CR Tech, LLC **1640 Spruce St.** **CRabas@AOL.com**
Grafton, WI 53024 **414-899-7590**

The Vision Advantage

Many processes use vision to aid their precision and provide the same capabilities as a human operator to compensate for the real world. Surface Mount Pick and Place machines transferred from mechanical centering of the components on the pickup to vision position detection and corresponding mechanical offset to compensate for mis-alignment 5 to 10 years ago. I believe all systems would claim vision alignment today. However, systems vary considerably in capability and many do not take full advantage of the potentials once a commitment to vision is made.

The basic concept is to pick the component with an appropriate vacuum nozzle and move the nozzle with component over a camera looking up at the nozzle to determine whether the component is centered on the nozzle. The displacement in centroid is transmitted to the pickup drive motors and the placement location of the nozzle is offset so the component not the nozzle is centered on the desired location on the board.

The first camera systems were very expensive, slow to capture a device, and slow to calculate the features of the component and find the centroid. The need was to determine all the information before the machine tried to place the component. The potential for delayed placement was huge and was the major limitation of the early systems. At first the vision was only used on IC components were speed was knowingly sacrificed and chip components were still mechanically centered by their body not their leads or pads.

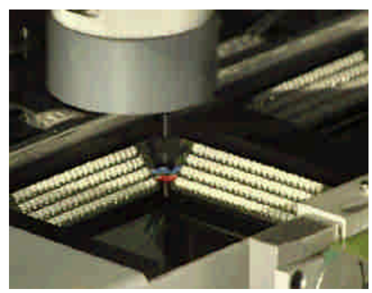

Fig 1 Bottom camera w lighting

Currently, the vision system can take pictures on the fly as the nozzle moved from the pickup location to the placement location (the camera is along the normal path from pickup to placement) and all information down to the desired offset is supplied at sufficient speed that it does not slow the placement speed. As the computers, cameras and associated technology improved, the potential for the vision increased and today the cameras provide multiple functions and data without slowing the placement motions. This paper discusses those capabilities to make sure you are aware of these other potentials for vision and their benefits.

The most obvious additional capability is inspection of the components being picked up by the same camera. If a camera is to look at the bottom of the part, it should be able to align the part based upon the leads or pads of the part not by the body of the package. The existing lead pattern is the basis of the centroid calculation. The placement location of the board is based upon the programmed location of the part centroid, which is matched to the vision system's centroid of the component pads. Some new systems even accept offset data from separate vision systems (post printing but pre-placement) that give the centroid of the solder print rather than the pads on all sites of the board. There is data supporting better joint reliability by using centering on solder print if the print-pad alignment is limited to less than 1/3 off the pads.

As long as you can see the leads or balls on a BGA, why not inspect them for defects? Good vision systems also offer this capability. With the large range of component sizes, cameras with several magnifications are desired to have sufficient resolution to see small flip chips and large QFP and BGA packages in the same system. Rather than different cameras and inspection locations with associated loss of speed, our camera has several lenses that are computer selected based upon the component library information on component size. Just like the automatic nozzle change that matches the nozzle to the component, the lenses are also selected to match the size of the component just as fast. Now the camera has full screen resolution or field of view of both small and large components. It can check that all the balls are present before placement. It can check lead contact area in the expected correct location including the tips of column grid arrays. In summary, the components are placed per their leads pads or balls. Defective leads or balls reject the component so only good parts are placed. Now this is done on the fly as the part is moved from pickup to placement. The camera image is made possible by 4 sided, multi-angle, adjustable intensity

CR Tech, LLC **1640 Spruce St.** **CRabas@AOL.com**
Grafton, WI 53024 **414-899-7590**

and strobed LED lighting. The lighting information is programmed for each component and recalled from the component library based upon the component to be picked.

What else can we add to these features? When the required adjustment exceeds a small percentage of the part size, the system signals the computer that a pickup adjustment is required. Now a second camera mounted on each pickup head develops a second use. Originally added for checking board placement fiducials, this look down camera also is part of the component pickup alignment system. The 0201 components represent a pickup challenge since the nozzle is the same size as the component. Since vacuum sensing on small components is so tentative, the vision system confirms the pickup and alignment. If the vision systems detects too large an offset or several missing components, the machine can either look for another feeder position with the same parts, be programmed to build short for correction at the end of cycle, or can stop for a realignment. Current machine capability includes video alignment where the top camera shows the centroid of the nozzle crosshair and a camera view of the pickup location with a live image of the component in the pocket of the tape (or feeder or tray). The operator adjusts the position of the component in the view digitally from the touch screen, which reprograms the pickup location to the center of the component. The latest Trilogent feeders even offer micro-stepping feeders that can compensate for the variability in tape pitch so even though it delays the placement operation, it allows the machine to make good boards from defective tape reels. This ability to adjust the machine without needing a mechanical screwdriver adjustment is a real advancement in the technology.

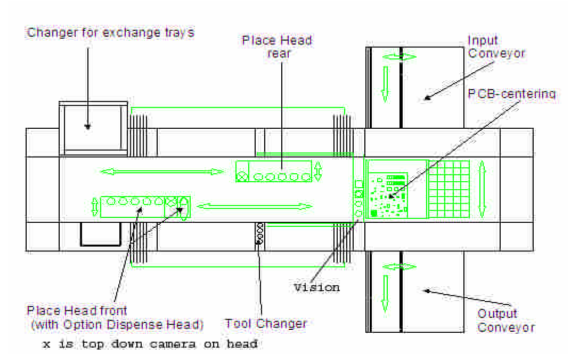

Fig 2 Machine layout - vision

This video alignment is also applied to the machine calibration so the entire machine alignment is video and computer controlled. The system allows for alignment of the tape to the feeder, the feeder to the slot and the slot to the rest of the machine. Because of this cross calibration, the feeders can be placed in any feeder slot with the calibration transferring with the feeder when recognized in a new location. Nozzles are calibrated with the cameras and boards are calibrated to the transport. Normally the system only looks for board fiducials when a new board is loaded. This global offset is applied to all the board placements. However, some boards don't match the expected design from CAD (trace swim on board lamination for instance) and again, maybe the solder paste is not exactly on the pads. For critical alignment, the top down viewing camera can make local adjustments. The goal is to place critical components so they will have the maximum probability of 100% reliability rather than a minimal connection that will pass electrical but later fail of life stressing.

Where some might criticize the time lost in stopping for recalibration and additional vision adjustment for board defects, the industry is learning that making junk at high speed is not a useful goal. The cost of repair is considerable and often does not represent the same quality level as a machine assembled board. Vision allows adjustment to maximize reliability from not perfect boards and components. The final reality is that prototypes cannot be made by hand relying on operator skill to compensate for imperfect components and boards. The intelligent placement system can make a single prototype accurately and discover and document the problems encountered in making the prototype so these problems can be addressed before production. Of equal value, the sample will truly represent the production run for performance both electrically and mechanically.

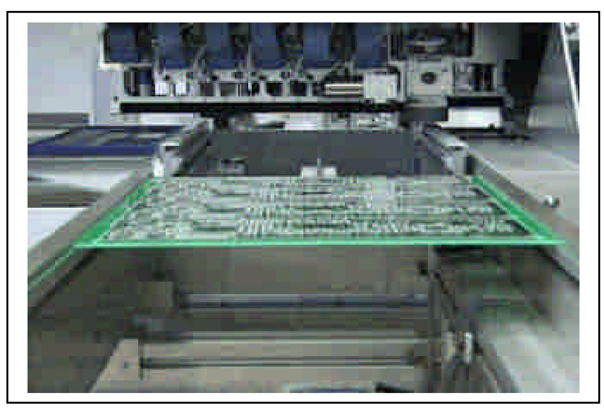

Fig 3 Head w 5 nozzles and camera

This is a good time to mention that all the data discovered in the calibration and offset correction is stored in the machine computer file. It is available for network download for future reference for offline analysis and system programming as well as for later board repair and updating.

CR Tech, LLC
1640 Spruce St. Grafton, WI 53024
CRabas@AOL.com 414-899-7590

The vision capability also allows for large odd form components such as connectors. The system takes multiple images. They are knit into a large image for objects beyond the 2.5” field of view. Optional servo grippers can then place this oversize component based upon its lead pattern to the pattern or holes in the board. The vision capability allows the system to place bare semiconductor die for Chip-On-Board and the vision capability can control the optional positive displacement dispenser on one of the pickup heads. The system then has the capability to repair solder prints with solderpaste and dispense adhesive for die bond or under fill. The vision system can find die edges and allow the dispenser needle to follow a path 0.001” from the die edge. The components can be dipped into flux or adhesive. The dispenser then can be used to apply under fill or to encapsulate the component. The vision capability converts the basic surface mount pick and place system into a multi-capability platform for odd form placement, die bonding and the ability to handle hybrid substrates, flex substrate and place components into packages. Along with Z position sensing for programmable placement force and crash-less nozzles, the vision system extends the capability to full featured, optimized assembly for the new electronics market.

Fig 4 PD Dispenser w height sensing

The complete use of the vision capabilities offers a very flexible system, easily calibrated and capable of optimizing the board performance in a real world. The operator can adjust the machine digitally based upon information from the vision system. When you look for pick and place capability, make sure to check that the system uses the full capabilities of vision to give you an advantage in the marketplace.

All of the systems capability described above exist on the current Mimot Advantage placement systems.