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Improving Laboratory Efficiency & Flexibility with Automated Sample Preparation Systems - the Impact of the Gilson GX-281 Dual Z-Arm Weighing Station

Application Note CL0112

Keywords

Weighing Station, GX-281 Liquid Handler, Sample Preparation, Automated Systems, Bar Coding, Tube Gripper, TRILUTION LH v3.0 Liquid Handling Software

Introduction

Automating sample preparation procedures eliminates variability and improves efficiency of the overall process, allowing the scientist to be confident in the resulting data from laboratory applications.

This note outlines the use of the Gilson TRILUTION® LH software to automate liquid handling, and other common procedures, to improve laboratory efficiency. The use of TRILUTION LH to incorporate third party devices (barcode readers, balances, pH meters, etc.) will be described. The application discussed focuses on a GX-281 Liquid Handler used to perform automated liquid handling with the inclusion of a balance.

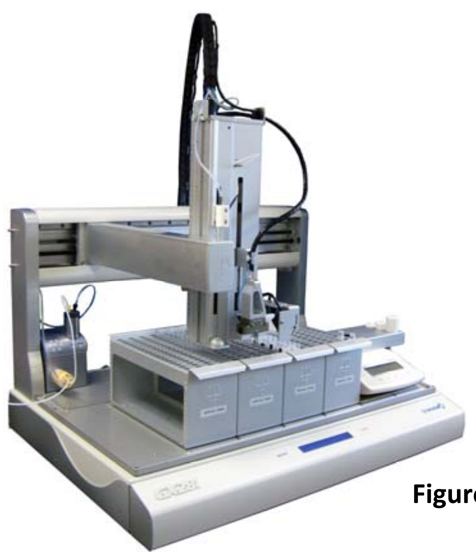

Figure 1. Gilson GX-281 Weighing Station

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The primary goal of any laboratory is to collect and analyze data, and it is rare for many samples to be ready for analysis the moment they enter the lab. Samples may need clean up or purification prior to downstream analysis. Standards and controls may need to be created and analyzed with the samples in order to form a baseline against which the samples will be compared. Samples may need to be modified (pH adjustments, solvent composition, sample derivatization, etc.) in order to make them more amenable to the analysis technique(s) that will be used. Obtaining data is generally more complicated than simply inserting a sample into a machine for analysis and getting the desired result at the end.

Sample preparation procedures are often among the most time consuming and labor intensive functions within the laboratory, and because of this, they are often a prime candidate for the introduction of error and inefficiencies into the sample analysis process. Sample preparation procedures often consist of a series of monotonous tasks, which by their nature make it difficult for laboratory personnel to maintain focus and concentration for long periods of time, when these procedures are performed using manual methods. These procedures require just as much care and attention as the final sample analysis, because small errors can be magnified and propagated throughout the process, and skew the final results.

Automation can address many potential bottlenecks and sources of error within the sample preparation process, improving process efficiency, personnel efficiency, and confidence in data obtained. When comparing automated solutions vs. manual methods, the following items should be considered:

- **Throughput**
  - ✓ The potential throughput of laboratory personnel is limited to the hours present within a workday.
  - ✓ Automated solutions operate at any time of the day, including unattended operation overnight or over the weekend.
- **Consistency**
  - ✓ The consistency of work completed by laboratory personnel can vary from person to person, and even from one instance of work to another when completed by the same person. For example, procedures such as pipetting can vary depending on the skill level of the user, and their ability to consistently apply the skill.
  - ✓ Liquid handling instrumentation can be used to produce reliable and consistent results every time.

- **Flexibility**
  - ✓ Liquid handling instrumentation and software packages provide a level of fine-tuned control over the sample preparation process. This level of control is typically not possible when performing procedures using manual methods. Time dependent parameters such as flow rate, or the parallelization of time dependent processes, such as incubations or derivatizations, would be difficult, or nearly impossible, for laboratory personnel to perform on a consistent basis.

Table 1: Gilson GX-281 Dual Z-Arm Weighing Station Configuration*

Description	**Part Numbers**
GX-281 Liquid Handler Base Unit – No Z-Arm	261036
GX-281 Liquid Handler Dual Z-Arm	Special 1852
Barcode Reader for GX-281 Dual Z-Arm - Barcode Reader (Keyence SR-600) with Fixed Mount	Special 1852B Requires: Tube Gripper (Special 1852E)
Tube Gripper for GX-281 Dual Z-Arm – Tube Gripper (Schunk PGN+ 50) with Fixed Mount	Special 1852E Requires: Solenoid Valve Manifold (Special 1852F or Special 1852G), and Gripper Fingers (Special 1852H)
Solenoid Valve Manifold for GX-281 Dual Z-Arm – Solenoid Valve Manifold (Festo VUVG-S10-M52-RT-M5-1S2RL-S3), 4 Valves	Special 1852F
Solenoid Valve Manifold for GX-281 Dual Z-Arm – Solenoid Valve Manifold (Festo VUVG-S10-M52-RT-M5-1S2RL-S3), 2 Valves	Special 1852G
Gripper Fingers for Tube Gripper (Special 1852E) – Gripper Fingers, 12 – 16 mm Test Tubes	Special 1852H
Balance	Sartorious CPA324S
Balance Adapter Plate for GX-281	Special 1904
Tube Locator Options:	Special 1904A
for Special 1904, 12x32mm Vial	Special 1904A
for Special 1904, 15x45mm Vial	Special 1904B
for Special 1904, 16x100mm Test Tube	Special 1904C
GX-281 Pump Options:	
GX Prep Solvent System	261350
402 Syringe Pump, Single	F410511
402 Syringe Pump, Dual with Tee	F410512
402 Syringe Pump, Dual with 2 Valves	F410513
TRILUTION® LH v3.0 Software Package	210630R30
TRILUTION LH v3.0 License, Lifetime	21063023

** The GX-281 Dual Z-Arm Weighing Station supports the same Z-Arm options as the standard GX-281 Z-Arm (probes, probe holders, probe guides, transfer tubing, etc.). These items are not included and should be ordered separately to fit each application.*

Materials & Methods

In order to highlight the benefits of an automated workflow, an application which involves sample weighing is presented below. This application was performed on a GX-281 Prep Liquid Handler (Gilson, Inc.: Middleton, WI) utilizing a CPA324S Analytical Balance (Sartorius AG: Goettingen, Germany), under software control using TRILUTION® LH v3.0 (Gilson, Inc.). Software control of the balance was achieved using GEARS (Gilson, Inc.), a set of software tools designed to integrate third party devices with TRILUTION LH v3.0. A summary of the liquid handling procedure is below:

1. Tare balance, prior to transfer of tube.
2. Transfer tube (empty) in specified *Well* from rack to balance, and record the *Tube Weight.*
3. Transfer specified *Sample Volume* to tube, and record *Total Weight.*
4. Calculate *Sample Weight.*
5. Transfer tube (with sample) to original rack location.
6. Record *Well*, *Sample Volume*, *Tube Weight*, *Total Weight*, and *Sample Weight* to spreadsheet for later analysis.
7. Repeat steps 1-6, for each sample to be processed.

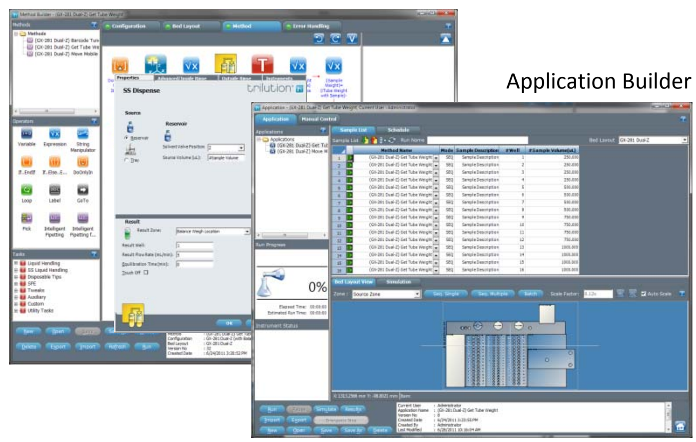

Figure 2. Screenshots of TRILUTION® LH v3.0

The liquid handling procedure was programmed in TRILUTION® LH v3.0, by utilizing a sequence of Operators and Tasks which were dragged into the Method Builder Workspace, resulting in a series of actions which mirrored the manual process (Figure 2). A Sample List was then created using the Application Builder of TRILUTION LH v3.0, where a *Well* and *Sample Volume* was defined (Figure 2). Finally, the Application was executed, and the instrumentation performed the sample preparation procedure, unattended.

During the execution of the Application, data obtained from the balance was recorded to a spreadsheet (in addition to the *Well* and *Sample Volume*), which was later used to determine the precision and accuracy of sample delivery performed on the liquid handling system (Table 2).

Results

Well	Sample (uL)	Tube Weight (g)	Total Weight (g)	Sample Δ (g)	Average (g)	Std. Dev. (g)	% CV	Expected Δ (g)	Error Δ (g)	% Error	Average % Error
1	250	4.6764	4.9229	0.2465	0.2505	0.0032	**1.29%**	0.2480	-0.0015	-0.59%	**1.01%**
2		4.6472	4.8978	0.2506					0.0026	1.06%	
3		4.6481	4.9025	0.2544					0.0064	2.59%	
4		4.6751	4.9255	0.2504					0.0024	0.98%	
5	500	4.6581	5.1509	0.4928	0.4956	0.0040	**0.80%**	0.4959	-0.0031	-0.63%	**-0.07%**
6		4.7068	5.2010	0.4942					-0.0017	-0.35%	
7		4.6783	5.1798	0.5015					0.0056	1.12%	
8		4.6622	5.1561	0.4939					-0.0020	-0.41%	
9	750	4.6837	5.4401	0.7564	0.7471	0.0071	**0.95%**	0.7439	0.0125	1.68%	**0.43%**
10		4.6635	5.4027	0.7392					-0.0047	-0.63%	
11		4.6863	5.4317	0.7454					0.0015	0.20%	
12		4.6788	5.4262	0.7474					0.0035	0.47%	
13	1000	4.6844	5.6714	0.9870	0.9907	0.0028	**0.29%**	0.9919	-0.0049	-0.49%	**-0.12%**
14		4.6993	5.6912	0.9919					0.0000	0.00%	
15		4.6772	5.6675	0.9903					-0.0016	-0.16%	
16		4.6650	5.6587	0.9937					0.0018	0.18%	

Sample Density (g/mL) **0.9919**

Table 2. Results and Analysis of Data Obtained from Weighing Application

Summary

The procedure described above represents a typical workflow for a laboratory process which requires the transfer of liquid samples from one location to another, coupled with the integration of a balance to record data for auditing purposes (in this case, to provide a means of measuring the volume of sample delivered, gravimetrically). As part of a larger overall sample analysis process, the data obtained in this application could provide a valuable piece of information for auditing purposes, or perhaps could be used as an input into a subsequent part of the process.

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