为贴安装机械建立零件数据库耗费时间、容易出错误百出，而且需要大量人力。加上生产线包括多个制造商，每台机器使用不同的软件编程（每种软件有自己的零件数据定义），结果成为昂贵而枯燥的过程。有一种称为虚拟原型的过程序，可使新产品的准备合理化，需要很少的操作技巧，并消除了停机损失或材料损失。虚拟原型是一个程序，使用零件库的几何形状和旋转，模拟组装的电路板。这个程序消除了某些手工操作，可用于为有问题的元部件进行分析，并改善元部件贴安装、可焊接性和测试。

Programming for Mixed-Vendor Lines

Bini Elhanan

Intelligent, centralized machine part data management cuts human error.

Creating part data libraries for placement machines is a daunting task that can be time-consuming, error-prone and labor intensive. Coupled with a multi-vendor line, in which each machine is programmed by different software (each with its own part data definition), the result is a costly and tedious process.

Assembly machines require certain parameters to handle parts. They include a geometric representation of the part and handling instructions, some of which may be derived from the geometry. Such information currently comes from data sheets or physical measurements. The manual definition process is tedious, with no checks to ensure accuracy. Imagine an SMT programmer breaking apart a single lead of a $300, 144-lead QFP IC to measure its width with a caliper (Vernier), because the lead couldn't be measured *in situ*. In addition to being a waste of money, the measurement is probably inaccurate. Or picture an expensive SMT line left idle for 15 or 30 minutes because a part cannot be placed and part data need to be reprogrammed.

Machine part data consist of a geometric description of a component (length, width, number of leads, etc.) and various handling parameters (nozzle, camera, lighting, etc.). Manual entry of geometric data involves slow and inaccurate measurement methods and numerous searches of part data sheets. Automatic generation of machine language geometry fields from the libraries is fast, accurate and efficient.

To understand the nature of manual part handling data definition, consider: One of the handling parameters for parts is the nozzle size most appropriate to pick it up. With manual definition, operators memorize the table of conversions of package size to nozzle. Acquiring this knowledge is a bottleneck in their training and the source of human error, resulting in wrong picks and placements. Conversely, an automatic process based on electronic libraries applies a formula to calculate nozzle size automatically and repeatably.

Libraries containing accurate geometric descriptions for most parts in use today are available. Specific machine format geometry can be derived from these descriptions. Other parameters can be deduced using rules. Part data creation becomes quick, accurate, reliable and automatic. Automatically created rotation orientation standardized part data improves and speeds up NPI processes. Adding virtual prototyping streamlines the process so that new product setup no longer requires skilled labor, eliminating loss of machine time or material (**Figure 1**).

Virtual prototyping removes the need for physical machine program verification onto double-sided sticky tape, which is costly in terms of line production time and scrap. Virtual prototyping is a programmatic method displaying a simulated populated board using the geometry and rotation of the machine part library. The simulation uses actual machine part data and machine programs to verify the accuracy of the data without using actual boards, parts or lines.

Libraries alone cannot do the trick. There must also be tools that use libraries. The most important is a common programming platform for all machines on the shop floor. Assemblers have come to rely upon a heterogeneous mix of machines, yet most suppliers' programming solutions fall apart in a multi-vendor line or factory. Independent software providers create software solutions capable of programming a heterogeneous line using similar tools and a common look and feel. These tools not only use part libraries from all vendors and machines, but also reduce operation costs through better line balancing, easier operator training and addi-

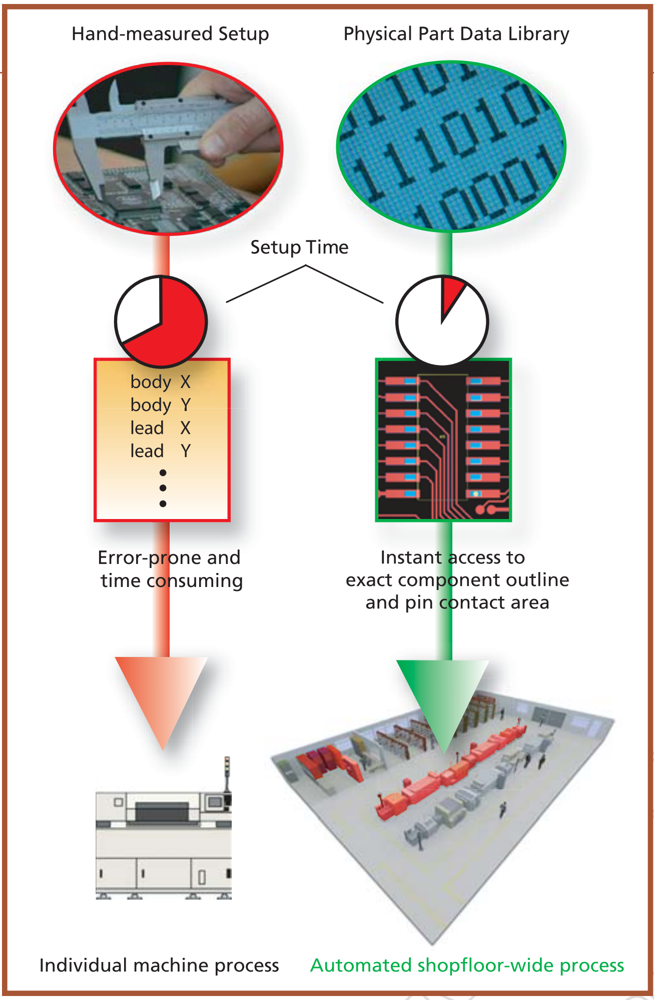

FIGURE 1: Manual operations (at left) rely on training operators, which is labor intensive and error-prone. Automation (right) offers a repeatable and centrally managed process.

tional capabilities (such as reduction of feeder setup time through calculated "grouping"[1] of products in high mix environments).

Physical part libraries are also used in a variety of tasks beyond creation and management of placement equipment parts data. Additional capabilities include:

- Analysis of BOMs and AVLs to eliminate erroneous alternate parts, saving hours of line downtime if an error goes undetected until production begins.
- Automatic creation of AOI machine part libraries that can prevent expensive machine downtime.
- Faster and more accurate fixture design.
- DfA and DfT analysis to detect part placement, solderability and testability problems long before they cause harm on the shop floor or, worse still, in a delivered product.
- Creation of better shop floor documentation.

The lack of central, multi-vendor, library-based parts data control systems causes such part data to be managed on the factory floor sporadically at line computers or the individual machine. This chaotic approach of manual data creation and maintenance is labor intensive and often inaccurate.

The absence of centrally managed part data leads to multiple, differing representations of the same parts on individual machines. This can lead to inconsistency, out-of-control situations and loss of time due to multiple machine-learn cycles for the same part.

Indeed, it is very common to find the same shape in a machine library in many different guises; e.g., 0805, 0805-1, 0805Fred, 0805_1. Technicians resort to redefining parts because they lack the tools to look for existing definitions. Not only is time lost to machine setup, but machines are underutilized because of less-than-optimal operational speed setting in the parts data.

Further inefficiencies arise in the following areas:

- Technician time is lost searching for data sheets and measuring parts using a Vernier.
- When a new product is run it can take in excess of 3 hours (depending upon the quantity of new shapes) to program and teach the shapes. This is not only costly in manpower, but the line is unproductive during this period.
- It is time consuming to move a program from one manufacturing line to another as a result of inconsistencies in the management of part data on different lines. Long delays result as the operator ensures that the program references the correct parts on the new line.

The NPI process to get the first board from the line is far too long, given these inefficient practices. With a more efficient NPI process, prototype boards are assembled quickly and time-to-market is reduced.

Translating the list of problematic issues into numbers helps to calculate return on investment for the implementation of intelligent part libraries. Assuming:

1. An average line generates $50 million in revenue a year. Its hourly profit is $250, assuming a 4% margin.
2. ROI will be calculated for a 10-line plant.
3. Thirty new jobs are introduced every week.
4. NPI setup time on the line is reduced by 50%, from 5 hours to 2.5 hours.

The savings for reducing NPI time alone is

30 (jobs per week) * 50 (weeks per year) * 2.5 hours per job * $250 per hour = $937,500 per year.

Automatic generation of accurate and reliable part data from intelligent part libraries, along with a common multi-vendor programming platform, provides a watershed solution. Operators need only be trained on one tool. Full realization of line balancing capabilities is possible as the task of defining part data for all applicable machines is no longer a bottleneck. Streamlined pre-production engineering becomes a reality. Further savings can be realized through improved operational efficiencies and line throughput. ■

Reference

1. "Grouping" of products is a process by which a significant number of different products that need to be assembled in small quantities in a given period are separated to groups sharing a common feeder setup. This process improves line uptime significantly by eliminating the need to change the feeder setup on a per product basis.

Bini Elhanan is director of technology at Valor Computerized Systems (valor.com); bini.elhanan@valor.com.