

One of the greatest areas of interest in pharmacy automation is pill counting and the forms of automation that have grown around it, probably because it is both time consuming and drudgery. The devices range from single pill counting stations to 200 cell robotics centers that begin with unlabeled vials and end with finished scripts. The price range for these devices is spectacular, starting at about \$2000 for a single station at the low end, to over \$250,000 at the high end.

Let's talk about the functions these devices perform and what they likely mean to the users. Let's use the functions that are performed by the fully automated robotic center as they cover the process.

First comes selecting an appropriate vial for the prescription. It is doubtful that many users have problems in this area, and questionable whether time is lost or gained by adding the task of filling canisters with vials, and limiting selection to two or three choices. The large machines do it because it is part of the overall automation process even though it replaces one manual operation with another..

Second is the process of labeling. This involves printing the label that goes on the vial, and then placing it on the vial. Again, it is doubtful that many users have problems in this area. There may or may not be some time saving here depending upon how complicated the process of loading the labeling supplies into the robot is, compared to doing it on a countertop. Again, the large machines do it because it is part of the overall automation process.

Third is the process of counting the pills for a script. This is the area where the pharmacy hopes to save enough time to justify the capital expenditure. They additionally hope to eliminate the drudge of manual counting and improve their customer service. The largest robotic units have about 200 pill counting cells arranged in an X-Y matrix. Several are sold in scaled-down versions that have about 100 cells. The cells are all identical, but are usually manually adapted for the single drug that they will dispense. Each cell carries a bar code label that usually contains the NDC code of the drug it will dispense. This is very important for verifying both dispensing and filling operations.

Each cell has a pill reservoir of equal volume. Therefore, the pill quantity it can hold depends upon the size and volume of the pill it dispenses. Each cell dispenses its pills directly into the customers vial, thereby eliminating any possibility of cross contamination. This is in stark contrast to some of the individual pill counters that use hoppers or rotating tables to deliver the pills for counting, and, therefore, are cross contaminators that require frequent cleaning.

At least one supplier has an additional reservoir at the output end of the cell, which allows the pills for one script to be stored. This allows multiple cells to count in parallel (at the same time). However, the robot can only pick up the scripts in serial order (one vial at a time), which substantially negates the value of the feature.

Each cell has to be filled manually from a supply bottle. Each filling is verified by scanning the

label on the cell and the label on the supply bottle for comparison. Some cells can be filled while in position, others require that they be removed from their position when filling. If cell capacity permits a whole supply bottle, or several, can be loaded at one time, which reduces supply bottle handling.

Fourth is the truly robotic process of moving the labeled vial to the proper cell to pick up the counted pills, and then deliver them to the output conveyor. The robotics usually involves two motor driven lead screws, which move a claw that carries the vial. The electronic system controller has mapped the individual cell locations and delivers the drive instructions to the XY motors, usually stepping motors, in order to position the customers vial under the proper cell. Several suppliers sell smaller versions of these larger machines where the robot is replaced by a human. These machines have no vial handling or labeling capability, and a human must position the vial under the proper cell to receive the pills which are counted out.

Fifth is the output conveyor. The customers vial can be shunted into one of multiple lanes, where it waits for the pharmacist to perform the final inspection verifying that the proper drug has been delivered in the customers vial, and then cap the vial. This job has to be done in any event, so no time saving here.

Okay, so how much time did we save, and where did we save it. As previously pointed out, vial handling and labeling are not problematic, nor time consuming. Not much savings to be had in the first two processes.

The pill counting process, on the other hand, can be both a drudge and time-consuming. Let's use the lowest cost form of automation, pill counting by weight, which is non-cross contaminating, as our standard for pill counting time per script. The new Torbal DRX-5SX System, which uses a small dedicated server to store a central database of average piece weights, claims to have reduced typical script counting times to 22 seconds per script. This includes scanning the script label, scanning the supply bottle (verification), placing the customers vial on the weighing pan, taring (zeroing out) the vial weight, and counting out the proper number of pills. The central database concept, along with a new average piece weight updating algorithm, has improved accuracy, eliminated all manual pill counting, and reduced the overhead for updating to a small fraction of a second per script. Since the robot does all of this work we save 22 seconds of human time per script. Well, not quite, a human has to fill the cells from supply bottles. This should be a small time on a per script basis, for instance if it takes 30 seconds to fill a cell but that filling produces 15 scripts, then the average time per script is 2 seconds. Let's add 3 seconds per script for labeling, which the scale does not do.

If we take 25 seconds per script (22+3) as our savings, then we save 2500 seconds, or 41.6 minutes, or 0.7 hours per 100 scripts. If our pharmacy does 500 scripts per day we save 208 minutes, or 3.5 hours, per day.

If our robotic system costs \$200,000 and we place the present value of money at 5%, then we have to reduce our calculated savings by \$10,000 per year. Let's place the cost of burdened pharmacy labor at \$60,000 a year. A typical work year, net of vacation, holidays, and sick days is about 48 weeks x 40 hours per week = 1920 hours. Cost of labor then is \$60,000/1920 hours

= \$31.25 per hour. Our savings then at 0.7 hours / 100 scripts is $0.7 \text{ hours} \times \$31.25 \text{ per hour} = \$21.87 \text{ per 100 scripts/day}$.

Let's try to recoup our capital investment in one year. Assume our pharmacy operates 360 days per year. Then we need to recoup \$200,000 divided by 360 days equals \$556 per day. This means we need \$556/day divided by \$21.87 / 100 scripts = $25.42 \times 100 = 2,542$ scripts per day in volume, done by the robotic machine. The machine may do 200 drugs but that only represent between one half and two thirds of the overall volume, so we may be talking about a 5,000 script per day pharmacy. Sounds like a large hospital pharmacy. In addition, you would need another 126 scripts per day to cover the present value of money ($\$10,000 / 360 \text{ days} = \$27.7 / \text{day}$, $\$27.7 / \$21.9 = 1.26 \times 100$ scripts).

Be careful if you try to extrapolate to the smaller machines, where the robot is replaced by a human. The vial and labeling operations are not included so no time savings there. The pill counting time is probably longer than 25 seconds if the human has to hold the vial under the cell while the counting is done, this after scanning the vial at the control station to identify the proper cell to unload, and walking to the cell bank. If this script has been pre-counted and stored in an output reservoir there may well be a net time saving. However, there are unanswered questions, such as, when and how did the labeled vial get into the user's hand? Is another user waiting while this user gets pills (only one user at a time because the machine identifies the cell to be unloaded with a LED)?

In addition, there is something called system maintenance that has to be considered in the robotic machines. Malfunctions add another whole dimension if they occur in the form of jammed cells. This could require that the cell be returned to the manufacturer for repair. Spare cells seem to be an obvious answer. Remember, these cells wouldn't need individual adjustment if they didn't have jamming or counting problems. They also cannot count all drugs. Some of the suppliers of robotic machines claim that they do 50% to 65% of total scripts for a pharmacy with a 200 cell machine. A dead robot could be a real disaster unless there is a backup plan.

What about the rest of the formulary not done by robotics. Innovation offers counting pills by weight as the solution because presently all pills can be counted by weight, which is not true of electro mechanical counters, and counted quickly and accurately.

Some of the raps on counting pills by weight are; the need to manually count out the sample of pills required for establishing the average piece weight (APW) of a drug (especially if this is just added non-productive work), the need to have a database of these APW's (or else do this for every script), the need to periodically update the database of APWs (if accuracy of count is to be maintained), and the need for a human to pour the pills. The Fulcrum (Torbal) scale group seems to have solved all these problems, except for the need for the human to pour the pills. They added a small central server to do it, but it seems to be well worth the added cost. They have eliminated all manual counting, and reduced the APW overhead time to a small fraction of a second on a per script basis. They arrange scales in a network (LAN or wireless) that shares the common APW database, and the user communicates with and controls the server by the use of a standard browser (such as Internet Explorer or Mozilla's Firefox) mounted on a PC.

This technique is cross contamination free, as the pills go directly from the supply bottle to the customers (patients) vial and works for all pills..

Some of the raps on electro mechanical pill counters are; they can be very bad sources of cross contamination if pills make contact with common parts (like hoppers, chutes, drawers, platters, etc.) which requires that they be cleaned frequently and which can be a complicated and time consuming process, the need to exclude some drugs because of their optical qualities or their shapes, and, in some cases, and the need for a database of sizes and shapes for drugs. On some units the risk of cross contamination is so high and so obvious it is hard to believe that pharmacies are willing to risk their patients well being and the pharmacy's assets by using them. They do eliminate manual counting, are probably more accurate than manual counting, and may well save enough time to justify their price (but that depends upon how often they are cleaned). It is hard to evaluate these units based upon published information.