Challenges of Equipment support in a factory with a diverse multigenerational toolset

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Abstract: Doing business in a cost competitive Market in a fabrication facility of limited size and budget requires that we continue to use some of our process equipment far beyond a normally accepted lifespan. This paper will cover many of the best known practices that have enabled success in a very diverse equipment environment. It will present an explanation of the major equipment groupings and the support challenge for each along with the practices put in place to accomplish high volume manufacturing requirements.

Process equipment can be divided into three major groupings, or generations: State of the Art, Tried and True Workhorse equipment, and Legacy equipment. Each of these groups presents a different set of benefits and obstacles that need to be addressed from both Process and Equipment perspectives.

State of the Art equipment represents the latest technology in any given equipment set. This equipment is generally considered to be the currently produced equipment by an OEM (original equipment manufacturer).

Benefits: State of the Art equipment usually comes with factory support for both process and maintenance. Depending on the OEM there may be anything from onsite OJT (on the job training) to formal factory training for both process and maintenance. These equipment sets will usually be delivered with manuals that cover process setup and development, Maintenance basics along with recommended PM (preventive maintenance) cycles, and an illustrated BOM (Bill of Materials). You may think, with all of this support behind the purchase of a shiny new tool, this would be an easy selection, but hold on.

Gotcha's: These tools do not come without challenges. First there is the issue of moving an existing process to a new platform. Since a new platform can have a different set of facilities inputs, functionality, and wafer environment the process will probably, read this as almost never, transfer exact. Many hours of engineering will be spent to match critical output characteristics such as deposition or etch rate. Matching device profiles and required parametrics will often be frustrating. As far as supporting from a maintenance standpoint this category of equipment provides logistical challenges.

Recommendations: For the first tool purchase, you must address the logistics behind spare parts, develop a trained maintenance technician force , and write all internal documentation/specifications for the toolset before the tool goes into production. It is critical to take full advantage of the potential benefits of vendor support on State of the Art tool purchases. This is the best opportunity to specify clear capability requirements, acceptance testing criteria, process development support, training, maximum allowed response times for tool issues, and continued software upgrades.

The next category of equipment is the Workhorse toolset. We all have some of these. Even though the OEM has stopped production of the particular model there are enough of them in use that they have reached critical mass. Either the OEM still supports the tools or there is enough profitability that independent companies have been formed around support of these tools.

Benefits: Anything from parts to software to both process and maintenance support can easily be found. Some of this classification of equipment has even spawned a support base strong enough to develop new operating systems, rebuild tools, or

refurbish the equipment with updated parts and electronics. Adding more tools into the facility from this category is less expensive, and usually has the benefit of an existing knowledge base internal for their support. If not, there is more opportunity for hiring in engineering support with previous experience on the toolset. Documentation may also already be in place along with an inventory of commonly used parts.

Gotcha's: A couple of challenges provided by the continued use of this type of equipment is that the operating systems become trailing technology and training new employees in the support of these tools becomes an internal responsibility.

Recommendations: Stay ahead of obsolescence by working with the third party vendors to develop modifications to operating systems and electronics to extend the life of these tools. Take advantage of the wealth of knowledge by joining or developing user groups for these tools.

The third classification of equipment to discuss is true Legacy equipment. This is equipment, or subsystems of equipment, that has very little to no support outside of internal knowledge. Supporting these tools is particularly difficult, expensive and requires extra resources to maintain. Generally these are systems that did not become mainstream tools throughout the industry, there are not enough of them to spawn the secondary support market, and/or they were developed internally. Tried and true workhorse equipment will also end up in this category when the profitability goes out of the secondary market. This category equates to being on an Island where you need to be totally self sufficient.

Benefits: Unlike a shipwrecked castaway, you know you will be stranded so you have the opportunity to pack! Self sufficiency on a Legacy toolset should be started long before getting stranded. If properly prepared, Legacy equipment can push out new capitol expenses and can sometimes even be expanded for very little cost.

Gotcha's: A real or even perceived technical advantage from a Legacy toolset can force a company into continued support of Legacy equipment if the shiny new equipment on the market does not offer the same capability. Legacy products that rely on the older equipment can do the same. The high support costs and potential for extensive delays from difficult to replace components round out the down side for this group.

Recommendations: Most OEMs will communicate to all known customers before they discontinue support for a toolset. The time to start a communication effort with the OEM is as soon as you receive that notice. Information to try to get from the OEM before they totally abandon the tool can include build data for each of your tools, production drawings for all parts, and any software documentation available. It will probably take some convincing to get the OEM to release this type of documentation start as early as possible to convince them to release it.

One of the most critical assets in support of any of these equipment groups is a strong Equipment Engineering Group. These engineers not only need to be experienced in hardware and maintenance but also in the process that the equipment will be running. We all know that compound semiconductor processing is vastly different from an equipment capability standpoint than Silicon. These engineers will be constantly working to improve the handling and reliability of the toolsets they are responsible for. For the ideal EE group it is also invaluable to have a dedicated Mechanical Design Engineer that can provide production drawings for reverse engineered parts as well as design of new improved parts. The mechanical engineer will also be relied upon to work with machine shops and other raw material vendors in the manufacture of these parts. When developing improved parts it is wise to make sure you retain the rights to the drawings and even develop a controlled database of these internally. Also insure that "non-disclosure" agreements are in place with all vendors and shops prior to sharing any information.

Specific Examples:

Now I will focus on a tool from the truly legacy group that we have been supporting in our factory for over 15 years and cover many of the things we have done to keep it running.

First is staying in contact with the original engineers and support personnel that worked on this tool from the beginning. The rolodex becomes your best friend. Be sure and stay in contact with these people on a regular basis. They usually will have moved on to new jobs in different areas but retain the knowledge and sometimes written information in the form of notes and logs. This is especially necessary when it comes to software. When trying to maintain trailing technology such as outdated operating systems (QNX2, DOS, Older versions of windows) it is great to be able to contact the person who wrote the drivers for the system. Building internal knowledge to cover this is very difficult. The best procedure to mitigate down time due to software or computer issues is to keep up to date clones of the hard drives or flash drives and backups of any configuration files. These are frequently used when tools are rebooted and files get corrupted or a hard drive crashes. As for hardware we have literally reverse engineered, redesigned, second sourced, or upgraded every part of the tool. Our database of equipment drawings for this toolset has over 2000 manufacturing drawings. Building good relationships with vendors is key to getting them to work with you to manufacture these parts. We have also dedicated an equipment engineer and two senior equipment technicians to full time support of this toolset.

In many cases equipment in the second and third categories do not have the capability for data logging and fault isolation that the state of the art equipment has built in. Adding these capabilities has been possible but requires IT and IS support personnel. We have implemented systems that mimic secs/gem capabilities with recipe download/verification. These have reduced the incidents of wrong recipe selection due to human error. Adding fault detection and data collection to some of these systems can be complex. It can span from connecting interface equipment to existing sensors and electronics to building stand alone sensor and wiring systems and building alarm interfaces to create the equipment control loop. Fortunately there are vendors that specialize in helping to design and interface these systems.

The bottom line is that no matter what you do you will eventually reach a point where it is no longer profitable to maintain the oldest of equipment. It is here that you need to develop a good exit strategy. Again, start as early as possible to determine a new tool that will be able to run the process. Remember, there will never be enough time when you are faced with factory output requirements.

Conclusion: From state of the art to truly out of date, supporting a diverse set of tools in same factory presents many challenges. Resource allocation is key in providing consistent productivity from each toolset. Developing strong Equipment Engineering group is critical to supporting the older, less supported equipment. The ability to be flexible in all aspects of tool support provides the capability of success.