



Project at Motorola

How Many Cellular Phones Can I Make?

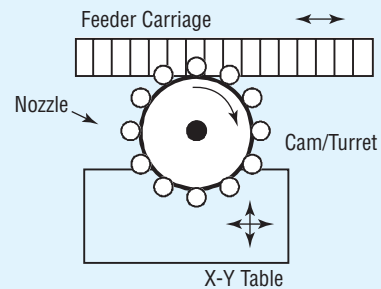
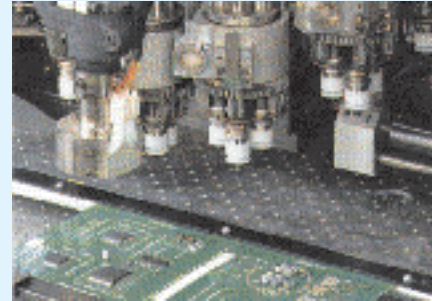
Motorola uses several types of specialized robots to assemble electronic products accurately and quickly. The picture and figure on page 144 depict the operation of a turret-type machine for assembling surface mount technology (SMT) printed wiring boards. Resistors, capacitors, and other parts are picked from the feeder carriage by one of the vacuum nozzles on the rotating turret. The X - Y table, which holds a panel containing one or more boards, moves to the placement location for a given part, while the turret advances one position. The average time to pick and place one part is called the *tact time*, for example, 0.1 second per part. The actual throughput, measured in boards per hour or in placements per hour (PPH), depends on a number of factors, including the number and variety of parts on the panel, the time to load and unload a panel in the machine, and the time to visually inspect fiducial marks and calibrate the position of the panel with respect to the coordinate system of the machine.

Throughput T can be estimated with the following equation, where n is the number of boards per panel, p is the number of parts per board, C is the tact time, L is the load-unload time, and M is the mark reading time.

$$T = \frac{n}{Cnp + L + M} \quad (1)$$

1. Find an equation that relates throughput, T , with the number of parts per board, p , if there are 3 boards per panel, the load-unload time is 5 seconds, the mark reading is 1 second, and the tact time is 0.2 seconds.
2. For the equation found in Problem 1, determine the number of parts per board, p , if throughput T is to be 360 boards per hour (0.1 board per second).

3. For the equation found in Problem 1, determine the number of parts per board, p , if throughput T is to be 540 boards per hour (0.15 board per second).



In Problems 4–6, use equation (1).

[Hint: Solve (1) for C first].

4. Determine the tact time, C , if the throughput is 216 boards per hour (0.06 board per second), there are 3 boards per panel, 100 parts per board, the mark reading is 1 second, and the load-unload time is 5 seconds.
5. Determine the tact time, C , if the throughput is 216 boards per hour (0.06 board per second), there are 3 boards per panel, 150 parts per board, the mark reading is 1 second, and the load-unload time is 5 seconds.
6. Determine the tact time, C , if the throughput is 216 boards per hour (0.06 board per second), there are 3 boards per panel, 200 parts per board, the mark reading is 1 second, and the load-unload time is 5 seconds.
7. Based on the results of Problems 4–6, as the number of parts per board increases, what happens to tact time if all other factors remain constant?