Panel Standards and AUTOMATION

As customers demand faster (and cheaper) tooling, custom programming becomes an attractive enhancement. **by DAVE ROESLER and KEITH HILDAHL**

Manufacturers use a range of standards to aid in panel tooling. In this article, we look at different levels of standardization, common tooling methods, and the pros and cons of automation. To one extreme is no standard. In this scenario, the CAM operator develops the panel each time. The disadvantages to this approach are obvious. Even for the most-skilled CAM operators, it all but guarantees inconsistencies between panels and among operators. Moreover, the approach is time consuming and error prone; for example, features get misplaced or, in some cases, missed altogether.

A better, yet still crude, approach is to copy the panel from an existing job. The method is simple: A panel is copied to a new job and modified for any unique requirements. While the operator won't have to reinvent each panel, there remain several disadvantages. The panel chosen for copying may not contain the most recent panelization requirements. As a result, the panels will be inconsistent based on the age of the panel copied. And again, a CAM operator may miss new features or forget to update panel features to the unique characteristics of the new job.

Another approach consists of maintaining a library of static panels. The library is a preexisting set of panels, each defining a given process or combination of processes. Static implies that the features of the panel are non-intelligent, geometric features that can be updated manually by the CAM operator only. This approach is an improvement in that the operator is not required to locate an existing job with the right panel. Reason: All panels begin from the library. Also, this approach requires a single set of panels to maintain and update as standards change. The downside, however, is that manual updating is still necessary to meet the job's unique requirements. Also, because the panels are static, a panel must exist for all permutations of processes. For example, requirements for a panel for a flex circuit that uses a drilled coverlay may differ from the requirements of a panel for a flex circuit that uses a photoimageable covercoat. The result is an ever-growing library of panels that costs more to maintain. Furthermore, errors may be introduced when updating standards, because the same changes must be made to all permutations. Finally, adding processes may require many new permutations.

'Dynamic' Panels

What's the ideal approach to panel standardization, then? To maintain a small set of dynamic panels. These panels contain the appropriate information to allow an operator to create new panels dynamically, based on processes used for a given job. To create a new panel the operator answers questions on excising, soldermask, imaging, etc., and the panel is dynamically changed to accommodate the necessary tooling. The advantages are numerous. Because the standard panels are dynamic, the subset of panels is small. This permits easier maintenance of the dynamic panel library when new processes and panel features are added. Since the standard panels are kept up-to-date, all new jobs contain the most recent panel standards. The panels, therefore, are consistent – and accurate – from job to job. Often, the ease of panel generation requires only an entry-level operator. A final advantage to this approach is that jobs are easily updated to the latest panelization standards.

Now that we have reviewed the various levels of panel standardization, let's examine what is required to achieve the highest level, or dynamic panel standardization.

First, the manufacturer must gather all necessary information regarding its processes and capabilities. Each process has its unique set of information (tooling holes, test coupons, identifiers, etc.). Once the information is gathered, process requirements must be compared to resolve conflicts and to permit reuse of features whenever possible. An example of reuse would be identifying tooling features that may be used by multiple processes. The advantage of this approach is to minimize panel real estate that may be used by redundant features.

Once all the process and capability information is collected and reviewed, the manufacturer must produce documentation. The ideal documentation, in this case, is the actual graphical database of the panel with features identified as to their use and process owner. Keeping together the geographical representation and description reduces the chances they'll become out of sync. At this point, those responsible for each process must review the documented panel. Ideally, this review is performed as a unit. By having everyone present, conflicts are resolved quickly with every process taken into consideration. Based on the review, panel feature and documentation changes are made. This process is repeated until all concerned agree that the panel is correct.

Now, the person responsible for creating the panel automation can make changes to the geometric panel representation, adding intelligence to make it dynamic and thus able to be automated.

THE PROS OF DYNAMIC PANELS

- Small subset of panels
- Simplified library maintenance
- Simplified standards updates
- Consistency from job to job
- Requires an entry-level operator

Policing the Standards

The major challenge to panel standards is policing them. Once panel standards are developed, all panel change requests must be challenged to determine if they are one-of-a-kind experiments or true standard changes driven by process additions or changes. Manufacturers must strive to adhere to the standards and carefully consider any changes. Manufacturers should also be mindful of "panelization by opinion," by which an engineer drives panel changes based on individual experiences. That said, enforcing standards must not become "impeding progress." Business demands require that manufacturers push the limits. For example, material utilization is critical to minimizing costs. In some instances, the violation of standards is acceptable if better material utilization is obtained.

Automation – the use of custom programming or scripting – achieves the highest level of panel standardization, creating the desired panel results and tooling files. Automation requires predictability, meaning consistency is critical. Operators must strictly observe standards for layering and file naming. Also, operators must identify dynamic panel features consistently and according to standard. Ideally, a standard process and procedure goes from initial data reading through final tooling output.

A key element to the ability to automate tooling is the base CAM tool (or tools). These tools must be programmable. The programmability of a given tool ranges from relatively simple scripting to high-level programming languages. Also, the tool must have the capability to identify and name features in the panel, which the manufacturer can reference later.

The programmability of the tool naturally dictates the skill level required of the operator to write and maintain the automated functions of the tool. Most users can learn to write scripts. Scripts, or macros, are a simple set of commands that direct the CAM system to act on the specified panel features. Many CAM systems have a feature that lets the operator record a script through typical interaction with the system. The result is a file that contains the text commands necessary to directly mimic the interactive commands used by the operator. This file serves as a starting point. The script is easily modified to achieve desired automation results.

Many CAM systems today support the use of high-level programming languages. These languages range from BASIC to C++. High-level programming languages permit greater flexibility and include sophisticated levels of logic. These high-level languages require a well-trained individual and, in the case of C++, perhaps a software engineer. Regardless of background or training, the operator must know good programming practices such as documentation and revision control. In the case of panel automation, this applies not only to the programs and scripts but also to the panel geometry.

Based on the skill of the operator needed, the manufacturer must determine what it can afford. Some manufacturers retain a programmer to develop and maintain automation, an ideal situation because the programmer is dedicated to the manufacturer, which also sets the priorities. Most manufacturers, however, have neither the money nor workload to justify maintaining a full-time programmer. Another option is the use of consultants to automate the tool. The advantage is that the service is used, and thus paid for, only when needed. Consulting groups take responsibility for hiring and retaining experienced programmers. Typically, the automation may be purchased outright or leased from the consulting organization. When using a consultant, the maintenance of the automation is critical. It is important that the manufacturer understand how the maintenance is handled and how much it costs.

There are two areas manufacturers will automate: panel generation and tool file generation. Panel automation refers to the generation of panel features, not the step-and-repeat of data. Generally, the time it takes to step-and-repeat images is not long enough to warrant automation. Also, the complex rules users must follow (die considerations, copper grain direction, interlocking of parts, etc.) make this task best-suited for a skilled CAM operator to perform manually. Tool file generation refers to the generation of artworks, rule die files, drill files, NC knife cut files, NC punch files, and so on.

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In both instances, consistency is very important. Layering, file naming, and panel feature naming schemes must be well defined and followed precisely. Also, the CAM tool must support the level of programmability that is required. Most available CAM systems are capable of producing the required panels and outputs without automation. However, to accommodate all users, their features are broad and flexible. But a given manufacturer's requirements are specific. For a given set of processes, the panel and outputs are always the same. For example, the artwork for a topside photoimaged circuit may always need to be positive with the emulsion down. Since off-the-shelf CAM tools are so general, the operator must remember each time to output the artwork with the correct contrast and emulsion direction.

Through automation, the operator does not need to remember this information. By specifying the process, in this case photoimageable artwork, the automation knows to create the proper contrast and emulsion direction. Because it is done automatically, it is done correctly and consistently. It is extremely disappointing when the CAM department spends valuable time and effort creating a proper panel only to output bad tools by simply specifying the wrong emulsion direction. ○

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