

# SMALL-SCALE BENCHTOP AUTOMATION

*broadening the adoption of lab automation*

Driven by the need to enable technically challenging or repetitive processes, many labs in drug discovery that were not previously adopters of laboratory automation are being increasingly drawn to the potential of simple small-scale benchtop automation. The immediately obvious benefits (ie cost, labour savings, better quality data, etc) are key to making small-scale benchtop automation accessible, particularly when they are coupled with moderate flexibility and moderate walkaway automation. Interest is greatest for those emerging applications of sample prep (ie protein and nucleic acid extraction, next gen sequencing, qPCR setup and the quantification and normalisation of genomic DNA samples). Recent advances in small scale bench-top automation can be summarised by instrument developments in the following areas: compact configurations; enclosed instruments; extended pipetting ranges; end-user empowerment; pre-validated protocols; turnkey solutions; new software; and new robotic configurations. Judging by the number of new instrument launches at the SLAS 2012 Conference & Exhibition, we can expect small-scale automation to generate considerable interest among bench scientists in the months ahead.

**W**hen thinking of laboratory automation frequently what first comes to mind are large robotic systems, most often requiring dedicated or contained facilities and highly trained personnel. The past decade saw the emergence of many vendors specialising in delivering such complex automated solutions. These vendors primarily served the needs of those pharma and biotech scientists involved in the core groups

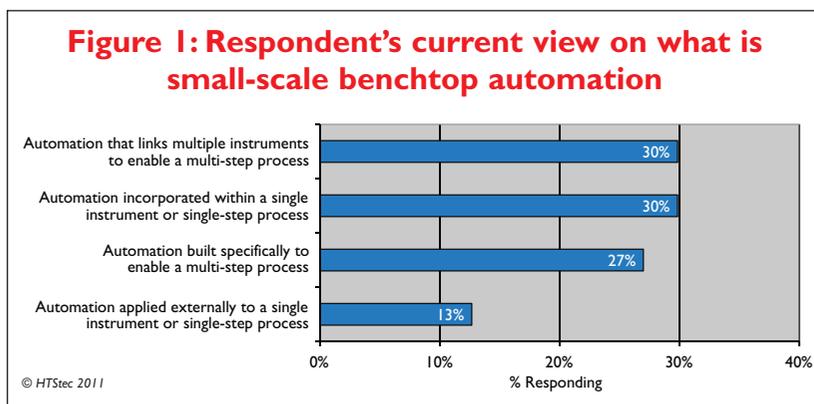
associated with high throughput screening (HTS) and profiling, compound management, sample storage and large-scale cell culture and maintenance. However, for each of these core labs there are 10s-100s of other labs both upstream and downstream in each company potentially interested in more efficient ways to carry out their routine tasks. Most of these potential automation opportunities do not require high throughput or involve

**By Dr John Comley**

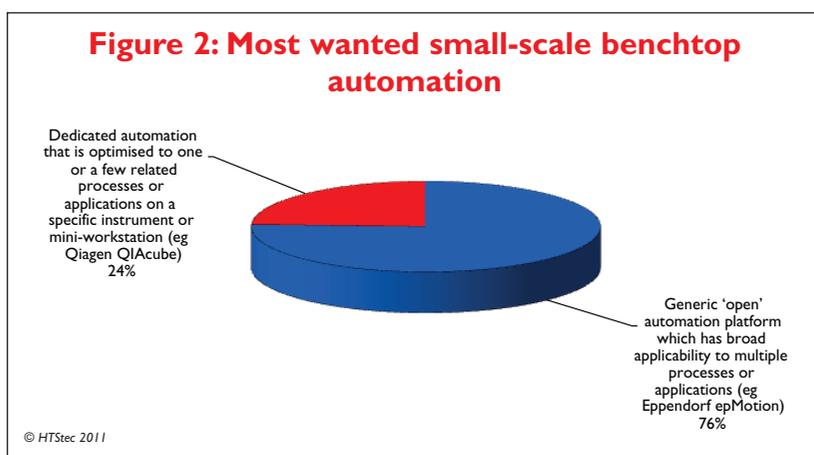
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## Automation

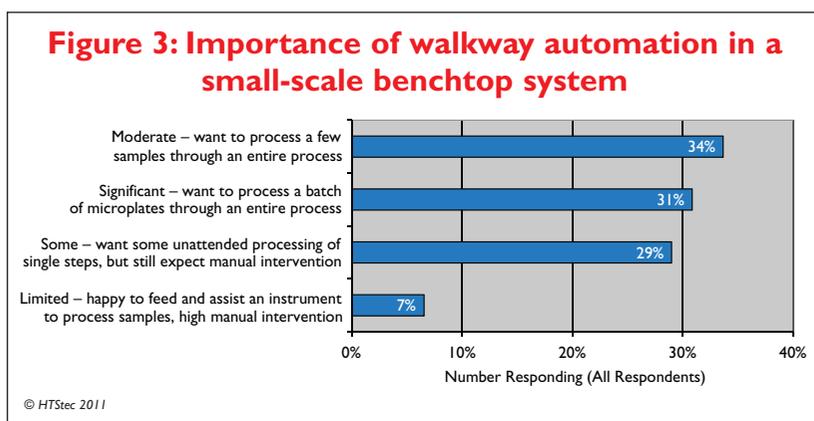
**Figure 1: Respondent's current view on what is small-scale benchtop automation**



**Figure 2: Most wanted small-scale benchtop automation**



**Figure 3: Importance of walkway automation in a small-scale benchtop system**



processing thousands of assays per day. Nor does the average lab have the budget or the space to accommodate 'big' automation. Many of these labs are unaware of the laboratory automation revolution that is about to hit them or some do not even grasp the potential benefits of automation. Despite this there are many repetitive or demanding tasks in modern drug discovery awaiting simple automated solutions, where the application of small-scale automation can offer numerous compelling advantages and make a big difference. After a phase where automation development resources appeared to be predominantly targeted at full-scale robotics, there has recently been a redeployment of effort towards simple-to-use small-scale automation. This has been driven in part by some emerging applications in sample prep, such as nucleic acid extraction, next-gen sequencing and qPCR setup, to the extent that the market is now beginning to buzz with new benchtop options. Other developments threaten to open up existing application areas to truly empowering automation, eg dose-response analysis. Sensing that small-scale benchtop automation was of interest both to vendors and end-users alike, HTStec undertook a survey on this topic in June 2011, which set out to investigate current attitudes and future market requirements for such systems. This article contains selected findings from that report and highlights many new systems that are being launched at the SLAS 2012 Conference & Exhibition to primarily address the needs of scientists working at the bench on small-scale low throughput applications.

### Types of small-scale automation preferred

Survey respondents' current preference on small-scale benchtop automation was almost equally divided between: automation that links multiple instruments to enable a multi-step process (30% preferring); automation incorporated within a single instrument or single-step process (30% preferring); and automation built specifically to enable a multi-step process (27% preferring); with least interest in automation applied externally to a single instrument or single-step process (only 13% preferring) (Figure 1).

The majority (76%) of survey respondents wanted to access generic 'open' automation platforms which have broad applicability to multiple processes or applications. Respondents were less interested (only 26% wanting) in accessing dedicated automation that is optimised to one or a few related processes or applications on a specific instrument or mini-workstation (Figure 2).

Survey respondents' current preference for the level of walkaway automation they want to achieve with small-scale benchtop automated system was evenly spread between: moderate (ie want to process a few samples through an entire process), 34% preferring; significant (ie want to process a batch of microplates through an entire process), 31% preferring; and some (ie want some unattended processing of single steps, but still expect manual intervention), 29% preferring; with only minimal interest in limited walkway automation (ie happy to feed and assist an instrument to process samples, high manual intervention), only 7% preferring (Figure 3).

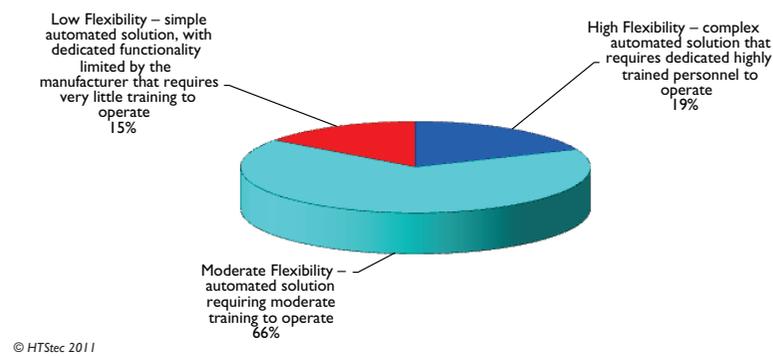
The majority (66%) of survey respondents required moderate flexibility (ie automated solution requiring moderate training to operate) in a small-scale benchtop automated system. Of the remaining survey respondents, 19% wanted high flexibility (ie complex automated solution that requires dedicated highly trained personnel to operate) and 15% low flexibility (ie simple automated solution, with dedicated functionality limited by the manufacturer that requires very little training to operate) (Figure 4). The above findings highlight the diversity of views on the type of small-scale automation that is most wanted by bench scientists. This is indicative of a market where the end user is still unfamiliar with all the options and no single solution is perceived as significantly superior to the rest. In such circumstances it is perhaps not surprising that many individuals are opting for generic 'open' platforms such as Eppendorf's epMotion® systems.

**Most important drivers**

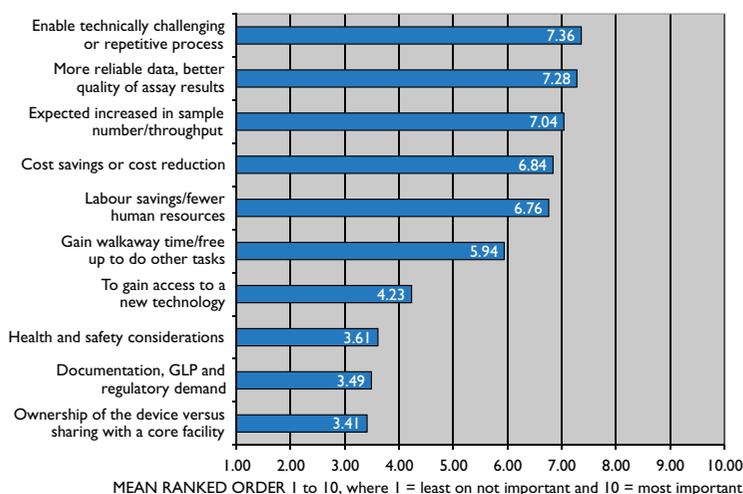
To enable a technically challenging or repetitive process was ranked the most important driver for implementing small-scale benchtop automation, this was closely followed by more reliable data, better quality of assay results and then expected increased in sample number/throughput. Ranked least important driver was ownership of the device versus sharing with a core facility (Figure 5).

Immediately obvious benefits (ie cost, labour savings, better quality data) were ranked as the greatest influence on making small-scale benchtop automation fully accessible. This was followed by frees end-user from error prone repetitive tasks and then opens up new experiments, ie hitherto impossible or impracticable or not considered. Least influence was proximity to their lab bench (Figure 6). So the myth that each scientist must have their own personal automated instrument, sitting on their part of the workbench for their use alone does not seem to hold.

**Figure 4: Flexibility required in small-scale benchtop automation**

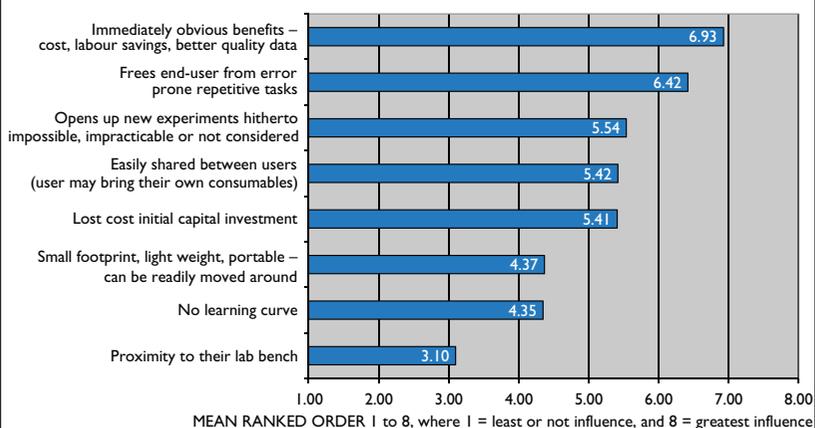


**Figure 5: Drivers for implementing small-scale benchtop automation**



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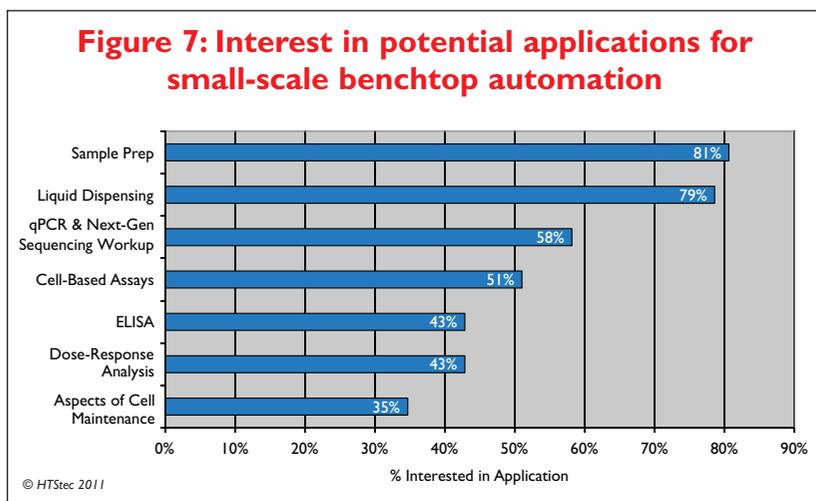
**Figure 6: The key to making small-scale benchtop automation accessible**



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## Automation

**Figure 7: Interest in potential applications for small-scale benchtop automation**



### Application areas for small-scale benchtop automation

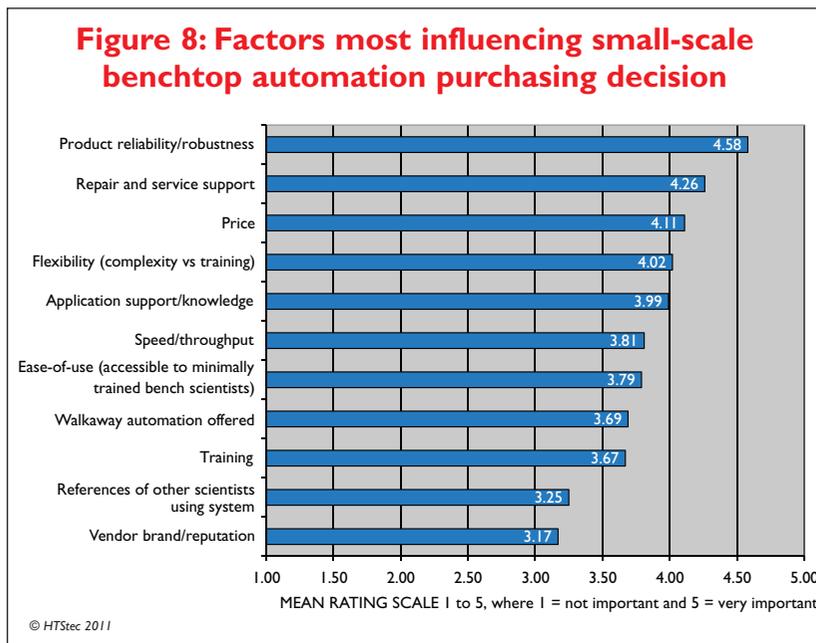
Of a list of potential application areas for a small-scale benchtop systems survey respondents showed greatest interest in sample prep (81% interested) and liquid dispensing (79% interested), followed by qPCR & next-gen sequencing (58% interested) and cell-based assays (51% interested). All other application had less than 50% interest (Figure 7).

### Purchasing plans

27% of survey respondents were actively looking to acquire automation technologies to overcome benchtop bottlenecks, and interest in purchasing small-scale benchtop automation over the next few years was high.

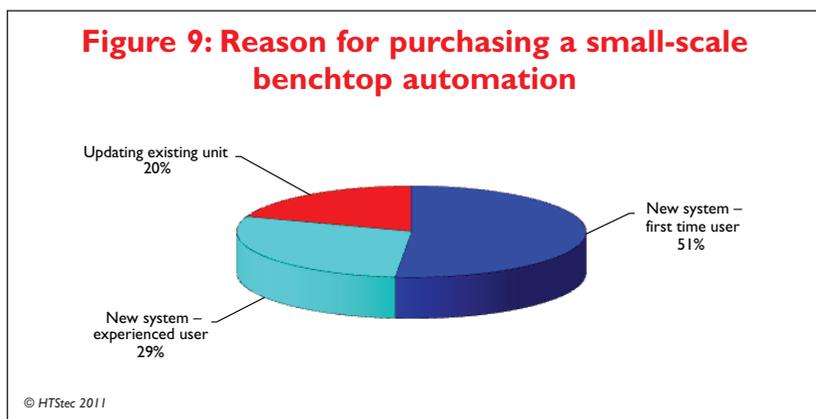
Product reliability/robustness was rated as the factor which was most important in the choice of a vendor for a small-scale benchtop automated purchases. This was followed by repair and service support, and then price. Rated least important was vendor brand/reputation (Figure 8).

**Figure 8: Factors most influencing small-scale benchtop automation purchasing decision**



The reason given by the majority (51%) of survey respondents for planned purchase of a small-scale benchtop automation system was a new system purchased by first-time user. This was followed by 29% new system purchased by experienced user, and then only 20% updating an existing unit (Figure 9). So it would appear that new small-scale automation is creating a market among scientists that previously were not adopters of automation.

**Figure 9: Reason for purchasing a small-scale benchtop automation**



Respondent's 2011 capex purchases on small-scale benchtop automation were broken down into the following components: 40% generic 'open' automation platforms; 17% dedicated or 'closed' automation platforms; 16% other (not assigned to anything); 14% automation that links multiple instruments; and 13% automation applied externally to an instrument (Figure 10).

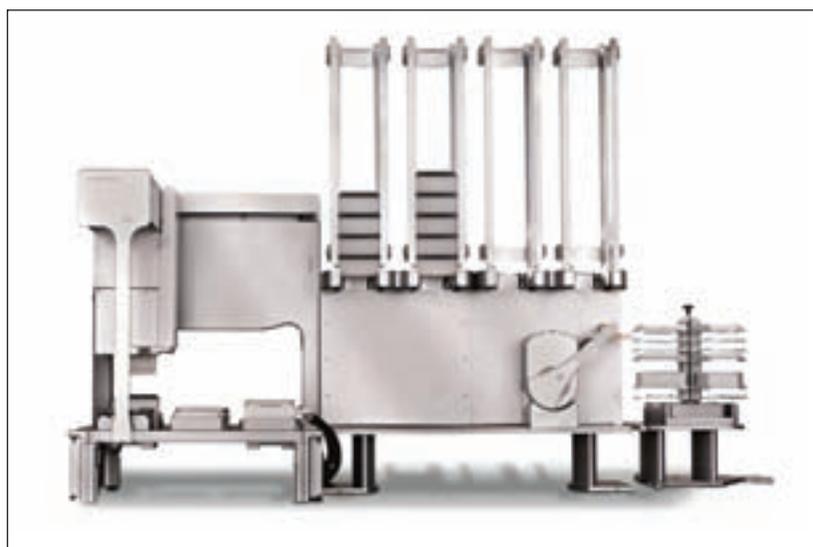
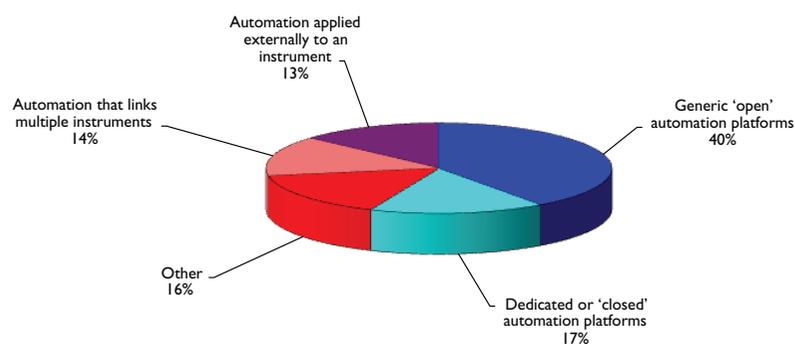
### Latest developments in small-scale benchtop automation

Agilent ([www.agilent.com](http://www.agilent.com)) offers two levels of modular Benchtop automation for life science applications. BenchCel Workstations are driven by the BenchCel Microplate Handler which combines labware storage with microplate handling for compact robotic configurations. The BenchCel is configured with two, four, or six labware storage racks and can integrate with up to four adjacent devices arrayed in a linear format. Agilent recently introduced the BenchBot Robot for more complex BenchBot workstation configurations. The

BenchBot Robot has a radial reach and can integrate with up to 10 devices. BenchBot workstations are easily scalable and can be reconfigured using the one touch teach button on the BenchBot. Agilent has been focusing on developing out-of-the-box solutions for sample preparation including optimised protocols. Next Generation Sequencing (NGS) sample prep has been one of the most rapidly growing sample preparation applications for Agilent desktop automation. Agilent has a comprehensive reagent and automation solution for NGS and more than 40 customers worldwide standardising NGS applications on the Bravo Liquid Handling Platform. Two scalable configurations are available to meet the needs of high throughput NGS labs. The NGS Bravo is outfitted with heating, cooling, shaking and magnetic separation accessories to process 960 libraries or 192 exomes per work week. The BenchCel NGS Workstation is the next level of NGS automation and by adding the Labware MiniHub for labware storage and the BenchCel 4R for microplate handling you can achieve the highest level of walkaway time (Figure 11).

The BioRAPTR FRD from Beckman Coulter ([www.beckman.com](http://www.beckman.com)) is a non-contact reagent dispenser capable of dispensing independent volumes into each well, from up to eight different reagents at a time. Per well dispense volumes range from 100nL to 60mL, and plate formats can include 96 to 1536 wells. It has recently used the BioRAPTR to initiate the differentiation of embryonic stem cells by adapting the 'hanging drop' method of embryoid body (EB) formation into a microplate format. The stem cells were safely and evenly distributed across a 384-well plate with the BioRAPTR, resulting in a single embryoid body per well. This method improved EB consistency and also enabled a design of experiment (DOE) to optimise the differentiation of stem cells into cardiomyocytes. The ability of the BioRAPTR to dispense different volumes of each reagent into different wells allowed Beckman Coulter to test numerous combinations of pro-cardiomyocytic compounds. In addition, it has used its Automated Assay Optimisation (AAO) for BioRAPTR software to convert the factorial mixture conditions into well dispense volumes for each reagent, greatly simplifying this complex task. These optimisation experiments resulted in a seven-fold increase in cardiomyocyte yield. This work demonstrates the type of elaborate experiments that can be quickly and easily automated using the BioRAPTR FRD (Figure 12).

**Figure 10. Breakdown of 2011 capex purchasing on small-scale benchtop automation**



**Figure 11:** Agilent BenchBot workstation for NGS



**Figure 12:** Beckman Coulter's BioRAPTR FRD™ microfluidic workstation

## Automation



**Figure 13**  
BioTek's new 405 Touch  
microplate washer

BioTek's ([www.biotek.com](http://www.biotek.com)) new 405 Touch Microplate Washer incorporates a modern touch screen user interface for intuitive and flexible onboard instrument control of 96- and 384-well microplate washing. A graphical colour display guides users through protocol creation, instrument maintenance and wash protocol execution at the touch of a button. Predefined protocols for everything from ELISA and cell washing to vacuum filtration and biomagnetic separation for Luminex xMAP workflows allow washing immediately out of box. A context sensitive help system is a key press away whenever questions arise. Instructional videos walk users through instrument setup and basic use. A USB flash drive port enables convenient file transfer especially helpful when an instrument is shared between researchers. Integrated buffer switching within the washer's main case allow for up to four buffers to be automatically primed and ready for use without taking up additional space on the lab bench. Quick-change manifolds enable wash modules to be quickly removed for

maintenance and without any tools. Built upon the ELx405 Washer, the 405 Touch also offers all the features of this well-known product including its patented Dual-Action manifold, optimised cell washing for loosely adherent cell layers and patent pending Ultrasonic Advantage for self-maintenance of the washer's aspiration and dispense tubes. A range of 405 Touch configurations is offered for different sample processing requirements. All models can be automated with a BioStack Microplate stacker or by integrating into a third party robotic system. 21 CFR Part 11 compliance is available with optional Liquid Handling Control Secure Software (Figure 13).

Built on Caliper's G3 platform, the Sciclone NGS leverages 25 years of industrial automation experience with molecular biology expertise to provide a high-throughput solution for complex procedures to prepare nucleic acids for Next Generation Sequencing. Caliper Life Sciences ([www.caliperls.com](http://www.caliperls.com)) engages in true partnerships with its customers, offering pre-validated protocols as well as onsite customisation, training and sample validation for application-specific workflows including targeted resequencing (both exome and custom panel), transcriptome expression profiling (RNAseq), and whole genome sequencing (WGS). The Sciclone NGS is compatible with all commercial kits, and works closely with industrial partners as well as key opinion leaders from the academic community to offer enabling solutions for life science researchers. The Sciclone NGS integrates three thermal control stations (0-110°C) and a thermal shaker (0-70°C) on to an enclosed 24-position deck, allowing true walkaway automation for the most complicated protocols, greatly reducing the variability associated with user-intervention.



**Figure 14:** Caliper Life Sciences Sciclone NGS

The 96-channel pipetting head offers precise liquid handling over a wide dynamic volume range (0-200µL), and an integrated gripper for the movement of plates between on-deck thermal, shaking, and magnet positions. Unlike

complex automation solutions involving multiple moving parts, and passing of plates between stacking and liquid handling hardware, the fixed deck design eliminates the risk of losing costly reagents and invaluable samples while vastly simplifying programming. The system is controlled through the Maestro software package, which masks a powerful software engine behind a simple, easy-to-use graphical interface. User-defined parameters allow the operator to adjust protocols for sample numbers, automatically adjusting tip and reagent usage to eliminate costly waste in unused tips and reagent dead volume (Figure 14).

CyBio ([www.cybio-ag.com](http://www.cybio-ag.com)) recently launched the new benchtop pipettor CyBi®-FeliX. Serving the need to save bench space and provide built in containment this small flexible laboratory liquid handling system offers a multifunctional approach to scalable automation. In spite of the compact 650mm x 450mm (W/D) footprint, it features 12 deck positions arranged in a novel two-level approach and addresses a wide set of applications in the field of proteomics and genomics as well as biological and biochemical methods. The self-contained CyBi®-FeliX is designed for routine liquid handling tasks in all SBS footprint labware, such as plate replication, reformatting, hit picking and serial dilution in rows and columns. For CyBi®-FeliX platform there is a selection of hot swap pipetting heads available. In addition to multi-channel 96/384 heads, the new CHOICE™ pipetting head allows for single or 8, 12 respectively 16, 24 parallel pipetting. Even more remarkable than the format flexibility, the patent-pending CHOICE™ technology goes beyond the scope of traditional volume ranges and increases them by four orders of magnitude (100nL-1mL) united in one pipetting head. This means the user is able to work within different volume ranges without compromising the pipetting accuracy and avoiding the need for manual intervention throughout his method. CyBi®-FeliX automatically adapts to the required volumes and formats by simply matching a series of tools and tips. In order to ease daily routines and allow lab staff to focus on more significant duties, CyBi®-FeliX is complemented by intuitive and powerful new liquid handling software, enabling complex setups in minutes (Figure 15).

The various Eppendorf ([www.eppendorf.com](http://www.eppendorf.com)) epMotion® systems are generic open automation platforms addressing the needs for multiple applications requiring automated liquid handling. The epMotion concept is a fine balance between good



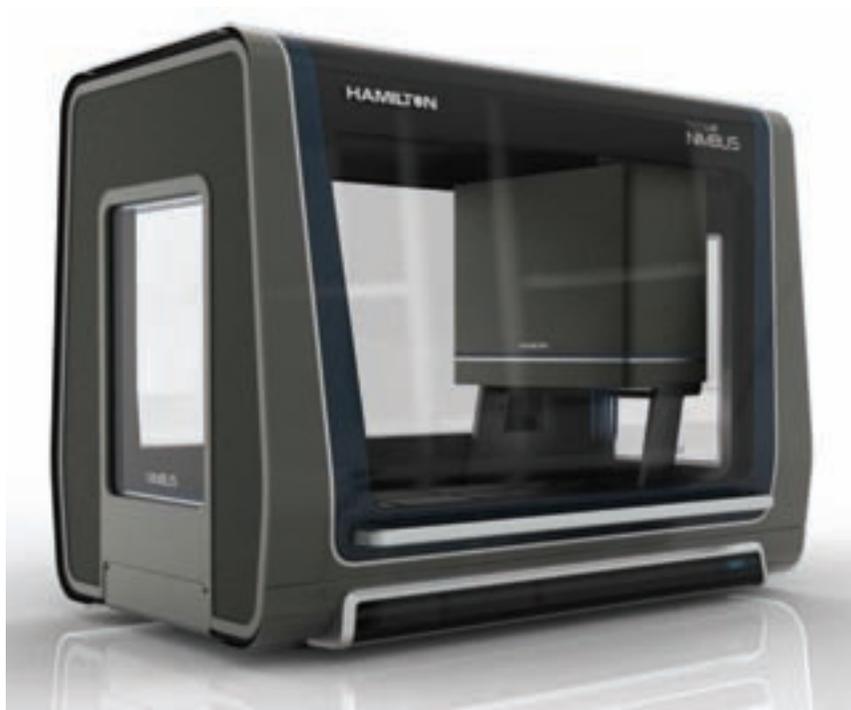
Figure 15: CyBio's new CyBi®-FeliX – compact automated liquid handling system

application and process flexibility on the one hand and ease-of-use and small training efforts on the other hand. For example, sample preparation protocols for multiple vendors can be used on the system, but leaving the flexibility to modify and tune the protocols according to specific user needs. The epMotion systems provide automated single and multi-channel pipetting of single tubes, racks, 96- or 384-well plates in low to medium throughput range at high precision where manual liquid handling is a bottleneck. For more demanding documentation and compliance requirements in the pharmaceutical and biotechnical industry the epMotion systems can be upgraded with the epBlue ID™ add-on software module and/or with the GxP solution. The epBlue ID facilitates simple and safe data exchange with LIMS or ELN systems and barcode sample tracking where origin and destination barcodes are recorded and documented. The new epMotion GxP solution was developed according to GAMP 5 and tailored for organisational and process requirements of 21 CFR part



Figure 16: Generic automated pipetting with Eppendorf epMotion® 5075 TMX PC version

## Automation



**Figure 17:** A new enclosure for the Hamilton NIMBUS automated liquid handling workstation which includes side integration bays for plate stackers, hotels or third party devices

11, 58, 211 and 820, EU Annex 11, GLP and GMP. Eppendorf as a vendor has taken care of the major part of the required system validation and qualification, leaving users more time to focus on



**Figure 18:** Front left: Hudson PlateCrane EX with 5 stacks, Hudson PA1000 Barcode Print & Apply in back left, Liconic STX110 incubator in back right and Genetix CloneSelect Imager in front left. System will apply barcodes to plates either on the fly or as an off-line process. Plates are loaded into the incubator, then removed on schedule to the reader, then back to incubator. Data is collected and logged. User is alerted by email to any errors, exceptions and the end of the process

validating their application part. Important features here are electronic signatures, audit trail and log file documentation (Figure 16).

NIMBUS is the family of compact liquid handling workstations from Hamilton Robotics ([www.hamiltonrobotics.com](http://www.hamiltonrobotics.com)). The platform is offered in two versions – 96-channel, for microplate applications such as plate replications, serial dilutions and reagent additions, and the NIMBUS4 with up to four independent channels that can be configured with any combination of 1mL or 5mL pipetting heads, for tube-to-tube, tube-to-plate and plate-to-plate transfers. A number of NIMBUS enhancements are planned for introduction at SLAS 2012. These include a new Shift and Scan accessory that enables integrated barcode reading and sample tracking. Also new is a Hamilton Gripper for a variety of plate handling movements, including to and from off-deck third-party devices. New NIMBUS software, called Instinct, will also be introduced. The new software offers a user-friendly interface and the ability to generate wizard-guided scripts for automatic deck layout creation. This easy-to-use Instinct software shortens user learning curves. Enclosed NIMBUS systems will also now be available with Integration Bays on the sides to accommodate instrument accessories such as stackers and third-party devices that can be accessed with Hamilton grippers. The enclosure can be equipped with an optional high efficiency particulate air (HEPA) filter, which delivers clean air to the pipetting work surface. A clean pipetting environment is important in a range of applications such as sample preparation for cell culture and cell-based assays and DNA and RNA amplification setup. Additional third-party device capabilities will be introduced on an ongoing basis to meet the changing demands of NIMBUS users (Figure 17).

Hudson Robotics ([www.hudsonrobotics.com](http://www.hudsonrobotics.com)) continues a 28-year tradition of delivering advanced controls and tools to all levels of lab automation users. The latest version of SoftLinX (version V), the company's powerful and easy to use automation scheduling program, is now available at no charge to most labs. The improved features in SoftLinX V allow users to determine the level of automation they need. Basic methods for integration of 1-3 instruments to Hudson's PlateCrane or StackLink stacker systems are simple to create and run. Advanced methods with exception handling, email notification, barcode management and multi-users can be created and delivered as turnkey

## Automation



**Figure 19:** The Access™ laboratory workstation from Labcyte supports the wider application of Echo liquid handlers

solutions for applications such as colony picking, qPCR and automated flow cytometry. Hudson Robotics continues to develop its own suite of benchtop instruments while expanding its suite of SoftLinx interfaces to third party devices. Researchers decide which tools are best for their applications and how advanced the automation needs to be. Turnkey solutions for applications such as automated plate coating, serial dilutions, multiple Elisa assays, Zebrafish and more are available. SoftLinx is the single program that handles the first stage of lab automation; simple plate

feeding to a device all the way to advanced system integration of 20+ instruments with advanced error handling and on-the-fly response. Additionally, small labs and novice users can reap some of the benefits of an automated assay without the automation. SoftLinx can track and prompt a user through an application even when the independent instruments are operated

manually. SoftLinx easily accommodates the addition of automated plate handling at anytime (Figure 18).

To support the increasing use of the Echo® liquid handler in diverse application areas, Labcyte ([www.labcyte.com](http://www.labcyte.com)) developed a new robotic platform catering to the bench-top research environment without compromising the benefits of automation. The Access™ laboratory workstation combines any Echo liquid handler with a compact, modular robotics platform offering a range of options for complementary devices and accessories. With this system researchers can add automated plate loading to a standalone Echo liquid handler, or take it a step further with the integration of devices – all without consuming workspace. The Access workstation also includes Tempo™ automation control software, which instantly adds scheduling power to protocols created by Echo® software applications. Tempo software manages plate activity and data in real time, simplifying error recovery. Keeping a focus on diverse applications, Labcyte has already validated a number of configurations for the Access workstation to generate assay-ready plates for compound screening, genomic screening, cell-based assays and more. One example is the configuration of an Access workstation combining the Echo liquid handler with the Roche LightCycler® 480 or LightCycler® 1536 to assess gene expression with quantitative PCR (qPCR). Cells can be cultured, lysed with Roche RealTime ready reagents and transferred from 384- or 1536-well acoustically qualified, tissue culture treated microplates, into 96-, 384- or 1536-well PCR plates. In this configuration the Access workstation enables miniaturisation of qPCR experiments and simplification of the entire workflow from cell lysate to qPCR data, for a walk-away high throughput qPCR solution (Figure 19).

CELFTM from Logos Biosystems ([www.logosbio.com](http://www.logosbio.com)) is the world's first automated cell culture system developed for small- to mid-sized laboratories for automating cell passage, media exchange and image capturing. Within its small dimension of 95cm x 70cm x 80cm, it incorporates all necessary functionalities for effortless, automated cell culture at the touch of a button. Designed for weekend cell culture, CELFTM includes a CO<sub>2</sub> incubator, media/trypsin reservoirs, precise robotic systems, and a biosafety cabinet. Users can set up unique protocols on Friday and come back to newly passaged plates on Monday with no weekend work.

**Figure 20**  
CELFTM: Logos Biosystems  
automated cell culture system



## Automation

**Figure 21**  
DNA normalisation option for  
PerkinElmer's JANUS®  
automated workstation



CELFTM can handle any combination of 100mm dishes and/or 6, 12, 24 well plates with a six-position plate hotel inside the incubator. Not only does CELFTM passage cells, it can also schedule addition of reagents, such as drug treatment. CELFTM has a HEPA filter system ensuring a class 100 environment during operation. CELFTM provides an automated reservoir for heating and cooling reagents, accommodating six standard 50ml conical tubes for easy storage. The temperature is accurately controlled by a peltier system for heating (to 37°C) and cooling (to 4°C). CELFTM has an accurate pipetting system controlled by a syringe pump, employing 5ml disposable tip for liquid handling. The level of reagents is automatically monitored by an ultrasonic liquid level detector installed in the robotic arm. A patented microscope system for multipoint imaging was installed in CELFTM for monitoring cell conditions, containing two motorised stages for rotating a dish and auto-focusing. Captured images can be saved on to an external USB drive (Figure 20).

Accurate quantification and normalisation of genomic DNA samples and next-generation sequencing (NGS) libraries is critical for successful sequencing results, especially when multiplexing samples in the sequencer. To improve the quality and throughput of this tedious and error-prone process, PerkinElmer ([www.perkinelmer.com](http://www.perkinelmer.com)) is pleased to offer a new version of its DNA Normalisation Option for the JANUS® Automated Workstation. This software module runs within the WinPREP® software on JANUS to streamline the process of normalising nucleic acid samples prior to NGS and other high-value analyses. JANUS can quickly prepare assay plates for analysis by the EnSpire® Multimode Reader (or

other analysers). JANUS delivers the plate to EnSpire, directs reading of the plate, and then captures the assay results. Exception handling options allow customers to triage samples based on quantity and quality as determined by the assay results. The program calculates the correct volumes for each sample, then rapidly and precisely executes the many pipetting steps required to prepare samples of equal concentration. The powerful multi-tasking capabilities of JANUS enable preparation of 96 normalised samples in 10 minutes or less once quantitation data is captured. The platform is designed to be flexible with respect to input data; it can normalise samples based on assay results from other plate readers as well as technologies such as qPCR or the Caliper LabChip GXII, allowing customers to utilise their preferred instrument for nucleic acid quantitation (Figure 21).

The Maxwell® 16 Instrument from Promega ([www.promega.com](http://www.promega.com)) is a small, compact benchtop system that extracts high-quality DNA, RNA, viral total nucleic acid or recombinant proteins from up to 16 samples in 30-45 minutes. The Maxwell® 16 uses a novel paramagnetic particle processing technology. This eliminates liquid transfer which significantly reduces splashing, aerosols and other sources of contamination. The Maxwell® 16 Instrument is preprogrammed with purification protocols. This, combined with kits containing prefilled reagent cartridges, maximise simplicity and convenience. Add samples or lysate directly to the prefilled reagent cartridges, press start and walk away. The latest innovation is an RNA purification procedure from cells and tissue. The new Maxwell® 16 simplyRNA Purification kits have minimal lysate handling and no centrifugation before automated purification on the Maxwell®

16 Instrument. The low elution volume is used to generate concentrated high-quality RNA suitable for use in downstream applications such as quantitative RT-PCR. All reagents and consumables, including DNase and all plastics, are included in the kit. For quantitation of nucleic acids, the QuantiFluor™ ST is an affordable, sensitive fluorometer, designed for quick, easy and accurate fluorescence measurements. Single-point calibration saves time, and a dual-channel design (UV and Blue) allows you to switch between two assays with the touch of a button. For use with the QuantiFluor ST, is the QuantiFluor™ dsDNA System, which contains a fluorescent DNA-binding dye for sensitive quantitation of small amounts of double-stranded DNA (dsDNA) in solution. The dye shows minimal binding to single-stranded DNA (ssDNA) and RNA, allowing specific quantitation of dsDNA (Figure 22).



**Figure 22**  
With the automated Maxwell® 16 System from Promega, you can extract DNA, RNA or protein from up to 16 samples in less than 45 minutes

Qiagen ([www.qiagen.com](http://www.qiagen.com)) provides a number of benchtop instruments that can automate each step of the life science or molecular testing workflow, from the preparation of the sample through detection and analysis. Automation eliminates handling errors – such as preparing the sample or pipetting a PCR reaction – and frees up time for the researcher to complete other tasks. Sample preparation involves the isolation of proteins and nucleic acids, which can be automated with the QIAcube for up to 12 samples based on spin column technology and with access to more than 100 protocols that are expanded on a continuous basis. The QIAextractor is suitable for larger throughputs and processes 96 samples in one run. The setup of the PCR reaction can be automated with the QIAgility, a compact instrument that eliminates manual pipetting steps for a wide range of formats, including assays with the Rotor-Gene Q real-time PCR cycler. Both research and molecular testing laboratories are also gaining more interest in the lean concept and in integrating whole workflows. The QIASymphony RGQ, a larger benchtop instrument, facilitates this by automating sample preparation through to detection without any user intervention for up to 96 samples per run for a variety of sample types and applications. Detection by electrophoresis also can be fully automated with the QIAxcel Advanced, a benchtop instrument that was recently launched and includes new software for the system setup and data analysis. DNA fragment analysis of 12 samples can be performed by capillary electrophoresis in as little as three minutes. Ready-to-run gel cartridges allow 96 samples to be analysed

with a minimum of hands-on interaction, reducing manual handling errors and eliminating the need for tedious gel preparation (Figure 23).

Roboline is a personal workstation from Satorius Biohit ([www.biohit.com](http://www.biohit.com)) and a perfect solution to automate your pipetting work. It frees your hands from pipetting so that you can concentrate on other laboratory tasks. Roboline answers to higher demand in the laboratory for sophistication and efficiency. Roboline is a quiet, small footprint (4+2 trays), truly personal and approachable pipetting automate. It completely automates your pipetting work; whether cherry picking, reagent aliquoting, viral studies, dilution series or something else. The



**Figure 23:** The QIAcube from QIAGEN automates the isolation of proteins and nucleic acids based on spin column technology

## Automation



**Figure 24:** Biohit Roboline pipetting automate is developed by Sartorius Biohit

easiness and user-friendliness of Roboline is based on several facts. The graphical user interface can be learned in just 15 minutes and the simple drag-and-drop function helps you modify your protocol. Additional features, such as the standard curve wizard, ease programming. The software has a simulator check to eliminate human errors and the unit uses conductive tips to secure liquid transfer. You can save your application and use it again



**Figure 25:** Benchtop convenience for your titration experiments with the HP D300 Digital Dispenser from Tecan

without reprogramming. Much like a standard pipette, the flexibility of Roboline enables pipetting of any combination of columns, rows, single wells or entire plates. The housing is easy to clean and the closed environment protects samples from contamination. A removable tray makes unloading and loading possible even when the robot is working on another task. Roboline's size (25.4lb, the smallest on the market) and low noise level (60dB) make it a true bench-top instrument. Roboline is developed by Sartorius Biohit which has many years of experience in liquid handling and the manufacturing of electronic pipettes (Figure 24).

The new HP D300 Digital Dispenser is an automated benchtop instrument used to generate dose response curves for the pharmaceutical research sector. Available exclusively through Tecan, ([www.tecan.com/digitaltitration](http://www.tecan.com/digitaltitration)) this innovative device can cut titration times from hours or days to just minutes. The HP D300 offers the unique flexibility to walk up and easily perform titrations at the bench. It provides fast and reliable performance across a large dynamic range, eliminating the need for slow, error-prone and wasteful dilution steps. Using disposable dispense heads to avoid cross-contamination, the instrument offers complete freedom for non-contact dispensing from 13pL to 5µL, delivering any dose to any well in 96 and 384 plate formats and virtually eliminating waste of valuable compounds. The HP D300 software is simple, yet powerful enabling practically anyone in the lab to set up classic or complex drug titrations with only minutes of training. Drug-drug interaction studies (2D) are difficult and time consuming to prepare using conventional methods, but are set up in minutes using the HP D300. Randomisation of the samples within a plate is also accomplished with the click of a button, reducing edge effect bias in cell-based assays. The HP D300 offers a solution to address the most challenging experiments encountered in the lab. The pharmaceutical industry is recognising a need for change, and there is a growing trend towards benchtop automation solutions. New technologies such as Direct Digital Dispensing can offer fresh solutions to entrenched challenges, helping to improve productivity and accelerate the discovery of better drugs. The HP D300 Digital Dispenser is available now for delivery in Europe and North America (Figure 25).

The Thermo Scientific ([www.thermo.com](http://www.thermo.com)) Orbitor BenchTrak is a complete modular and customisable automation solution that incorporates 'click-in'



**Figure 26**  
The new Thermo Scientific  
Orbitor BenchTrak

integration components. The BenchTrak significantly extends the functionality and versatility of the renowned Thermo Scientific Orbitor RS plate mover. In addition to the expanded reach provided by the track, the solution is available with a complete range of quick-connect modules including: instrument locating platforms, mezzanines, guarding and microplate storage options (random access or stacked). The Orbitor BenchTrak easily fits on to existing standard laboratory benches, and all elements are PC driven. Compared to other competitive platforms the Orbitor BenchTrak does not require endusers to have extensive automation expertise typical of larger articulated robot systems. Like the Orbitor RS, the Orbitor BenchTrak utilises industry leading Thermo Scientific Momentum 3.1 workflow software to empower users to create benchtop workstations capable of performing a wide variety of workflows such as sample preparation, ELISA, nucleic acid and protein purification, cell or biochemical assays, cell maintenance, qPCR and next generation sequencing. To maintain ease-of-use, the BenchTrak will be released in combination with the new and innovative Thermo Scientific LOCaMotion teach wizard. Available in 'On-bench' or 'In-bench' models and in multiple track lengths, customers can pick a physical configuration and the level of installation/integration service that matches their needs. Multiple Orbitor BenchTraks can be connected together to create

complex system layouts (topologies) that address customers workflow and needs. The Orbitor BenchTrak is available for new systems and field upgrades for existing Orbitor RS workstations in February 2012 (Figure 26).

### Discussion

It is possible to tease out the following trends in small-scale bench top automation from the vendor snapshots:

**Compact configurations:** It is self-evident that nearly all the instruments reported in the review have been built to save space and minimise their bench foot print.

**Instrument enclosures:** Increasingly instruments are equipped with enclosures and optional HEPA filtration, to deliver clean air to the pipetting work surface important in a range of applications such as sample preparation for cell culture and cell-based assays, and DNA and RNA amplification setup (Caliper, Cybio, Eppendorf, Hamilton, Logos, Promega, Qiagen, Satorius Biohit).

**Extended pipetting ranges:** Many of the capabilities of the instruments described would not be possible without the extended dispensing ranges (from pL to mL) that are now supported with greater accuracy (Beckman, Caliper, CyBio, Labcyte, Tecan).

**End-user empowerment:** Some instruments can be extremely empowering enabling practically anyone

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in the lab to quickly set up highly complex liquid handling protocols (eg dose response, assay optimisation or plate randomisation) that would be extremely time-consuming or even impossible by hand. (Beckman, Tecan). Other systems enhance the productivity of the automation novice by making benchtop systems truly personal and approachable (Satorius Biohit); or eliminate the burden of weekend cell culture work (Logos); or allow end-users without extensive automation expertise easy access to their system (Thermo Scientific).

**Pre-validated protocols:** Increasingly out-of-the-box solutions for sample preparation include pre-defined, pre-optimised and pre-configured protocols. These are mainly focused on next gen sequencing sample prep, qPCR setup, quantification and normalisation of genomic DNA samples and miniaturised qPCR to monitor gene expression (Agilent, Caliper, BioTek, Labcyte, PerkinElmer).

**Turnkey solutions:** The range of compact turnkey boxes with associated reagent kits enabling the optimised isolation of protein and nucleic acids and qPCR setup has significantly expanded (Promega, Qiagen). Some larger turnkey workstations also include detection (Qiagen). Other vendors offer turnkey solutions through simple system integration (Hudson).

**New software:** Is the key to all systems with user-friendly touch screen interfaces, wizard-guided scripts to shorten user learning curves and flexible onboard instrument control the norm (Agilent, Biotek, Hamilton, Satorius Biohit). More advanced systems now include as standard integrated barcode reading and sample tracking, system validation and qualification, error recovery and exception handling (Eppendorf, Hamilton, Hudson, Labcyte, PerkinElmer). In addition, innovative deck designs eliminate the risk of losing costly reagents and precious samples while vastly simplifying programming and saving space (Caliper, Cybio, Hamilton).

**New robotic configurations:** The functionality and versatility of existing plate movers have been enhanced to create modular and customisable benchtop automation solutions that incorporate 'click-in' integration components (Thermo Scientific). Others are catering to the bench-top research environment with compact robotics that does not compromise the benefits of automation (Agilent, Labcyte).

If the number of new instrument launches at the SLAS 2012 Conference & Exhibition (many of which are first reported in this article) and the range of applications supported is our gauge, we

can expect to see the wider uptake and deployment of small-scale benchtop automation in the future, particularly among new or novice users of automation. **DDW**

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