The Shift from Manual to Automated Device Programming

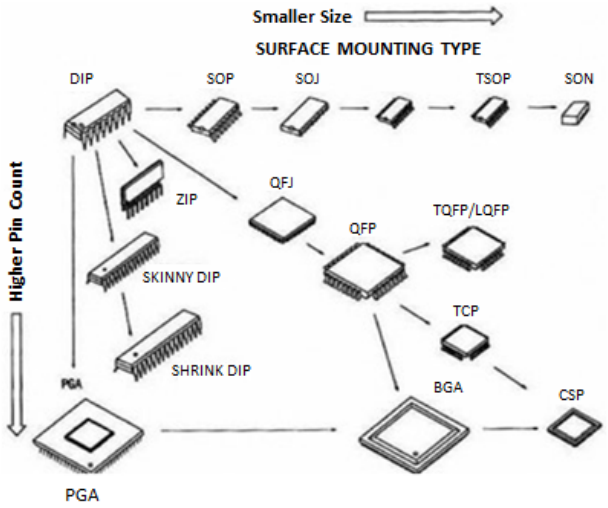
SUMMARY:
New generations of smaller, finer pitch semiconductor devices are powering today's new systems and devices in automotive, consumer, and industrial applications. Combined with increasing labor costs and demand for the highest quality, factory managers say the time has come for automated equipment in the programming process.
This paper looks at the trends driving the move toward automated device programming in China and Asia overall. It also shares some questions to ask when choosing an automated programming equipment supplier.

Trend #1: China is racing into middle income status

China manufacturing wages continue their rise, reaching an all-time high of $7294 per year ($45,431 Yuan) in 2013. As of April 1st 2014, the minimum wage for workers in Shanghai rose to $293 per month ($1820 Yuan). The rise in labor costs especially impacts manual programming processes. While it is possible that Chinese manufacturing could start outsourcing to lower-income markets like Vietnam, there is significant factory investment in China that can remain profitable with greater automation. Device Programming is a process with a proven capability for automation over the past 15 years in global markets.

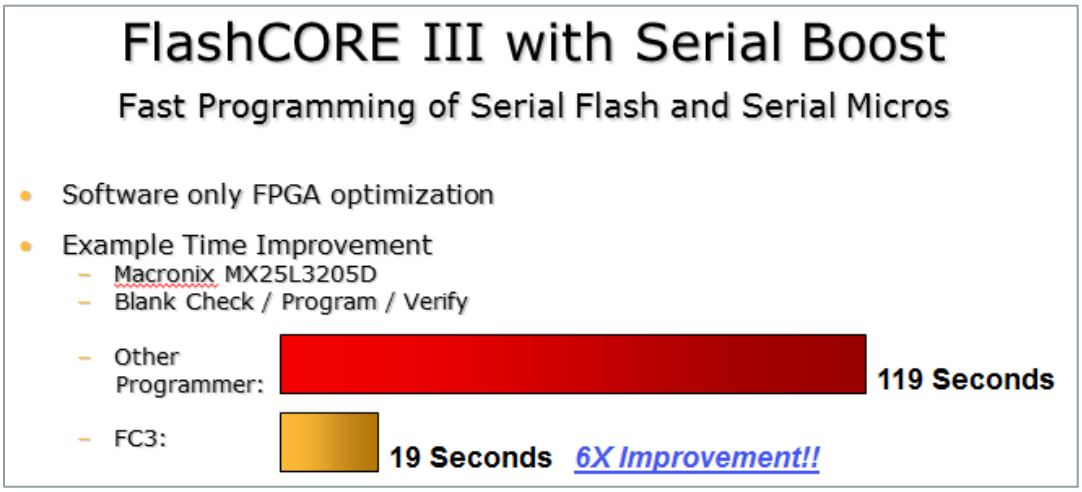
Trend #2: Semiconductor packages are shrinking in size

Programmable semiconductor packaging is being driven by the market requirement for increases in operating speed, higher density and lower power. Smartphones, tablets, e-readers and navigation devices further the demand for continued growth. At the same time, the demand for smaller, thinner and less expensive device packaging is forcing electronics manufacturers to control programming cost. The safest most cost effective way to reliably handle smaller parts is with automated programming equipment.
The charts below graphically highlight the industry's past history and current trends in IC packages showing the influence of accommodating both package miniaturization and increasing pin counts.



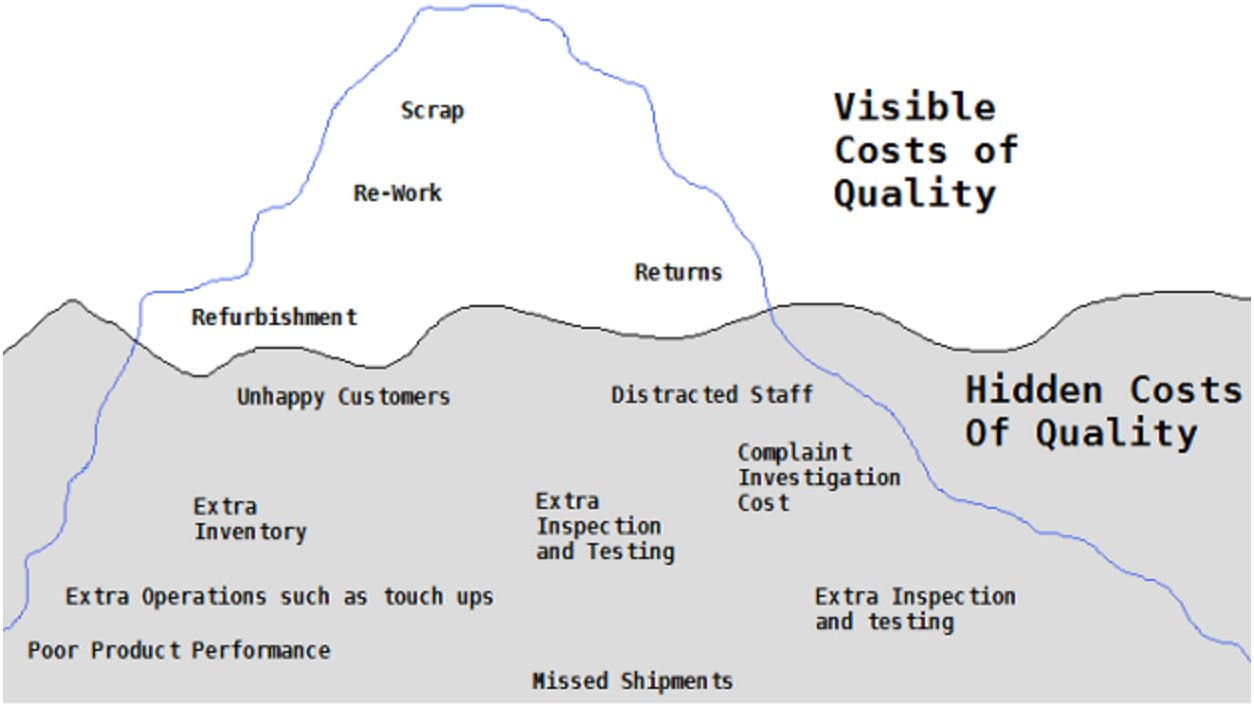
Trend #3: Fast programming times result in higher costs with manual programming

Programming engines such as Data I/O's FlashCORE III with Serial Boost technology speed up programming times. Microcontrollers used in most industrial applications require programming small amounts of data (kilobits or kilobytes) having short programming times. For manual programming operations, this leaves one operator managing a single desktop programmer. An automated system can deploy up to 24 programmers in a single system, and operators can manage multiple programming systems. When labor rates were lower, the solution was to simply add more manual programming stations along with manual labor. Smart factory managers move to automated systems with fast programming engines.



Trend #4: Factory managers focus on the elimination of hidden factory costs

High levels of product quality are difficult to achieve using manual processes. Human error rates for manual processes are affected by many factors including task complexity, worker motivation, fatigue, number of process steps, training, pace and process design. Since customers have high expectations for product quality, internal systems must be developed to catch the defects created by manual processes. The term "The Hidden Factory" has been used to describe the effort to identify and correct defects before they exit the factory in a product. The hidden factory includes such items as inspection, expediting, excess inventory, larger than necessary lot sizes, redundant equipment, extra direct labor, management time, engineering time, added floor space and warranty claims.



Source: sixsigmamaterial.com

Companies commonly underestimate the size of their own hidden factory since it can be difficult to capture all of the cost of poor quality. The high variability of manual processes increases the opportunity for defects, causing hidden factory costs to rise.

Programming of semiconductor components is an example of an industrial process that has multiple manual steps. With manual programming a work order is generated, components must be released from stores, moved to the programming work center, removed from their packaging, manually placed into programming sockets, programmed with the correct software version, tested, reprogrammed if necessary, manually marked and placed into a pass/fail bin, returned to their packaging, moved to stores and entered into inventory. The many manual steps in this process can lead to defects such as programming with the correct version, undetected ESD damage, co-planarity issues, programming the component multiple times leading to premature component failure, component lead damage, incorrect component orientation in packaging, mismarked components and component scrap. Automation of component programming is an effective way to reduce this level of non-value added work.

Programming automation is fundamental to competitiveness in cost and quality for automotive, industrial and consumer electronic products.

40 Typical Problems Associated with Device Programming

Top 10 in Blue

Set up

- Wrong job selected
- Error in setting up special features
- Wrong device selected
- Wrong data file selected
- Wrong marking data
- Wrong adapter used
- Errors by the test engineer in creating the Job file
- Serialization done incorrectly
- Check sum calculation does not match engineering's check sum

Manual device handling

- Device leads damaged
- Failed devices placed in good tray
- Blank devices placed in good tray
- Good devices mis-oriented in good tray

Programming

- Bad silicon fails
- Error in algorithm
- Low yield due to poor device to socket match
- Programming from a defective Master Device

Marking

- Label mis-oriented
- Operator confused on which ink dot color goes where
- Wrong label used
- Label not centered

Maintenance

- Sockets not cleaned appropriately
- Sockets not replaced when yield drops
- Automation maintenance schedule not followed
- Service attempted by unqualified technician

Media handling

- Blank trays mixed up with completed trays
- Failed device tray mixed up with completed trays
- Tray dropped
- Tray bumped and devices fall to floor
- Devices that fell put back into the tray

Data Management

- Statistics not collected
- Statistics not analyzed
- Large quantities of devices returned on RMA without knowing why they failed
- Log files not analyzed to determine operator training requirements
- Root cause of problems not resolved

People Management

- Semiconductor company resources not used to solve problems
- Programming vendor resources not used to solve problems
- Programming processes not documented and people not trained
- Maintenance processes not documented and people not trained
- Staff change without proper training

Of the 40 typical problems associated with manual programming, 36 are resolved using automated systems and the remaining 4 through process control software.

40 Typical Problems Associated with Device Programming

Only 4 problem left when using automation

Set up

- Wrong job selected
- Errors by the test engineer in creating the Job file

Manual device handling

Programming

Marking

Maintenance

Media handling

Data Management

- Statistics not analyzed

People Management

- Staff change without proper training

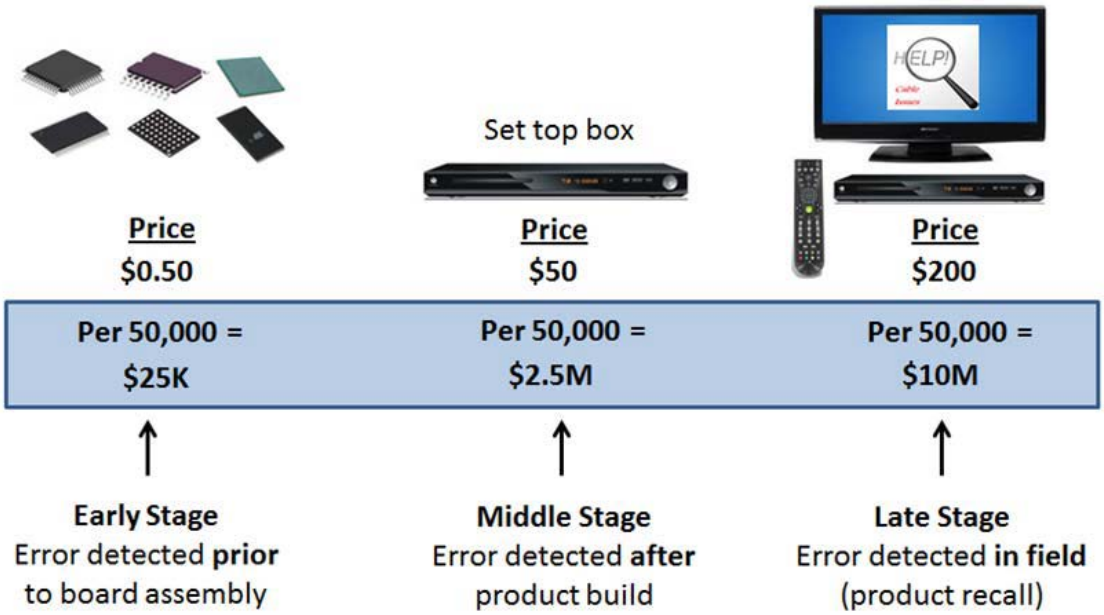
AUTOMATION SIMPLIFIES PROGRAMMING TASK!

Data I/O PSV3000

Automated programming solutions help to ensure a lower cost, higher quality product in a number of ways:

Reduced component damage – Manual insertion of components for programming can cause damage to leads. Automated programming equipment virtually eliminates the co-planarity problems that are common with manual programming. Co-planarity problems can lead to latent defects and are often not detected until final assembly, burn-in or when the product reaches the customer hands. It is commonly believed that quality defects found at the customer level are 10 to 100 times more expensive to correct as defects identified at the component level.

Costs of error detection at early, middle, and late stages in the production process



Lot and serial number tracking – Many highly regulated industries, such as medical, aerospace and automotive have stringent requirements for tracking of components. Some vendors of automated programming equipment provide sophisticated software for tracking component serial numbers and lots.

Lower product cost – Reduced product cost is possible through the reduction of manual labor, reduced inspection labor, low kitting labor, reduced warranty claims and lower labor cost for lot and serial number tracking.

Lower software error rates – Automating the component programming function assures that the latest software version is loaded and correct version level is properly marked on the component.

Increased product reliability – Automated programming is inherently more reliable than manual programming, requiring fewer attempts to program a component, therefore increasing reliability of the assembly. Latent defects are reduced, lowering warranty claim costs.

Clearly, automation has a significant role in reducing product variability and cost. We have seen how manual processes have high variability caused by human error and how human error is compounded by multi-step processes. This high product variability has necessitated the addition of many costly job functions to contain product defects with the factory (the hidden factory). Automation of manual processes such as flash memory programming has an important impact on product cost and quality, making a factory more competitive in the global marketplace.

Choosing a programming solution that is right for you

A trusted supplier should be reliable, knowledgeable and have a thorough understanding of your business requirements. Capital equipment investments are a huge undertaking and knowing what to ask is critical. If the initial purchase price is the only purchasing factor, spending less money up-front may turn into cost problems later. The most successful companies are those producing **quality whole products as cost effectively as possible.** Make sure the quality of the programming system meets your standards. Carefully review the service and support offerings including local support, on-site training and spare parts availability. Find a programming solution that excels in performance and reliability at an affordable price.

Supplier Credentials

Build a long-term working relationship with a reputable programming equipment supplier with a long-term history of innovation and success. Find a supplier with the knowledge to build the whole product, including programming electronics, handler robotics and system software.

- How long has the company been in business?
- Is the company financially stable? Are they debt free?
- Can the company support new devices as they become available?
- Does the company have brand recognition and a solid reputation?

Advantage Data I/O:

For more than 40 years, Data I/O is recognized as world's most trusted programming equipment supplier with more than 1 billion devices programmed. With more than 40 industry firsts, Data I/O continues to lead the way in industry leadership and innovation. Data I/O whole product solutions include; handling robotics, programming electronics and system software, all designed to work together.

Programming Quality

Your product is designed to the highest quality standards and you should look for a programming supplier with the same high standards. Data I/O maintains partnerships with leading semiconductor suppliers to insure the highest quality.

- Are the programming algorithms written according to manufacturer specifications?
- Are programming algorithms updated for device enhancements by the semi-vendor?
- Has the programmer been tested for potential bit loss of MLC NAND, post reflow?

Advantage Data I/O:

All Data I/O programming algorithms are developed according to the manufacturer's specifications. Data I/O works closely with the semiconductor vendors in advance to resolve problems before they occur in a production environment. If problems do occur, we provide a crucial link between the semiconductor vendor and the customer. Electronics manufactures for **mission critical** applications choose Data I/O programming equipment, for quality, dependability, reliability and service. Data I/O programmers with SuperBoost Technology ensures highest quality MLC NAND when following best practices.

Handling Quality

Figure 1

Camera vision alignment as seen in figure 1 is the safest and most efficient way to ensure precise component placement into sockets and I/O media while protecting the lead integrity of each device.

- How does your automated system align devices?
- Are there any tooling changeovers required?
- What are the Field of View (FOV) capabilities of the camera?
- Is there any risk of lead damage?

Mechanical Precisor:

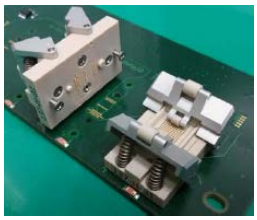
Warning: Fine-pitch parts with pin tolerances ranging from 0.3mm to 1.0mm should never be dropped into a mechanical precisor for alignment. Dropping a fine-pitch part (QFP, TSOP, SOIC, SOT and others) has the following drawbacks.

- High risk of bent pins and lead damage
- Drop-in mechanical precisors collect dust and debris, risk of bent pins
- Adds an extra step to the handling process
- Increases changeover time
- Requires inventory management
- Increase in scrap costs

Advantage Data I/O:

The only safe mechanical precisors are those that align the device from the top of the package, never touching the pins. Data I/O offline automated programming systems do not use mechanical precisors and include vision systems to ensure the highest device lead integrity. The upward camera vision system includes object-recognition software to locate a part and its orientation. The parts-positioning coordinates are transferred to the pick-and-place machine for precision placement into a socket.

Highest Yields



Socket yield performance and socket life have a significant impact on the total cost of programming. Investing more up front for high insertion count (HIC) socket adapters with yield performance up to 99.9% can offer substantial long-term savings compared to standard burn-in sockets.

- Are high insertion counts sockets available?
- What is the socket insertion life?
- What are the typical programming yields for sockets?
- Are the sockets replaceable?

Advantage Data I/O:

Data I/O offers both standard burn-in sockets and high-insertion count (HIC) sockets. Data I/O's high insertion count sockets with stainless steel/gold plated spring probe contacts deliver low noise programming signals for yields up to 99.9%. High insertion count (HIC) adapters make value flow from raw material through consumption using the least amount of resources, including time, people and materials. Efficiencies are gained through simplified socket inventory management, lower overall socket costs, reduced scrap costs, less rework, and optimized operator utilization. The end result is higher manufacturing profits.

Service and Support

Maintenance cost is an important factor to consider when choosing an automated programming equipment supplier

- What is covered under the first year warranty?
- Does the vendor offer local service and support?
- What types of service spares programs are offered?
- What are your lead times for spare parts
- What is included with installation and training?

Advantage Data I/O:

Data I/O is headquartered in Redmond Washington (USA) with subsidiaries in Shanghai China and Munich Germany. New systems include installation and training by Data I/O trained field service engineers. Basic and self-service spares kits are available, in addition to stocking of regional spare parts. Support is available 24/7 along with annual update and repair contracts.

Summary
Rising labor rates, shrinking device technologies, hidden factory costs and human error are accelerating the move from manual to automated device programming.

You want to find a business partner with a history of high programming quality, high programming yields, superior component handling and excellent maintenance, at an affordable price.