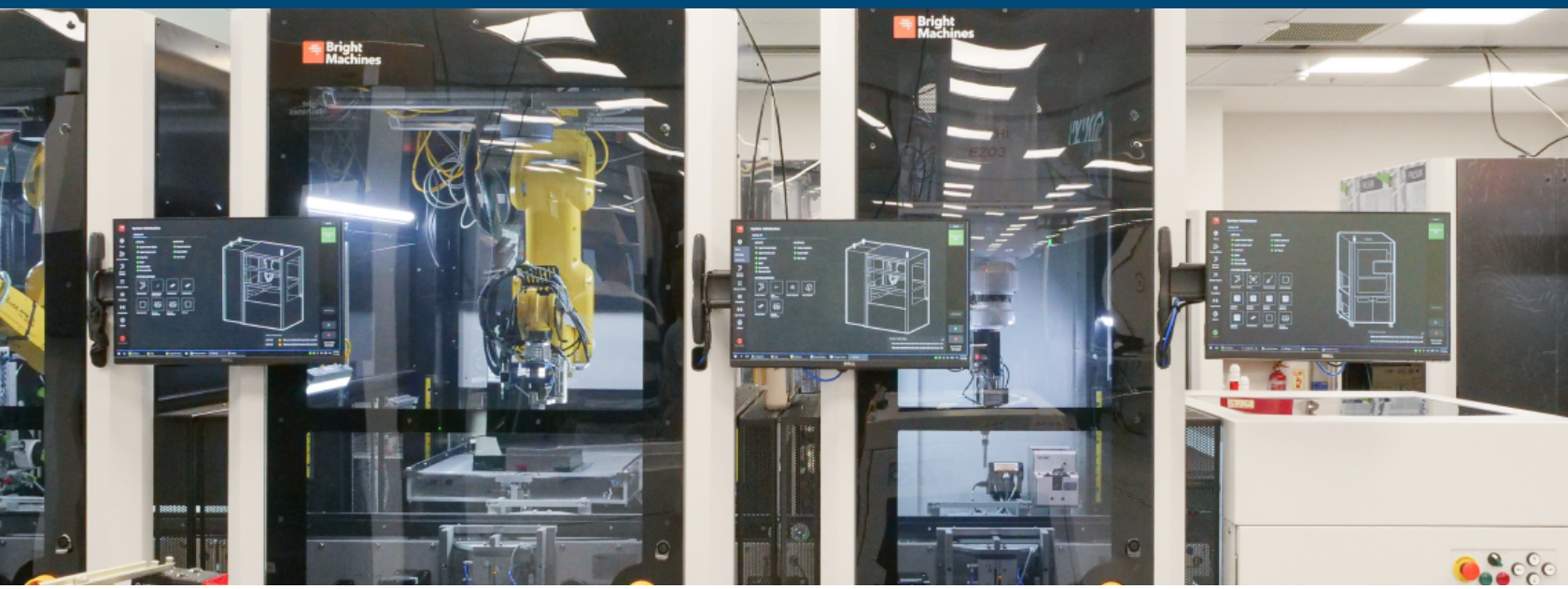
Bright Machines



Strategically Addressing Factory Effectiveness

White Paper

Many factories still rely heavily on human labor to perform product assembly. Such factories are vulnerable to disruptions when unexpected events occur such as trade policy changes, extreme weather, terrorist activities, and disease. These disruptions can compromise the ability of the factory to build enough products to meet customer orders.

Although extraordinary disruptions have a significant impact, the ability of a factory to fulfill customer orders is also greatly affected by everyday "normal" activities. Factory effectiveness is a function of the availability, performance, and quality of operations. In this paper, labor effectiveness will be compared to equipment effectiveness within the context of a case study involving a large electronics equipment manufacturer.

60%
Overall Labor Effectiveness (OLE)

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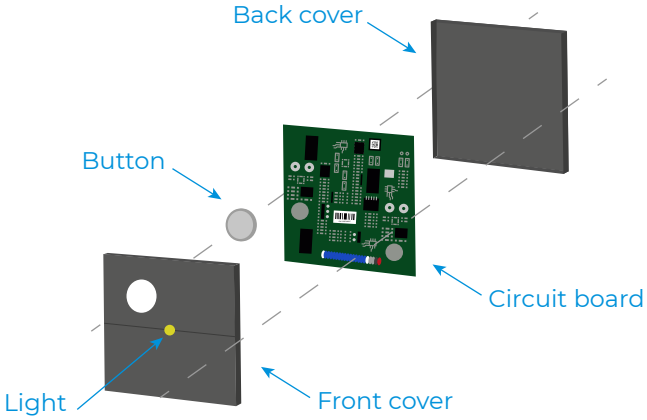
85%
Overall Equipment Effectiveness (OEE)

Effectiveness = Availability **x** Performance **x** Quality

Case study

Cost is an important consideration in the market for home sprinkler systems typically sold by home improvement centers and local hardware stores. Nowadays, these smart systems contain a central controller which responds to real-time conditions and prescribes an intelligent watering schedule.

The controller consists of plastic covers around a circuit board, a button for providing input, and a light with various colors to signal output. The assembly process involves pick and place operations to join the components and running a suite of tests to ensure proper functionality. The manufacturer in this case was assembling 360,000 controllers on an annual basis. The assembly line was setup in their Mexico factory and required nine human operators.

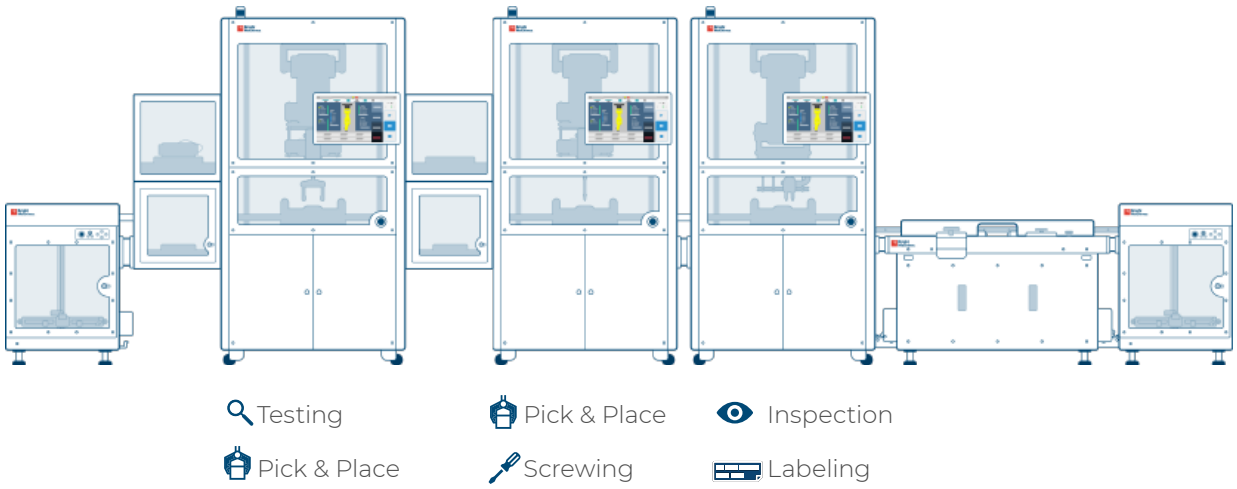


OLE metrics	Potential drag on OLE
Availability	Underutilized employees
	Absenteeism
Performance	Incomplete work instructions
	Insufficient training
Quality	Improper use of tools
	Employee turnover

With their existing line, the manufacturer was running two, eight-hour shifts, six days a week and using extra shifts as needed during peak summer season when demand spiked. The main challenge they faced was a low OLE (Overall Labor Effectiveness) which was about 60%. This was driven by a variety of factors including underutilized employees, absenteeism, incomplete work instructions, insufficient training, improper use of tools, and employee turnover all of which are challenges that any factory faces.

Automated assembly

The manufacturer was looking for options to improve factory effectiveness and become more competitive in terms of product cost and product quality. Bright Machines used their software platform, Brightware™, to configure an assembly line which automated the box build and functional testing operations. With the new line, there were two human operators at the end of the line for final packing and one part time human operator doing material replenishment. Since the original line required nine human operators, this represented a 72% decrease in required staffing.



The automated assembly line involved three configurable robotic cells. The first cell was configured for functional testing. Circuit boards were fed into the cell using a circuit board feeder and a robotic arm picked and placed each of the circuit boards into an automated test fixture where a suite of functional tests were performed. It took 150 seconds to perform all the testing, and this was the bottleneck in the line. Therefore, three test fixtures were used so the the testing cycle time could be reduced to 50 seconds. In the second cell, the plastic covers and control button were fed into the cell and the robotic arm was programmed to perform the component assembly and to fasten the unit together using screws. The third cell was configured for final inspection, testing to make sure the control button and output light worked correctly. For passing units, a label was printed with the unit's serial number and MAC address on it and then the label was affixed to the unit and the unit was sent to the operator.

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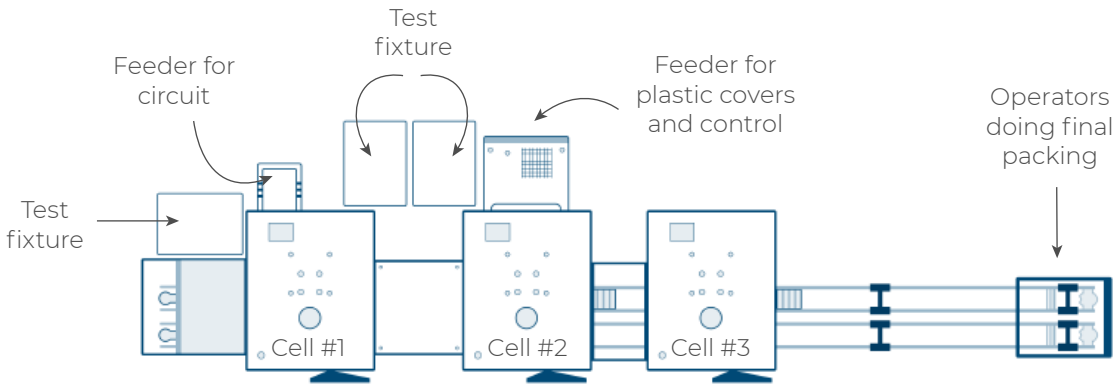
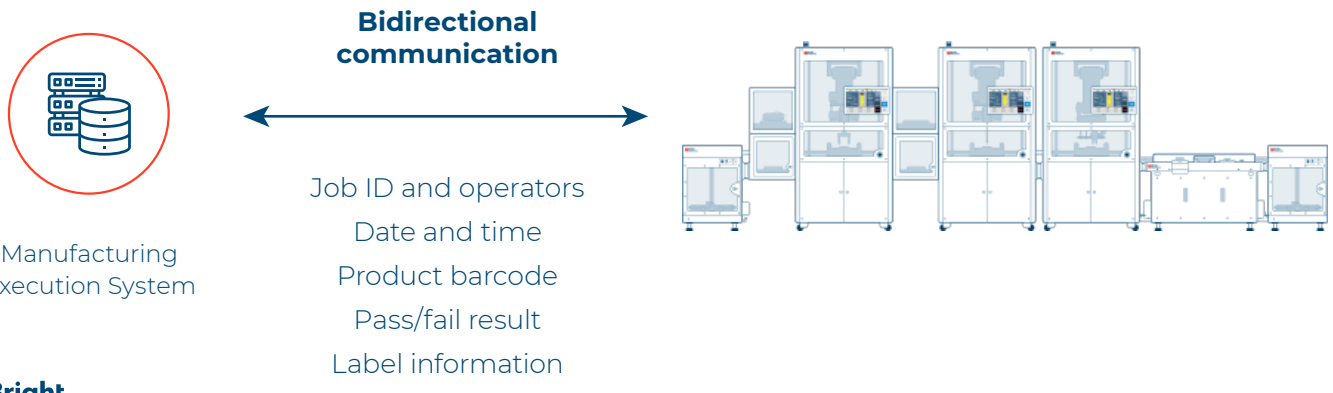


Factory integration

There is a touch screen interface on each of the three robotic cells. Operators can use the interface to control jobs and to monitor the progress of them. From a single view, operators can see the status of the circuit board feeder, each of the three test fixtures, and the result of the final inspection of the control button and light.

The automated line is also connected to the factory's Manufacturing Execution System (MES). In the second cell, the results of the screwdriving operation can be sent to the MES. Specifically, the job ID, timecode, product barcode, operator IDs, and screwdriving result is sent using bidirectional communication. The third cell also communicates with the MES. This time sending the name of the inspection test performed, the test program used, and the pass/fail result. For units that passed, the MES sends the serial number and MAC address which is then printed onto a label and affixed to the passing unit. This enables tight control over the printed labels as well as overall process traceability.



Improved effectiveness

With the existing line of nine human operators, the manufacturer was experiencing 60% overall labor effectiveness due to several factors which affected availability, performance, and quality. By bringing in a new automated line, they were able to reduce staff required by 72% which provided a significant annual cost savings. And the new automated line had better availability, performance, and quality which resulted in an overall equipment effectiveness of 85%.

Manual assembly	Automated assembly	
60% OLE	85% OEE	85% OEE
35s cycle time	50s cycle time	35s cycle time
360k volume per year	360k volume per year	510k volume per year

The improved effectiveness meant they could slow the line down and still achieve the annual volume required. With the existing line, the human operators working at 60% OLE needed to achieve a cycle time of 35 seconds in order to build an annual volume of 360,000 units. With the improved 85% OEE, the new line only needed a cycle time of 50 seconds in order to achieve the same 360,000 units per year. With a slower line speed, less skilled operators with less training could be used for the final packing because they had more time to complete the task. There are many benefits of automated assembly which enable factories which use it to improve their overall factory effectiveness.