Chip Shooting  
In-Line vs. Rotary

In-Line vs. Rotary
On almost every chip placement machine made today there is one of two types of component handling systems.

With an in-line system the vacuum nozzles are positioned in a row, depending on the manufacturer and machine model, 4, 6, 7 or even 8 nozzles are located on each motion control system. The spacing between the nozzles usually corresponds with the spacing between the feeder locations making gang (or simultaneous) pick-up possible. The machine specifications for throughput or the IPC-9850 numbers that are quoted usually represent the machine running in a simultaneous pick and place mode. Component compensation is done either on-the-fly using laser or by vision processing.

The optimum function of the in-line design is realized when assembling multi-up panels or panels with high numbers of resistors and capacitors. Multi-up panels are more likely to allow repeat hits on the same feeder. When lined up in the correct order, this can increase the opportunities for the gang pick-up function and allow the machine to perform at its maximum efficiency.

There are also some limitations to the in-line design concept. As the number of nozzles on the placement head increases, the opportunities for gang pick-up decreases. This is because the number of placements required from each feeder is rarely consistent causing the robot to pick some of the components, shift to a different location and then pick the rest, or make multiple trips to and from the feeder supply table to the board and back again. Subsequently, the X Y component placement location on the board may not optimize with the feeder positions in that cycle; this can force excessive motion by the placement head and increasing total cycle time of the panel.

The size of the nozzle in each holder also affects the ability of the placement head to correctly match the feeder set-up with the tool set when utilizing the gang pick function.
Nozzle Restrictions and Limitations
Another limitation of the in-line concept is it can either increase the overall machine length or restrict access of some nozzle positions to some feeder locations creating programming challenges.

Example:

Any nozzle can access any feeder, but machine size increases

This is caused by the over travel required to get the inside nozzle over the outside feeder, the amount of additional travel required is determined by the number of nozzles and the distance between them.

Restricted access of some nozzles to specific feeder positions

To avoid additional equipment length and reduce the length of drive systems and linear guides, restrictions are enforced on the ability to program the machine.

Non-Simultaneous Pick-up

To avoid conflicts and increase the opportunities for gang pick, the machine software will often suggest adding additional feeders of the same part number to maximize the gang pick opportunities, but this requires:

- Additional component reels (that you may not have especially if you are in a high mix low volume production environment) If your only building a couple of dozen boards, you most likely don’t have 4 or 5 reels of any one part number. This also causes inventory issues as the parts are allocated to the production floor.
• Additional feeders (that you may not have because you setting up another job and they are needed there, in addition, having many additional feeders on the production floor is expensive)

• Additional feeder slots (that you may not have because the current job uses most of the available feeder positions on the machine)

• Additional time to set-up and dismantle these additional feeders and reels.

Pick-up Offsets
Smaller components like 0201’s and 01005’s often require pick-up position off-sets to insure stable pick-up and high pick-up rate before recovery. Picking components one-by-one with an “X” and “Y” shift between pick-ups slows the machine down effecting overall output.
When tooling for a wide range of component types, the number of nozzles and total efficiency can be significantly reduced.

In-line systems are usually designed with the center-to-center pitch representing the pitch of an 8mm feeder. When the machine is configured to place larger components, often two or three pick-up positions are lost to the larger sized part. This either reduces the number of nozzles remaining for chip shooting and slows the placement speed, or requires the machine stop placing for a nozzle change sequence. Nozzle changes generally take 2-3 seconds for each discard and each pick-up of a new tool.

Rotary Head Concept

Using a rotary Pick & Place design, depending on make and model, there are 4, 6, 12, 16, 20 or even 30 nozzles available on a single rotary head to handle components on each cycle as opposed to the 4, 6, 7 or 8 in the in-line systems.

- Since the rotary system picks parts one-by-one, there are no restrictions on feeder locations. The pick-up point on the head always remains the same.
- Every nozzle holder can access every feeder position.
- Additional feeder locations are not required to optimize the set-up.
• Over shoot is not required for feeder access so machine footprint can be minimized.
• Additional feeders are not required to achieve specified speed.
• The rotary head can pick many parts from the same feeder or one part from numerous feeders with negligible increase in cycle time.
• Component pick-up offsets for 0201 and 01005 components does not add any additional cycle time.

In a 25 year history of surface mount assembly, Fuji has utilized numerous in-line and rotary systems on many different equipment designs. As a flexible placer, where speed is not an issue, an in-line system performs fairly well despite its limitations; however, for the placement of small chip components the rotary system generally out performs. The rotary design is very low maintenance, experiences less opportunities for de-ration from specified speed, eliminates feeder location restrictions and can make on-the-fly pick-up offsets when placing small components including 0201 and 01005 size parts. The mini rotary placement head is an exceptionally efficient use of mechanical mechanism that simplifies motion and reduces the number of systems that must interact with the tool. After decades of experience as a leader in the SMT assembly business, Fuji feels the rotary head is the best technology currently available in the market today for chip component placement.

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