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Pick-and-Place Feeder density within SMT and Electronics Assembly

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Abstract

With the growth of Surface Mount Technology (SMT) driven by new technological innovations and next generation products, machine feeder density becomes extremely important in electronics manufacturing.

As products become more intelligent, diverse and efficient, the associated product BOM (Bill of Materials) and parts diversity increases in scope. This increase in parts count and diversity per product drives the necessity for higher feeder density per Pick-and-Place (P&P) machine.

This per machine feeder density also becomes critical when constructing and accurately determining the potential SMT production lines to fulfill customer needs without resulting in an excess or 'over capacity' situation. Constructing a SMT production line based on the requirement of feeder input vs. CPH (components per hour) increases the capital equipment cost of the P&P segment of the line. With a larger percentage of the P&P equipment cost associated to CPH rather than the amount of feeder inputs available at the machine level, in essence end users pay more for CPH vs. feeder inputs. With current and future consumer demands for ever increasing product intelligence this creates an under achieving or underutilized capacity production line for manufacturers.

A balance between machine feeder inputs needed for product diversity and CPH to meet customer required volumes is essential for the highest efficiency production lines.

One way to increase the feeder machine density is to utilize the thinnest feeder possible or to combine feeder positions, for example, 2 for 1 or 2 for 3. A disadvantage of a combined feeder input solution is reduced ease of use and flexibility. Utilizing a single input feeder increases ease of use and adds the highest level of flexibility to accommodate the most diverse products now and in the future.

Feeder per machine density can be measured in 2 ways, either by total amount of 8mm inputs per linear meter or total amount of 8mm inputs per m². Of course a higher number results in higher production flexibility to address product diversity without creating an over capacity production line.

In order to keep up with the fast moving consumer products technology and diversity, P&P machine suppliers must increase feeder density in traditional ways or by means of new creative innovations to better serve the end user.

Importance of SMT Pick-and-Place Feeder Density

With the continued growth of SMT driven by new technological innovations and next generation products, machine feeder density becomes extremely important in electronics manufacturing.

As the end products become more intelligent, diverse and efficient, the associated product BOM (Bill of Materials) and parts diversity increases in scope. This increase in parts count and diversity per product drives the necessity for higher feeder density per P&P machine.

Feeder Density per P&P machine

The need for higher feeder density has driven the P&P machine suppliers to design and implement new solutions in tape-and-reel (TnR) feeding technology. Whether this means physically thinner tape feeders or combing lanes within the same working area of the tape feeder, the end result is the same and can be measured with a simple density equation. There are actually two methods in which feeder density can be measured; either by total amount of 8mm inputs per linear meter or total amount of 8mm inputs per m² (machine footprint) – See Figure 1.

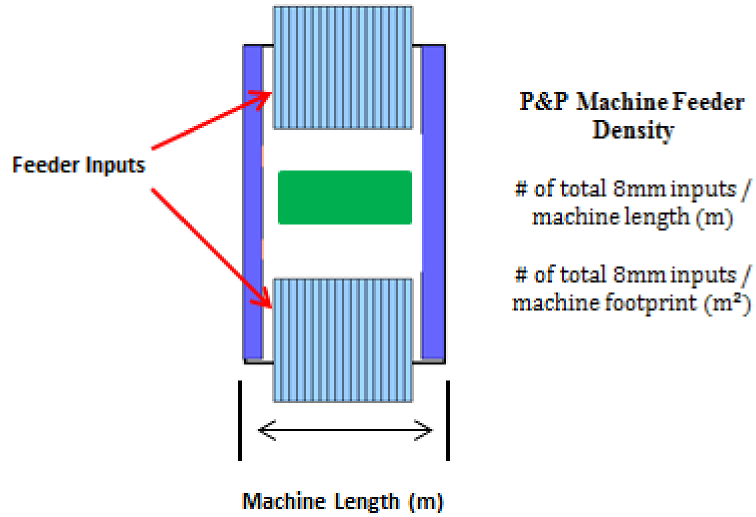


Figure 1 – Feeder Density per P&P machine

Machine line length is important, of course, due to the affect of linear length on the entire production line. Machine footprint (L x W) is equally important when looking at overall real estate available for production lines within a factory.

Higher feeder density P&P machines allow the manufacturer more production flexibility to solve challenges and produce the ever increasing diversity in end products for consumers. Increased feeder density also enables the end users to combine viable products to decrease feeder changeovers and increase valuable machine and production line uptime.
Below are some common P&P machine supplier solutions with associated feeder density calculations – See Table1.
When reviewing Table 1, the higher the value/s equates to a more densely packed and more efficient use of feeder space in relation to machine footprint.

Table 1 – Feeder Density (P&P solutions)

P&P Machine Feeder Density		
	Feeder Density – 8mm inputs / length (m)	Feeder Density – 8mm inputs / footprint (m^2)
Supplier – A	80.0	35.9
Supplier – B	93.7	36.5
Supplier – C	101.5	38.2
Supplier – D	93.4	50.2
Supplier – E	112.8	61.3

When looking at feeder density, there are two options for P&P machine suppliers to help increase this metric; utilize the thinnest tape feeder possible or to combine feeder positions or lanes, for example, 2 for 1 or 3 for 2 – See Figure 2.
A disadvantage of a combined feeder input solution is ease of use and flexibility for the operator. Utilizing a single input feeder greatly increases ease of use and adds the highest level of flexibility in a manufacturing environment.

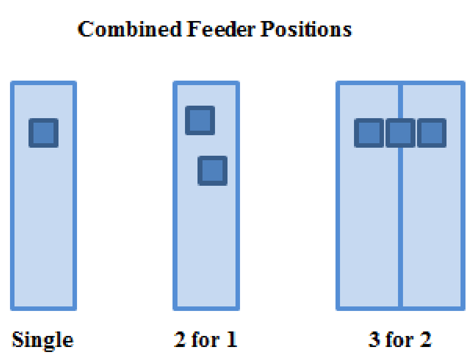


Figure 2 – Combined 8mm Feeder Positions

Another factor to consider when looking at feeder density per P&P machine is the correlation between feeder density and throughput or CPH of the machine – See Table 2. This table utilizes the feeder density data from Table 1 and goes one step further by correlating the feeder density value with machine output in CPH.

Table 2 – Machine Feeder Density / CPH ratio

P&P Machine Feeder Density / CPH				
	Feeder Density – length (m)	Feeder Density – footprint (m^2)	Feeder Density / CPH – length (m), *x* 10^{-5}	Feeder Density / CPH – footprint (m^2), *x* 10^{-5}
Supplier – A	80.0	35.9	83	37
Supplier – B	93.7	36.5	122	47
Supplier – C	101.5	38.2	203	76
Supplier – D	93.4	50.2	115	62
Supplier – E	112.8	61.3	451	245

This ratio could become very important in the future and is similar to a currently very common ratio used in the market that relates cost to output – PO ratio or sales price divided by CPH. This PO ratio is commonly used by manufacturers to help with cost of manufacturing projections when sourcing new equipment. In the future this feeder density ratio could become just as important when making manufacturing decisions.

When reviewing Table 2, the higher the value/s equates to more balanced solution and added flexibility for manufacturers to design and utilize P&P machine solutions to their full capability in terms of throughput or CPH. This is important, as in general, P&P machine pricing is more derived from CPH rather than feeder inputs or feature set.

Feeder Density effect on Expected Machine Utilization

The importance of feeder density per P&P machine leads into other important areas of production line manufacturing. One of these areas is related to machine utilization. Specifically, machine utilization when compared to expected machine throughput or CPH. Manufacturers often use utilization metrics to measure the effectiveness of their P&P machines or in simple terms "did we get what we paid for?" There is now more than ever a growing correlation between per machine feeder density and machine utilization, as now quite often P&P line solutions are being increasingly driven by feeder inputs rather than machine output. This creates a low machine utilization percentage when compared with machine expected output and results in higher initial capital equipment costs for the manufacturers. This added cost eventually finds its way all the way down to the end customer or user as ultimately the cost per placement (CPP) has been increased and inflated.

Table 3 shown below lists estimated product application sample data showing throughput or CPH required based upon product volume requirements and # of feeder inputs required to produce the product. The ratio is then calculated based upon # of feeder inputs required / CPH. This ratio is similar to the Feeder Density / CPH ratio shown in Table 2. This data supports the increased product diversity outlined above and supports the need for higher density feeding solutions within P&P machine solutions.

Table 3 – Product Application Data Set (Feeder slots required / CPH)

Product Application Data			
Product Market Segment	# of Feeder slots req'd	CPH req'd (Volume)	Feeder slots req'd / CPH *x* 10^{-5}
Defense (Topside)	140	55,000	255
Defense (Bottom-side)	250	60,000	417
Consumer (Top + Bot)	255	42,000	607
Defense	190	30,000	633
Industrial	70	30,000	233
Consumer	245	41,000	598
Medical	140	18,000	778
Automotive	80	60,000	133
Consumer	200	38,000	526

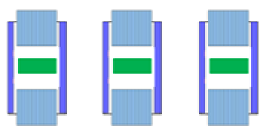
The above data in Table 3 shows the trend towards SMT P&P machines driven by the # of feeder slots required to produce the products as opposed to being driven purely by throughput or CPH. From the data, the higher the feeder slot / CPH ratio equates to products driven by diversity and complexity rather than CPH. The higher the ratio equates to products driven by CPH.

This per machine feeder density also becomes critical when constructing and accurately determining the potential for new SMT production lines to fulfill customer requirements and needs without resulting in an excess or ‘over capacity’ situation. Constructing a SMT production line based on the requirement of feeder input vs. CPH increases the capital equipment cost of the P&P segment of the line. With a larger percentage of the P&P equipment cost associated to CPH rather than the amount of feeder inputs available at the machine level, in essence end users pay more for CPH vs. feeder inputs. This becomes even more important as in most cases the P&P portion of SMT production lines contributes to ~50-60% of the total cost of the line! With current and future consumer demands for ever increasing product intelligence this creates an under achieving or underutilized capacity production line for manufacturers. This metric of utilized capacity is quickly becoming more important when measuring production line capacity vs. utilization to help lower manufacturing cost and specifically cost per placement (CPP) within the P&P portion of the line.

Figure 3 is a typical product application example showing the importance of feeder density and its effect on the P&P segment of the production line. The example shows an over capacity solution for Supplier 1 and a much more balanced solution for Supplier 2. The example shows the clear relationship between P&P machine feeder density and production line utilization capacity vs. expected capacity. A fine balance between machine feeder inputs needed for product diversity and CPH to meet customer required volumes is essential for the highest efficiency production lines.

Product Requirements		
Volume (CPH)	42,000	Application Segment - Consumer
Feeder slots	252	

Supplier 1								
Expected CPH (per machine)	77,000							
Feeder slots (per machine)	120							
# of machines req'd (CPH)	0.55	1						
# of machines req'd (feeder slots)	2.10	3				Total	**over-capacity**	**utilization vs. expected CPH**
			77,000	77,000	77,000	231,000	550%	18%
			120	120	120	360		



Supplier 2							
Expected CPH (per machine)	25,000						
Feeder slots (per machine)	132						
# of machines req'd (CPH)	1.68	2					
# of machines req'd (feeder slots)	1.91	2			Total	**over-capacity**	**utilization vs. expected CPH**
			25,000	25,000	50,000	119%	84%
			132	132	264		

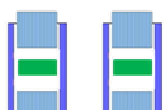


Figure 3 – Product Requirement Example

Conclusion

There is little doubt that consumer products have already and are continuing to become more intelligent, more efficient and more diverse resulting in a need for higher density feeder P&P machine solutions. This increase in product intelligence and diversity remains decoupled from volume requirements. Even if production volumes were to hold steady or decrease the problem of increased feeder capacity and feeder density remains and must be solved to keep up with the ever changing and increasing diversity of products. As shown above there is a unique balance between feeder density and expected CPH within P&P machine solutions that must be accounted for by manufacturers of electronics when designing and equipping new and current manufacturing lines for future product designs and challenges.

In order to keep up with the fast moving consumer products technology and diversity, P&P machine suppliers must increase feeder density in traditional ways or new creative innovations to better serve the end user.