



## Robotics Takes on the Life Sciences

**Thanks to six major industry trends, robotic analytical testers are increasingly smaller, faster, simpler and more modular in design.**

Mike Szeszterniak, Industry Market Manager—Life Sciences, Parker Hannifin



*This miniature stepper drive from Parker measures 1" x 1" x 3", runs on 24 VDC and is powerful enough to run a NEMA 17 stepper motor.*

Life sciences is one industry that is currently undergoing a turbulent development environment. Major advancements such as next-generation DNA sequencing and molecular imaging are expected to drive growth in categories such as immunochemistry and genetic testing. Add to this that changes in government regulations and market conditions are forcing life science OEMs to build their products using faster, smaller more modular technologies. Six major industry trends have arisen from this dynamic environment. These trends are shaping the design and manufacture of automated robotic devices for the life sciences.

### **Trending in Robotic Analytical Testers**

The first trend is that lab instruments have smaller footprints. As laboratories become smaller and more efficient, their floor and bench top space has become more valuable and they need smaller instruments that will fit in these smaller spaces. This need has had a ripple effect in industry, forcing companies that supply OEM life science manufacturers to provide increasingly smaller components. Parker, for instance, offers robotic components such as miniature stages and drives and mini servo motors. These electromechanical components often work hand in hand with fluidics, so the company offers micro valves and pumps as well.

Changes are also ongoing with suppliers like Parker that build custom engineered systems such as those for digital pathology which, for instance, require a velocity following error of less than 0.5 micron. A

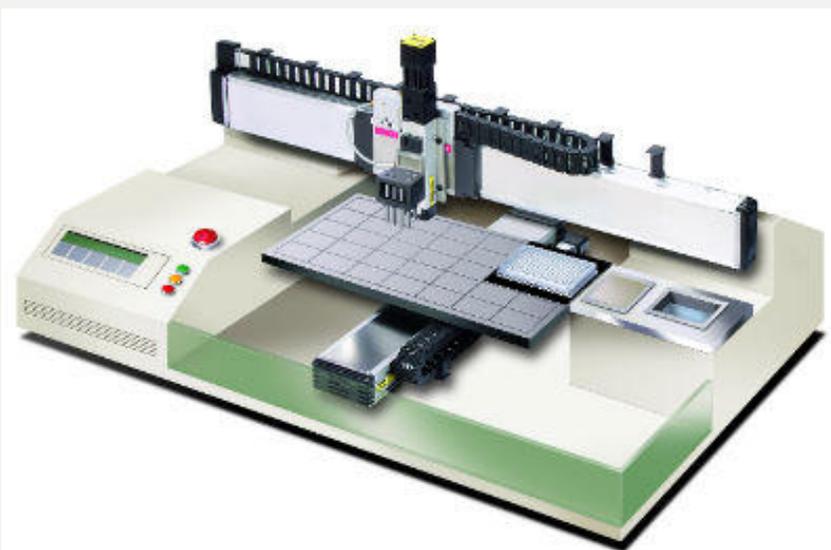
smaller instrument can be had by placing fluidics components that support robotics as close to the samples as possible. In the past, pumps and valves would go in the rear or bottom of the instrument and then plumb up to a dispensing device, typically a probe that automated the delivery of fluid into a well plate. Today, fluidic components are small enough to sit directly on top of the probe.



*These high-precision miniature linear stages measure just 25 mm high and 80 mm wide. This series is available with multiple drive trains (linear motor, ball screw, lead screw, and micrometer) allowing the user to match the stage's performance to the applications requirements.*

Trend two, which is analytical equipment has higher throughputs, springs from basic economics. Faster moving samples means lower cost per sample, so the chase is on for speed. One way OEMs are increasing throughput is with motion systems comprising miniaturized stages, for instance actuators and highly dynamic linear motors that can accelerate, decelerate and settle very quickly so the next operation in the robotic system can happen faster. Parker designs stages around specific linear motion drive trains to meet an OEM's desired footprint and application specs. The systems also feature a shorter sample move distance, which helps boost throughput.

In the world of diagnostics, reducing “carryover” in an automated on-line analyzer also helps up throughput. Carryover occurs in these systems when a portion of a sample left in the valve contaminates the next liquid running through it. The more chance there is for contamination, the more a wash cycle is necessary, which slows throughput. Newer valve designs have cut down on carryover, thereby boosting system speed. For instance, a shear valve that closes off the fluid path between the samples or the reagents results in limited carryover.

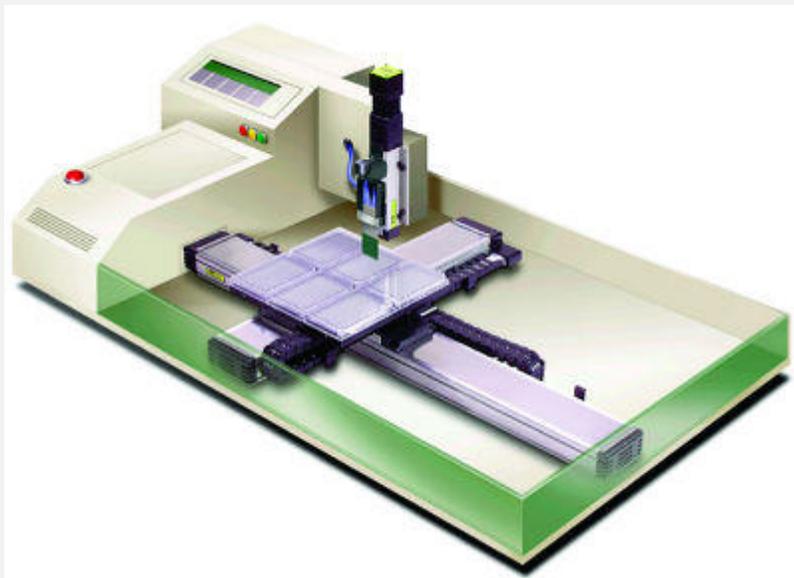


*Microarray analysis permits scientists to detect and analyze thousands of genes in an array simultaneously. Microarray spotting demands high speed and precise positioning to achieve array density and production throughput requirements.*

The third trend is that analytical devices need smaller sample and reagent volumes. Smaller volumes are possible thanks to robotic components that make automated analyzers more precise. For example, miniature positioners can automate the exact placement of samples in microwell plates, flat plates with multiple "wells" used as small test tubes. In addition, automated analyzers can use valves that handle higher pressures, thereby requiring smaller sample and reagent volumes. This helps cut a lab's costs. Typical pressure here are 30 psi, but this should soon jump to 50 to 80 psi as piezo devices increasingly replace solenoid coils in actuators. Piezo devices provide significantly more force than solenoids, allowing higher pressure flows and higher throughput.

Trend four is an increase in demand for modular and multipurpose instruments. These are attractive to end users because they let labs start out small and add modules when they need additional testing capacity. In general, a typical system comprises sample, reagent, washing, cleaning and waste modules. Life science OEMs often look to optimize and repurpose modules for other instruments because doing so lets OEMs make it through the FDA cycle a lot faster.

Here, suppliers to life science OEMs such as Parker might offer pre-designed subsystems that provide high precision and throughput for moving dispensing heads or micro plates in applications such as mass spectrometry, liquid handling for reagent dispensing, cellular assays plate reformatting, or simple pipetting.



*Liquid handling in the life sciences can include processes ranging from the manipulation of test compounds, to the addition of biological reagents to form screening assays. To maintain process integrity and avoid sample contamination, typical liquid handlers require multi-axis robots capable of smooth motion and precise positioning.*

An example of more elaborate custom equipment comes from a modular robotic system developed for a hematology instrument manufacturer. The system's automated load and unload features let it perform multiple experiments. The equipment featured all the 5-axes mechanics built onto a plate. Should the robot go down, all the user must do is unbolt four bolts, disconnect the wires, pull the robot out and put in a new one. This approach lets the unit be up and running again in about 20 minutes. An added benefit to the modular approach is that a system takes up less space.

The fifth trend has fluidics getting simpler in robotic analyzers. This trend arose because clinical laboratories and hospitals cannot afford for an instrument to go down when critical samples are involved. Certain robotic systems that used to have 50 needles on the end of a dispensing unit and lots of tubing

increasingly use special valve manifolds that eliminate the need for tubing and result in less chance for failure. The manifolds basically minimize the chance for leakage. The devices typically handle anywhere from four to 40 valves.

Another way to look at this trend is that manifolds help life science OEMs outsourcing their manufacturing streamline their operations. For example, the manifolds eliminate work an employee at a test bench must perform to integrate 30 pieces of tubing. The employee might instead spend 1/10 of the labor integrating a manifold.

Although last, trend six, is perhaps the most important: Development environments have changed significantly over the last five to 10 years. For example, robotics has advanced so far that it's possible to minimize or eliminate human movement. The result is automated medical, pharma and diagnostic equipment that can provide high levels of consistency.

### **Into the Future**

These trends are likely to persist into the future. They have helped force life science OEMs to be increasingly lean, meaning they define what the customer wants and deliver just that. Also, companies must work with much smaller staffs today, with most of the experienced engineers who pioneered the technologies having retired or moved on. Thus, it's likely that an OEM might not have the same in-house expertise as in the past.

This has led to OEMs outsourcing development to focus more on their core competencies. OEMs are also purchasing more complex technologies that need to be integrated into their systems. The result is a big push towards creating partnerships with technology providers to spread out management responsibilities and help reduce overall risks.

### **Next-Generation Medical Robotics**

The six major trends have affected the design of many new medical devices for the life sciences. Here are a few examples of systems that include next-generation technology.

#### *Diagnostic Instrument for Digital Pathology*

The automated diagnostic system performs microscopy high speed imaging of cells. Software in the system stitches images together without the need for the motion system to stop. This allows for much higher throughput of the system. Also, software detects diseases instead of human eyes, reducing human error.

#### *Diagnostic Instrument for Liquid Handling*

The workstation produces highly accurate and precise dispensing across a volume range of 100 nL to 60  $\mu$ L without cross-contamination, fully supporting integrated high-throughput screening, stand-alone assay development applications, and reagent additions applications in pharmacogenomic research. Key to its design is a dispense head that uses four independent fluid pathways. The system delivers reliable, high-quality performance with low dead volumes over an adjustable dispensing range

#### *Pharmaceutical Device for Cell Culture*

The equipment grows tissue and organs using cells deposited onto the slide. A special motion system harvests tissue cultures.

*Reprinted from Medical Design Technology, September 2013.*