisation of AOI test programmes, it is necessary to resort to extensive package libraries. The result is the often very time-consuming generation and maintenance of an AOI library including an article number reference. However, there are two ways around this: The first way is the fully automatic creation of a library and the associated reference table for article numbers based on the data mentioned at the beginning, including an existing PCB-A sample. All parameters required in addition to the imported data are determined directly from the PCB in a first run and an AOI library based on article numbers is generated fully automatically. This possibility is offered by the system software PILOT AOI from GÖPEL electronic with the powerful function MagicClick. The digital image of the PCB-A is thus generated from the real object in the first step and subsequently the AOI test programme incl. library is created fully automatically (Fig. 2).

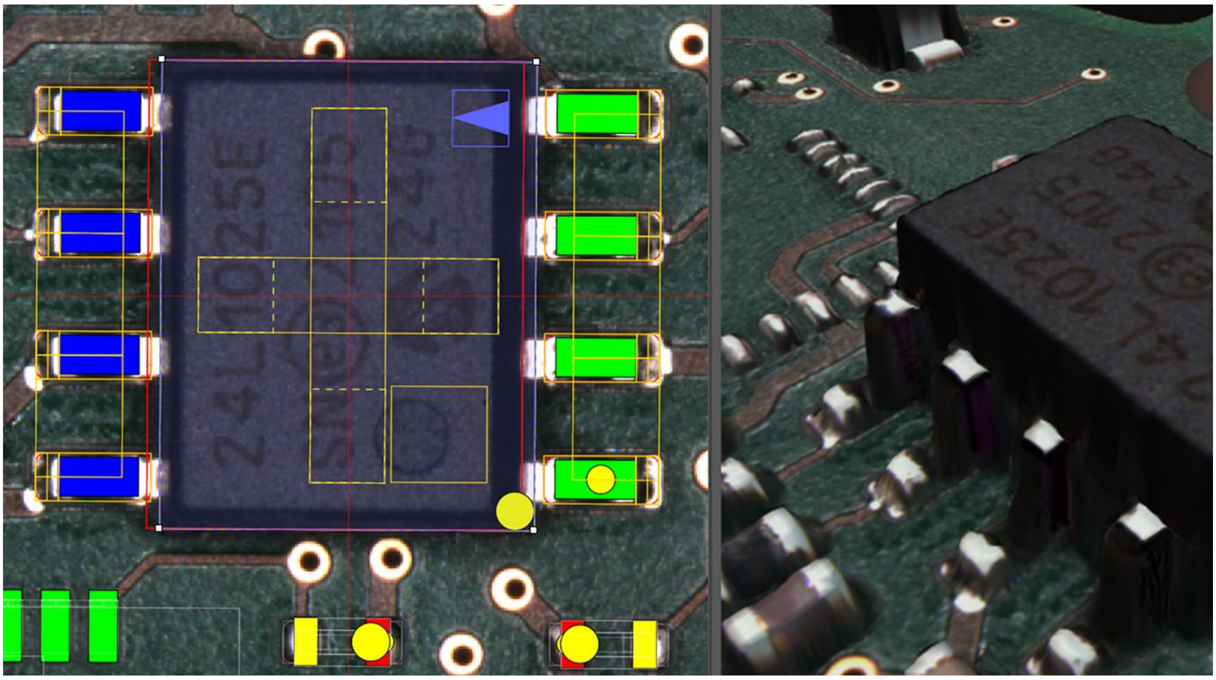

Figure 2: Generation of the digital image

In order to be able to take this step before the first assembly is done, it is absolutely necessary to provide detailed geometry data of the PCB -A. The ODB++ process data format offers one possibility for this. With reference to the article number of the respective component, all AOI-relevant data are generated via the manufacturer's design data (e.g. the pin shape and its contact areas on the pad) and are available for the creation of the test programme. The system software PILOT AOI from GÖPEL electronic offers such a data import and thus enables a much faster and more exact parameter setting for the respective AOI programme.

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However, this still does not take into account the characteristics of the solder joints under consideration of the production parameters as well as the camera configuration and the illumination arrangement in the AOI system. In order to reproduce these, a simulation process in several steps is necessary. The sequence of this process is shown in Figure 3, the result is the digital image of the PCB-A (Figure 4).

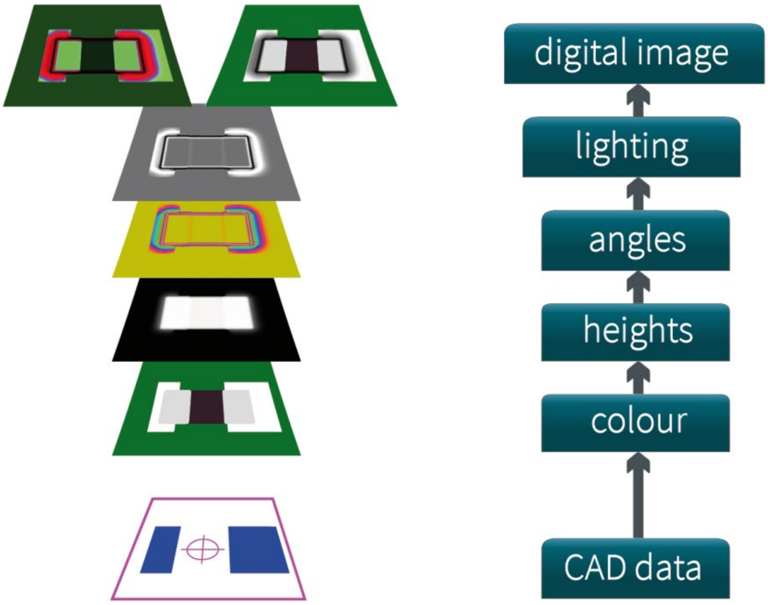

Figure 3: Simulation process for creating the digital image

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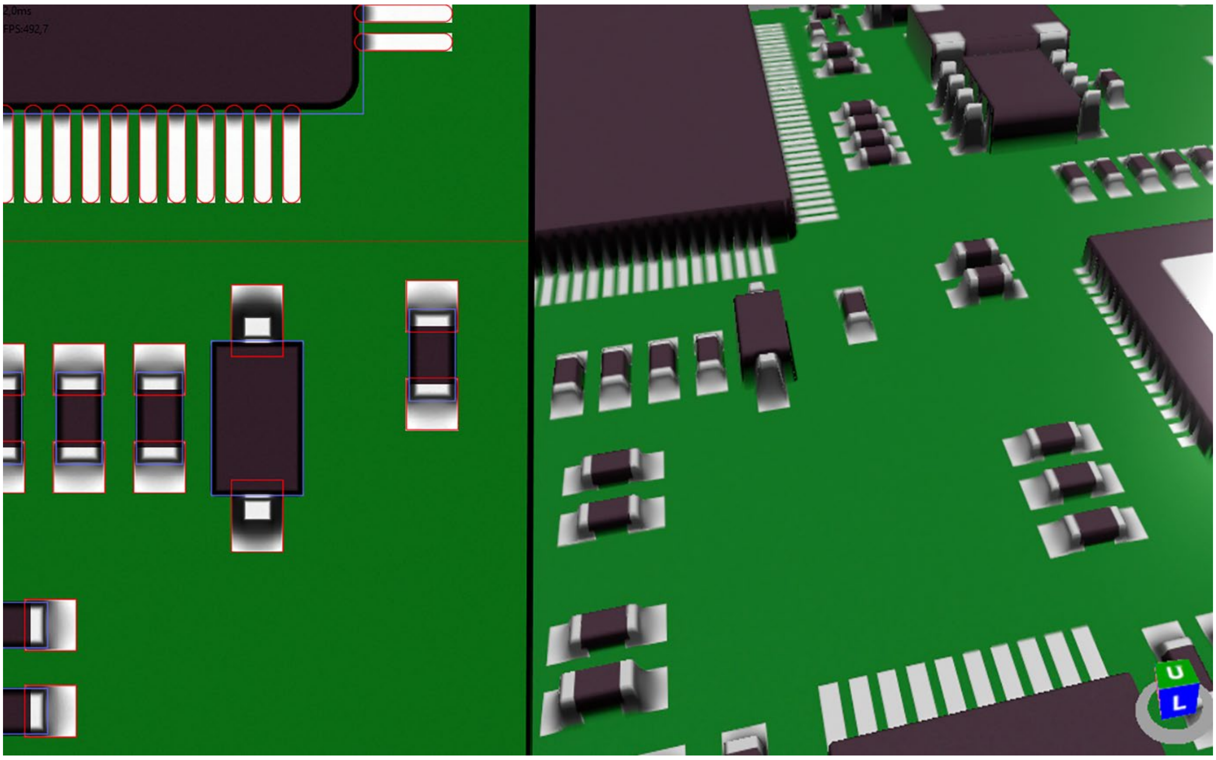

Figure 4: Final view of the digital twin

However, in terms of the manufacturing process, digital twin technology offers another very efficient application possibility: the AOI system itself. Typically
it leads a long life in the production line and is supplied by the manufacturer with updates and upgrades in both hardware and software. Training, support and further development of the software generally accompany the real AOI system throughout its entire life cycle. A digital twin of the complete AOI system is the ideal concept to support these requirements, to implement them in a high-quality manner and, above all, to accelerate them. Therefore, various known and new tools are combined to create a digital image of the system and its behaviour. With this digital twin, as many requirements, processes or behaviours as possible are to be virtualised and simulated, both at the user's and at GÖPEL electronic. Basically, the goal of this virtual representation of the AOI system is to improve the efficiency, performance and reliability of its physical counterpart.

This is realised by a single exchangeable file that contains as much detailed information as possible about an AOI system: Axis parameters, camera configuration, camera module type and its parameters, lighting situations and many other software and hardware parameters. Following the concepts known from information and computer technology such as "virtual machine", "image" and "sandbox", the hardware environment, i.e. the real AOI system itself, is abstracted and reproduced. The resulting

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image can be distributed and reloaded as desired. In conjunction with a virtual PCB-A including simulated solder joints, a flexibly usable virtual data space is created.

The user can thus perform test programme generation cost-effectively without having to rely on an actual system or mounted PCB. This can be done off the production line on a desktop PC or notebook. Potential challenges to board layout or test coverage can be overcome early on. Basic and advanced training or special tests can be carried out at an early stage without affecting the real system in terms of time. All system types from the SPI and AOI portfolio of GOEPEL electronic available at the user site can be loaded with one click within the system software PILOT AOI in order to test the inspection programme under different conditions (Fig. 5).

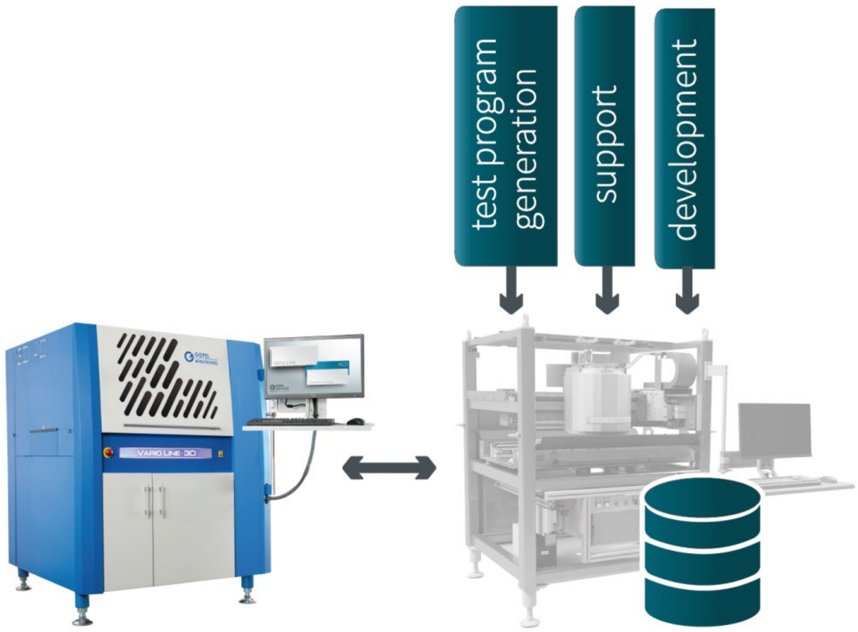

Figure 5: PILOT AOI system software

At GÖPEL electronic's headquarter, the concrete digital twin of the customer's system offers an immense advantage when it comes to service and support. The virtual system including measurement data of an inspected PCB-A can be made available in-house for programming support and troubleshooting in the shortest possible time. This enables a much more precise and faster analysis and test. The user's requirements can be passed on to 2nd-level support and development, including the digital image of the system and PCB-A. The real system in the production line, disconnected from this process, is already available for processing the next orders. Remote support or service work on the AOI system, which is costly for the user in terms of time and planning, can thus be quickly ruled out.

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The advantages of the virtual AOI system is also given in the development process of the PILOT AOI system software. New features are developed and tested in the virtual environment of its real counterpart right from the start. Development is thus as close to the physical real world as possible right from the start. When software is tested on the real system, nasty surprises are reduced to a minimum, resulting in further cost and time savings in development.

It turns out that the Digital Twin offers an adaptive model that can be used for a wide variety of perspectives and viewing areas; on the one hand for the manufacturer in the development, production and maintenance of partial or complete systems that influence his product or represent his product itself, and on the other hand for the user, who can in turn integrate the Digital Twin of the product into his virtual overall system. All in all, this technology specifically for AOI use results in a high gain in efficiency in an extremely resource-saving way.

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