Time Savings in Placement/Assembly through Family Setups and Minimizing Changeover

By Matt Wyglendowski
National Sales Manager, Production Systems Division

Electronics manufacturing has evolved in the last decade toward a preponderance of high mix, complex, and low volume manufacturing from what was once high volume, 'lights out' flowline assembly. High mix assembly however typically requires frequent change-over, particularly in component placement, where different setups (components, feeders, and programming setups) interrupt production time and result in lower equipment uptime and utilization.

Profit margins have also narrowed; and the more productive time lost to setup and down-time, the less profitable the manufacturing enterprise.

The solution is highly flexible equipment with lower change-over needs, driven by powerful software solutions. Reducing changeover requirements is key to increasing line uptime and thereby bringing in more revenue. Planning, consolidation, and elimination of process steps or unnecessary delays also contributes to turning downtime into productive time.

Figure 1 (right) shows necessary changeover times (typical) for a 3-module (placement) assembly line, with a 5,120mm line length 320 unique feeders/component types. In an all-manual changeover, the required time can be more than three-quarters of an hour. This is not acceptable. Note that the biggest time-waster is feeder cart changeover (2 carts per module), accounting for 2/3 of the downtime.

Necessary Change Over Time

How many minutes can be reduced?

* Based on 3 modules configuration

Change over jobs	Required Time(min)			
	Basic Time /Module	Manual	Line change over	Family setup
End previous model production	–	–		
1.Change program	**2.0**	**6.0**		
2.Return nozzles to stocker	**1.0**	**3.0**		
3.Change nozzle stocker (2 pcs)	**1.0**	**3.0**		
4.Setup backup pin (20 pcs)	**2.0**	**6.0**		
5.Change conveyor width	**0.5**	**1.5**		
6.Setup nozzles for next production	**1.0**	**3.0**		
7.Change cart (2 carts/module)	**10.0**	**30.0**		
Total time	**17.5**	**52.5**		
% of reduction	–	**0**		

In a manufacturing scenario where a facility has multiple lines in operation, multiple products line balancing (via software) as a means of production plan optimization can make the operation more efficient and boost up-time. Multi-product line balancing assigns components to selected machines based on machine capability and speed to create a more efficient production line. Feeder locations can be assigned by the program for optimum speed, or a common feeder setup can be used. Additionally,

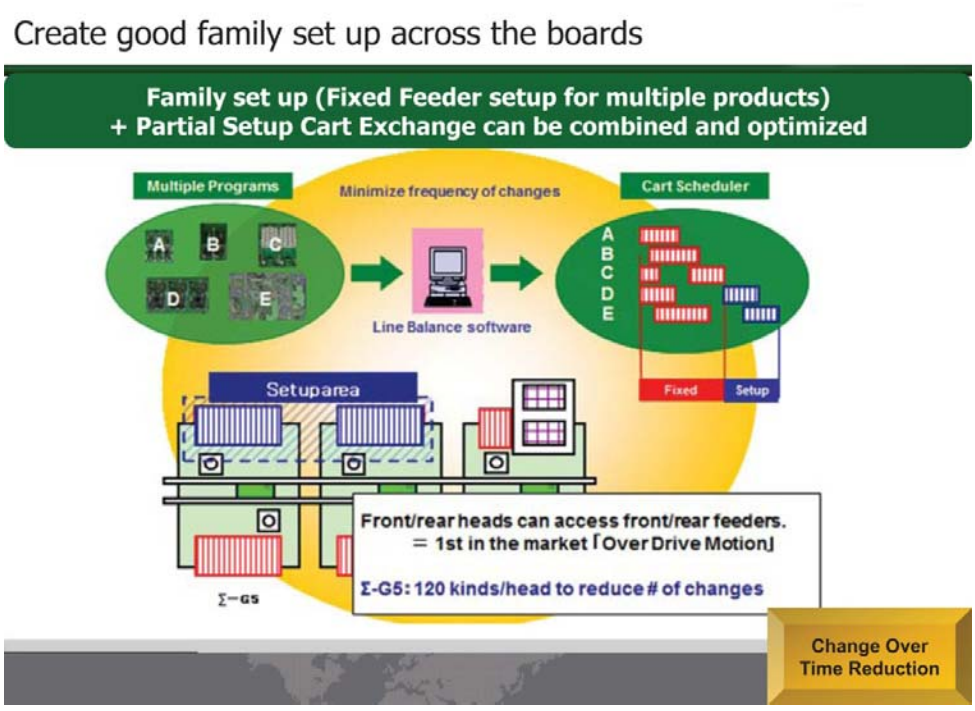
Two or more existing programs on individual machines can be merged and reallocated for best performance.

The solution is found in a combination of hardware and software. Examples of hardware contributions to the overall solution include quick change feeder carts, quick change nozzle setups, wide range component camera recognition systems, and wide component range capable heads.

Powerful hardware needs powerful software tools to make it realize its full potential for the process. Highly capable software 'pulls it all together'. For example, software solutions can eliminate placement head changes altogether; minimize or eliminate nozzle stocker changes; reduce feeder cart changes; and much more.

Application of a plan, or strategy, to put the hardware/software solution to work with greater operating efficiency and slashing downtime or setup time is the arrangement of the most common SMT components in what we call the "Good Family Feeder Setup", whereby feeder replacement work will be minimized and as a result, the customer can significantly reduce product changeover downtime.

In the Family Setup, shown in **Figure 2**, **(right),** all necessary components to build products (D, H, E) are arranged in a family setup in an SMT line using common feeders for common components. By this optimization, feeder replacement among products (D, H, E) is reduced to zero. Next, changeover planning combines the family setup with cart change strategy, whereby feeder cart or feeders are changed with respect to products and product groups to maximize efficiency. This minimizes the frequency of needed changes and makes changeover easier while minimizing downtime.



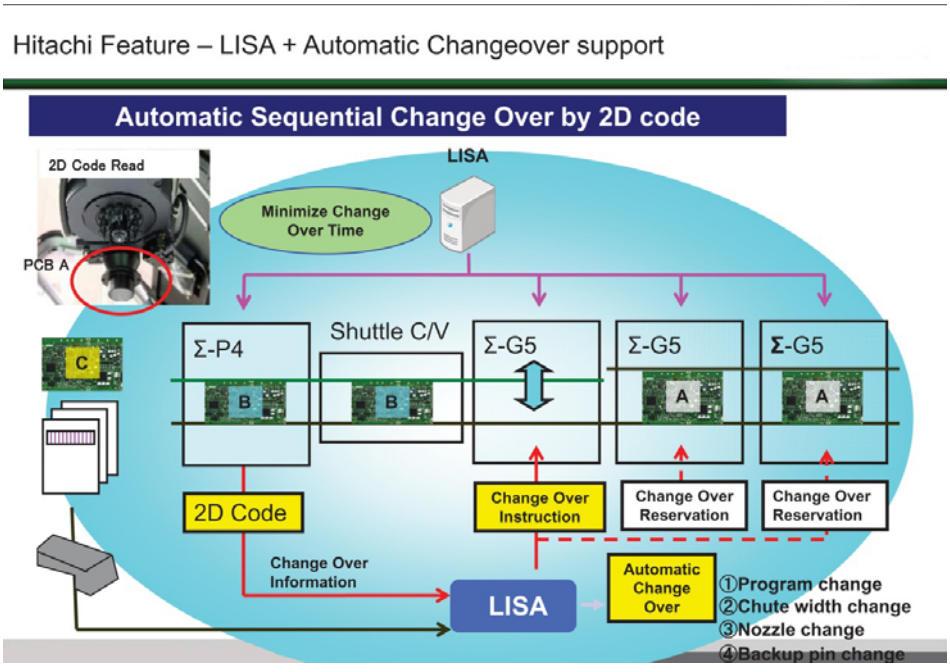
In the average daily production environment, one may have seven or eight products, and you don't want to change over every single product because that is a time-waster, so it is more effective to bundle products together, and process them using a program and controls that take advantage of a high part

feeder capacity so that several different products can be processed without stopping production for changeover.

A simple but good example, would be in the automotive industry, when perhaps one manufacture such as General Motors produces several different models, but each with a similar type of control electronic assembly. The board in each model may have slight differences in dimensions, or components used, etc. from the others in the other vehicles. So it is then practical to create a product 'family' set up approach where there would be only slight modifications made in the manufacturing recipe (e.g., automated transport width adjustment, etc. and in the parts selected in common from the feeders, so that three or four different boards of a similar product family can be run continuously without changeover.

Software plays the overarching role in simplifying changeover, and automating it for best time savings and efficiency. This is achieved through the use of LISA, an acronym for Line Information Support Administration. LISA is basically a line controller for the assembly machines. LISA, by controlling and automating such items as program change, chute width change, nozzle change, support pin change, thickness change, and backup pin change, makes it possible to minimize changeover time and realize a reduction in operation loss by automating individual sequential changeover via 2D code. LISA performs a range of functions including managing line data, monitoring line status, controlling automated program change function via mark or 2D barcode, and providing changeover work instruction all from one location. Nonstop automated changeover results directly in the benefit of changeover time reduction. This improves total productivity (OEE).

Overall Equipment Efficiency (OEE) is further enhanced with quick-change feeder carts that allow a mounter to hold the maximum number of feeder tapes. Family feeder setup capability slashes changeover time by more than 90%. Fully automated changeovers including nozzle change, backup pin support, conveyor width and program change via 2D barcode, all these changes to automation support OEE. We see also that time savings begin to accumulate; automated control of these **(Figure 3, above)** by LISA now saves 25% of the time previously needed for line changeover.



A balanced line is a more efficient line in operation. Better line balance is achieved when both placement heads are operating in a fully optimized fashion, without idle time, and without wasted motion, which also absorbs time. Given that feeders are not always in an optimum position for most efficient access by the heads, some idle time has been generally unavoidable; however a recently-introduced concept, known as an 'Overdrive' control system allows both heads in a 2-headed system to pick from each other's component supply and place on the same board simultaneously and without restriction. This results in the most flexibility achievable in a system with a single high speed head and a multi-function head.

Independent Dual Lane Operation – with manufacturing lanes A and B, for example, is another means of achieving high mix independent change-over without interruption, providing the most effective use of the SMT line for high mix variable production. It directly results in a reduction of non-operating time that would otherwise be lost to changeover and setup. Simply put, the "A" lane is dedicated to large lot production, while the "B" lane handles multiple model production that requires much changeover and setup work in an independent mode, small and medium lots, etc.

Now feeder capacity comes into play. A system that can accommodate up to 120 unique 8mm feeder tapes, for example, reduces the need for feeder carts and changeovers because there are enough feeders available on the machine to accommodate a wider range of products without having to change feeder carts. The feeders for multiple product assemblies can be housed on one machine, and this facilitates Family Setups (i.e., common feeder setups).

Now, family set up (fixed feeder setup for multiple products) as well as partial setup cart exchange can be combined and optimized. Multiple product assembly programs can be tied by the line balancing software to the cart scheduler. Changes requiring setup are minimized while fixed changeover recipes are plugged in and matched up. Thus, there are fewer changes. Additionally, the aforementioned 'Overdrive Motion' control system that allows both front and rear placement heads to access both front and rear feeder as needed without restriction speeds assembly and cuts lost time and unnecessary motion (or idle) time. Time savings now reach an unheard-of 91% **(Figure 4, right)**!

Necessary Change Over Time

How many minutes can be reduced?

* Based on 3 modules configuration

Change over jobs	Required Time (min)				
	Basic Time /Module	Manual	Line change over		Family setup
End previous model production	–	–	–		–
1.Change program	2.0	6.0	2.0		0.0
2.Return nozzles to stocker	1.0	3.0	1.0	One time	1.0
3.Change nozzle stocker (2 pcs)	1.0	3.0	3.0		0.0
4.Setup backup pin (20 pcs)	2.0	6.0	2.0	One time	2.0
5.Change conveyor width	0.5	1.5	0.5		0.5
6.Setup nozzles for next production	1.0	3.0	1.0		1.0
7.Change cart (2 carts/module)	10.0	30.0	30.0		0.0
Total time	17.5	52.5	39.5		4.5
% of reduction	–	0	25%		91%

Automatic change over

OEE is further supported, maximizing time savings and

efficiency, through the additional use of production support systems including such tools as an offline library creation system, offline programming, component/board level traceability, and offline changeover station, all of which simplify programming, operation, and process optimization.

Conclusion

Line balancing capabilities and machine attributes must be favorable towards any efforts to reduce changeover time and thus improve overall OEE in PCB assembly. Automating the changeover process and making the operation more efficient results in higher production time ratios and consequent lower manufacturing costs and higher yields. Line balancing and product Family Setups, combined with Mounter capabilities that include bar code reading capabilities, board warpage compensation, automated board width adjustment and program changes on the fly enhance flexibility and increase profitability through optimized OEE.

#####

Matt Wyglendowski is National Sales Manager for Hitachi High Technologies America's Production Systems Division. Matt has been in the Electronic PCBA industry for 20 years, and brings extensive knowledge and experience in all facets of the industry, including assembly, R&D, packaging and sales, to his position. For the past five years he has been focusing on the SMT placement industry, specifically high speed and flexible equipment with quick change-over capabilities for the North American market.

Contact:
Mobile: 972-998-2699
Direct: 972-615-9103
Email: matt.wyglendowski@hitachi-hta.com.