Destination Ahead

Embark on an Automation Journey to Surpass Your Competitors

HighRes® biosolutions

The Need For More

In our previous Destination Ahead e-books, we covered your need to outpace your competition to achieve your vision, and how to start planning for your journey.

What's next? Setting out to explore hardware devices, including a close examination of automated liquid handlers, as laboratory workhorses. Hardware is one of three tenets of the most successful automated systems, along with software and peopleware.

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So how can you maximize your organization's efforts and surpass those of your competitors?
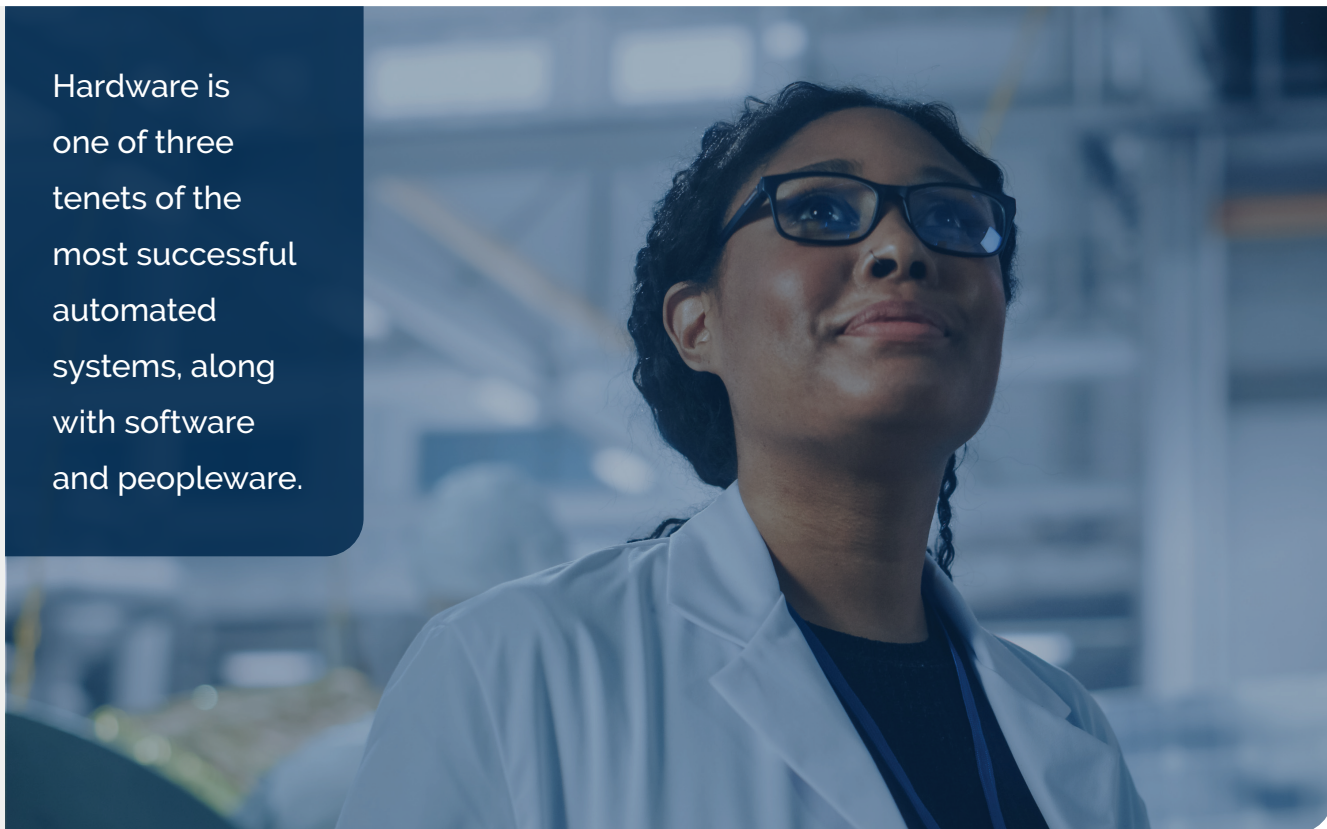
In this seven-part Destination Ahead e-book series, we'll guide you through major phases that you can expect of your automation journey.

For those well-experienced with automated solutions, you might read a few sections to refresh your memory.

On the other hand, for those new to or lightly familiar with automation, and especially whole lab workflow automation, we encourage you to take in as much information as possible in every section.

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The **Destination Ahead** e-book series will cover:

PHASE 1
The Beginning & End
Journey from status quo lab workflows to the land of whole lab automation for opportunity and a competitive edge. Whole lab workflow automation experts like HighRes Biosolutions serve as your North Star and personal escort along the way.

PHASE 2
Understand Your Situation, Your Goals, and Your Team
Introspection and a first-class crew make short work of pre-journey planning. Gather and organize your thoughts, and the thoughts of others, as you assemble your goal guideposts.

YOU ARE HERE

PHASE 3
Dive Deep into the World of Hardware
Hardware Harbor encompasses a large area. Learn helpful tips to traverse through seemingly endless devices and capabilities. Narrow capabilities and features to those best-suited for your budget as well as your current and future needs.

PHASE 4
Immerse Yourself in the World of Software
The Port of Software is an amazing destination along your journey. Gain an overview of data flow and software types and how to orchestrate all through a single, high-functioning information virtuoso. Then determine which platforms stack up to meet your needs.

PHASE 5
Finalize your Proposed Automated Solution Design
Did you chart the right course, or is a major correction in order? Before committing to a final whole lab workflow automation design, review the project overview and details from multiple perspectives.

PHASE 6
Set the Project Build in Motion
It's time to navigate from vision into reality. Get your teams and your site ready with close communication, detailed planning, and rigorous testing.
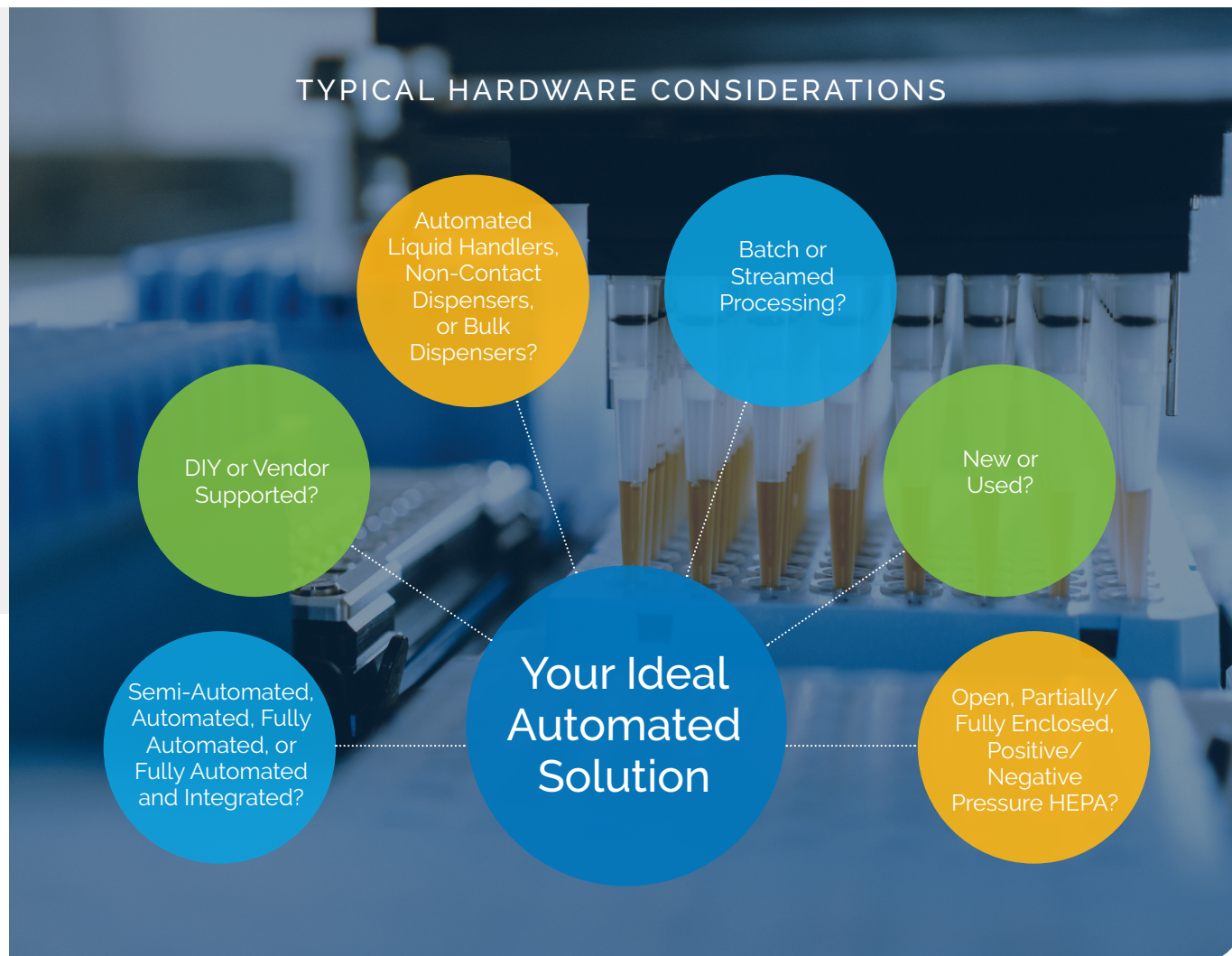
PHASE 7
Deploy!
Your automation journey isn't finished once the automated solution is in place. Prepare users and you new whole lab workflow automation system with knowledge transfer and system optimization. Put it to the ultimate battery of tests in your environment and with your samples and a host of quality and regulatory guidelines.

Explore the World
of Hardware

The world of automation hardware is wide and deep. If you followed the introspection and pre-planning outlined in Understand Your Situation, Your Goals, and Your Team, you've already had a brief overview into lab automation hardware as you defined areas to address in your organization or lab.

TYPICAL HARDWARE CONSIDERATIONS

Automated Liquid Handlers, Non-Contact Dispensers, or Bulk Dispensers?

Batch or Streamed Processing?

DIY or Vendor Supported?

New or Used?

Your Ideal Automated Solution

Semi-Automated, Automated, Fully Automated, or Fully Automated and Integrated?

Open, Partially/ Fully Enclosed, Positive/ Negative Pressure HEPA?

Narrow the Search

Revisit the physical map you created showing the process. Compare each step to hardware that may potentially meet those needs.

Are new devices in your budget range, and do they require you to make concessions in your process? More often than not, your process will have to adapt to suit an automated workflow.

Are the devices appropriate for use in the overarching process? Do you already have current hardware to meet needs while saving costs?

At this time, you should already understand the intent and scope of your ideal automated solution as documented in the user requirement specification (URS). (see "*Understand Your Situation, Your Goals, and Your Team*")
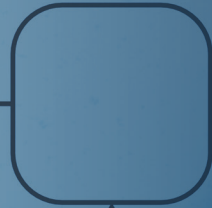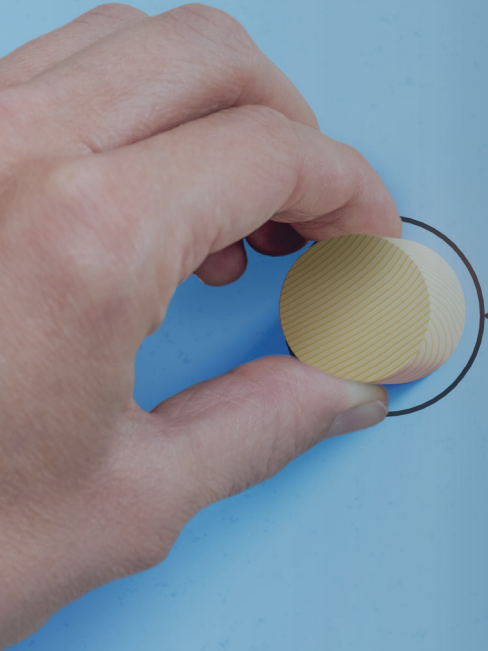
While a simple reader-feeder system or liquid handling workstation, with or without manufacturer support, can improve one step in a semi-automated process, it may create new pain points or bottlenecks in upstream or downstream steps. As a next tier, joining devices together in an automated work cell might require additional support and resources yet it can help to eliminate pain points throughout the workflow.

THE AUTOMATION CONTINUUM

Semi-Automated

Automated

Fully Automated

Fully Automated & Integrated
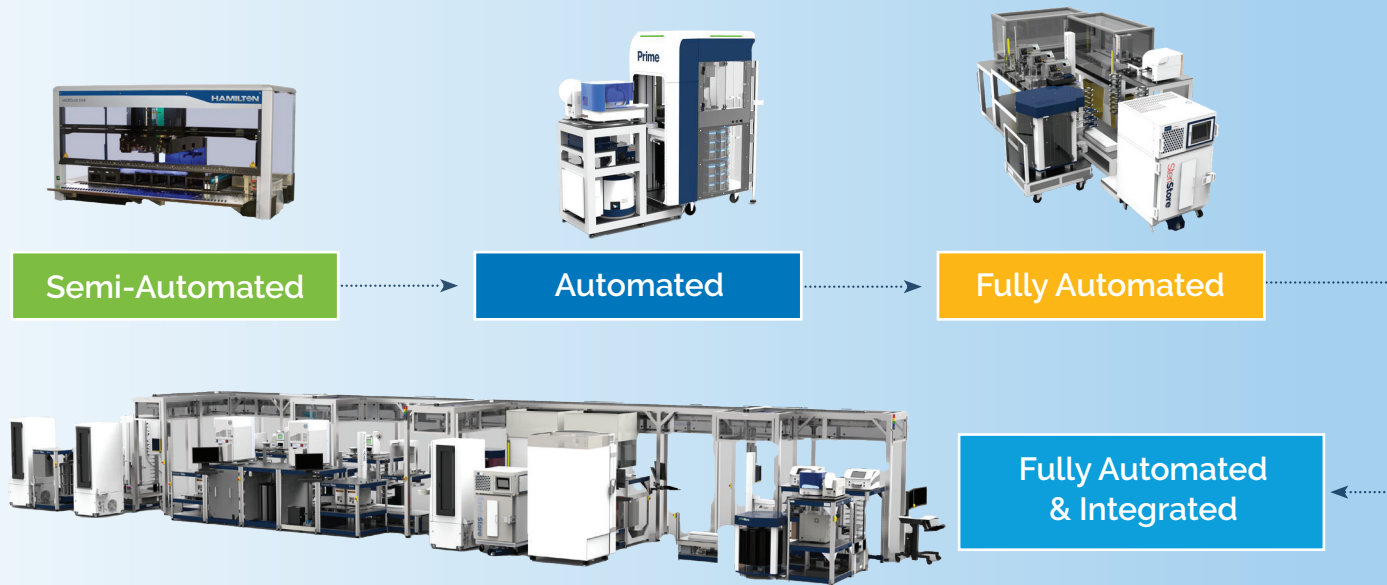
Finally, uniting devices and Work Cells in a fully automated and integrated manner can also require additional support and resources while also accelerating your lab as a high-functioning data factory.

? With that said, are you setting one foot into the world of automation by transitioning one or two workflow process steps from manual to automated?

? Or are you all in, moving from semi-automation into a whole lab workflow automation solution?

? Do your devices of interest have flexibility in response to your evolving or expanding process(es)?

Review the assay requirements and physical conditions in your URS. Use these to help guide your exploration of hardware options.

For instance, samples and reagents can be very sensitive to environmental parameters such as temperature, humidity, and light exposure.
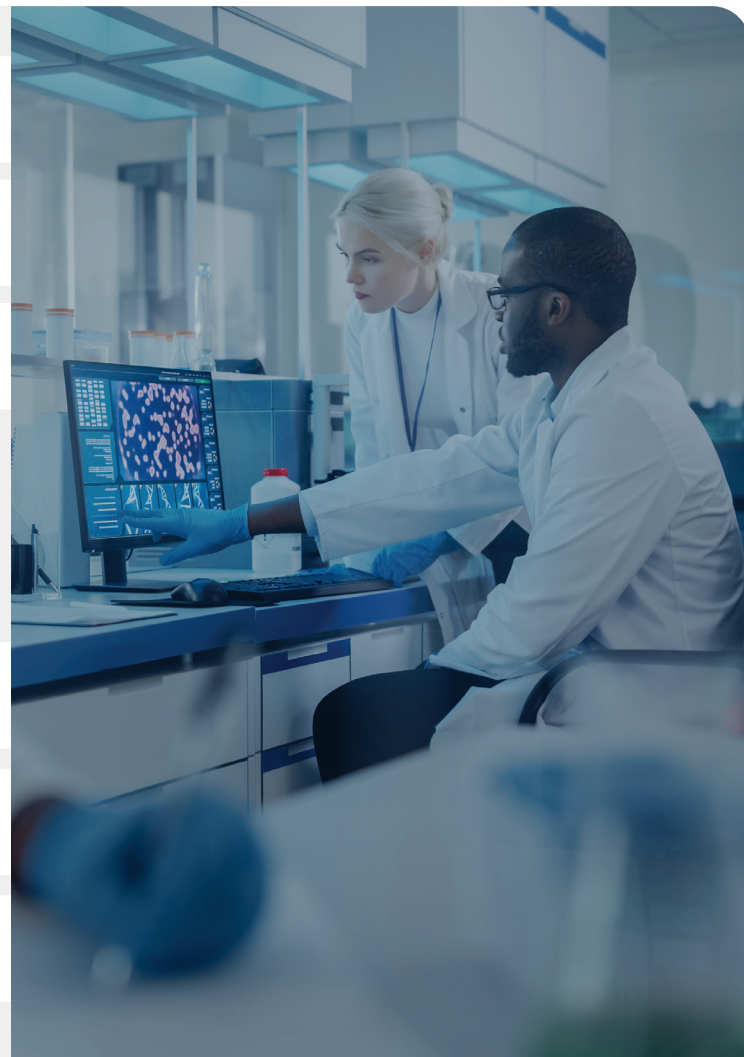
? Beyond active processing, what are your desired sample and reagent storage conditions? How will you keep samples and users safe from harm?

? At the facilities level, are devices suitable for your space?

? Are device or space adjustments necessary, and are there alternatives that do not require change?

Prepare For Modifications Now And In The Future

Again, keep in mind that your current assay protocol will likely be modified to fit an automated workflow. Changes may entail something as simple as changing a consumable labware type or reagent bottle, or it could be something more complex like using a different device.

This is where automation hardware and integration providers are especially useful in recommending an informed course of action.

Another important aspect of automation hardware is time. Not just that of processing time, but longevity of the overall system itself. This is where considering the modular nature of automation equipment is an invaluable asset.

Modularity empowers futureproofing as technologies or user needs change. By integrating new devices into an existing automated system, companies can realize a degree of integration cost saving down the road.

Mobility is another strong benefit that empowers futureproofing. Mobile devices and work cell components allow users to relocate resources quickly and easily throughout the facility in response to shifting priorities and projects.

Some automated infrastructures feature turntables, slides, carts, and docking stations to enhance modularity and mobility. These accessories further extend the flexible use of a mounted device to run in either online as part of an automated system or offline as a standalone manual device at the user's discretion.

IMPACTS ON YOUR AUTOMATION HARDWARE SELECTION PROCESS

Assay Requirements

- Humidity
- Light Blocking
- Reagent Properties
- Shaking and Spinning
- Sterility
- Storage Conditions
- Temperature and Gas Exchange
- Timing
- Toxicity

Facilities Criteria

- Ceiling Drops
- Cleanliness and Sterility
- Floor Flatness and Lagging
- Overall Physical Space
- Sample Safety
- User Access
- User Safety and Ergonomics
- Waste Disposal

Utilities Availability

- Data and Networking
- Electrical
- Gases
- Shipping Crate Storage and Disposal

Exploring Liquid Handlers

As liquid handling plays a major role in most assay workflows, it lends itself to an extra layer of scrutiny. In an automated system, reproducible liquid handling may be accomplished through bulk or non-contact dispensers or, more popularly, through automated liquid handlers (ALH).

Bulk dispensers precisely and quickly dispense large liquid volumes with a high degree of accuracy, but they do not aspirate or mix liquids. Many bulk dispensers offer limited reagent channels and use fixed rather than disposable tips to reduce overall consumable costs.

ALH dispense and aspirate precise liquid volumes with high accuracy and also mix samples. Often, ALH offer expanded functionality by integrating small devices, such as shakers, heating/cooling blocks, and plate sealers, onto their functional decks. The extent of expanded functionality, and therefore unattended run time, is constrained by the size of the ALH deck.

Consumable tip costs can be significant, especially in applications with many liquid handling steps, like library preparation. Some ALH can also require specialized training.

Acoustic dispensing is the most recent liquid handling technology advancement. Here, ultrasound waves move nano- and low microliter volumes from microplates or specialized acoustic tubes into microplates. Low volumes facilitate assay miniaturization to reduce reagent and sample consumption, while the non-contact acoustic method eliminates the use of consumable tips or risk of compound loss due to tip dead volumes.

Batched Or
Streamed Processing

A large choice facing those embarking on automation projects is whether to process samples in a batched or streaming format.

ALH-centric workflows (visualized below) are inherently batch-focused. Sample plates and consumables are manually loaded onto the ALH deck. The first plate doesn't start processing until the last plate is loaded. As the liquid handling method proceeds along with steps completed by other devices integrated on the ALH deck, the first plate on the deck must wait for the last plate to finish processing before the next step can occur.

Visualization batched processing from Gantt chart (top) Device Utilization (bottom)
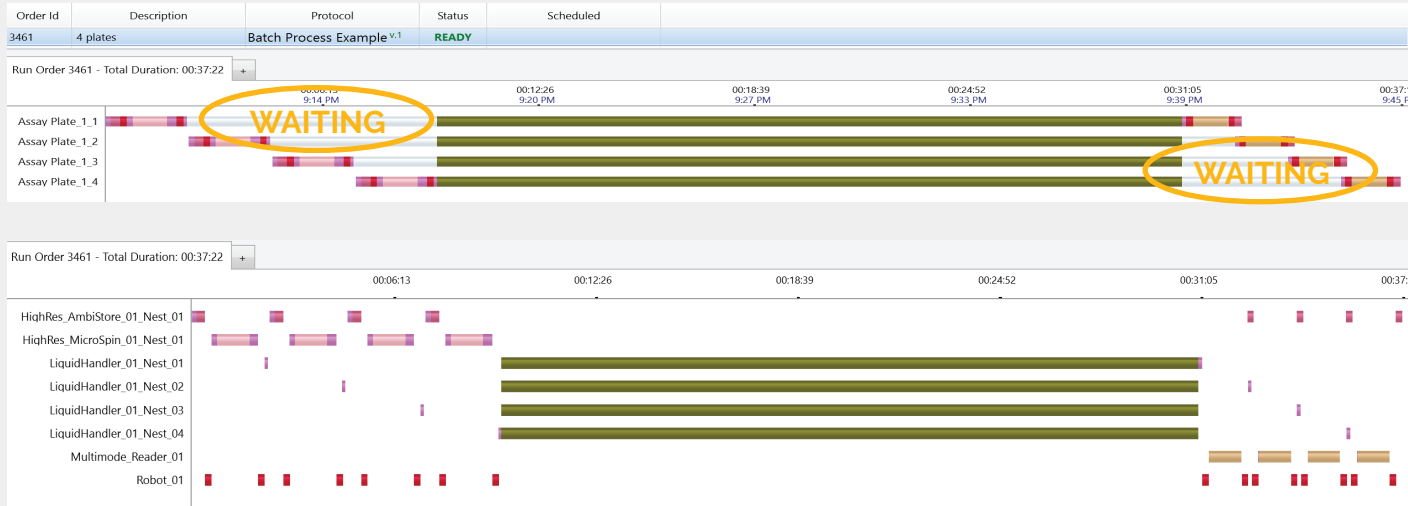

The resulting waiting time variability reduces sample uniformity. And, as all plates finish processing on the ALH before moving to the next workflow step, downstream bottlenecks can and will occur. When errors arise, all sample processing ceases while the error is investigated and mitigated.

By contrast, robot-centric workflows (visualized below) occur in a streamed, parallel, or continuous manner. Sample plates and consumables are automatically moved from a designated storage device or area to the ALH as needed.

Processes proceed in parallel on the microplates and the ALH can be dedicated to its intended function of handling liquids. For example, one plate could be centrifuging on a table while another plate receives reagents on the liquid handler.

Visualization Streamed Processing from Gantt Chart (top) Device Utilization (bottom)

PACED CONSISTENCY
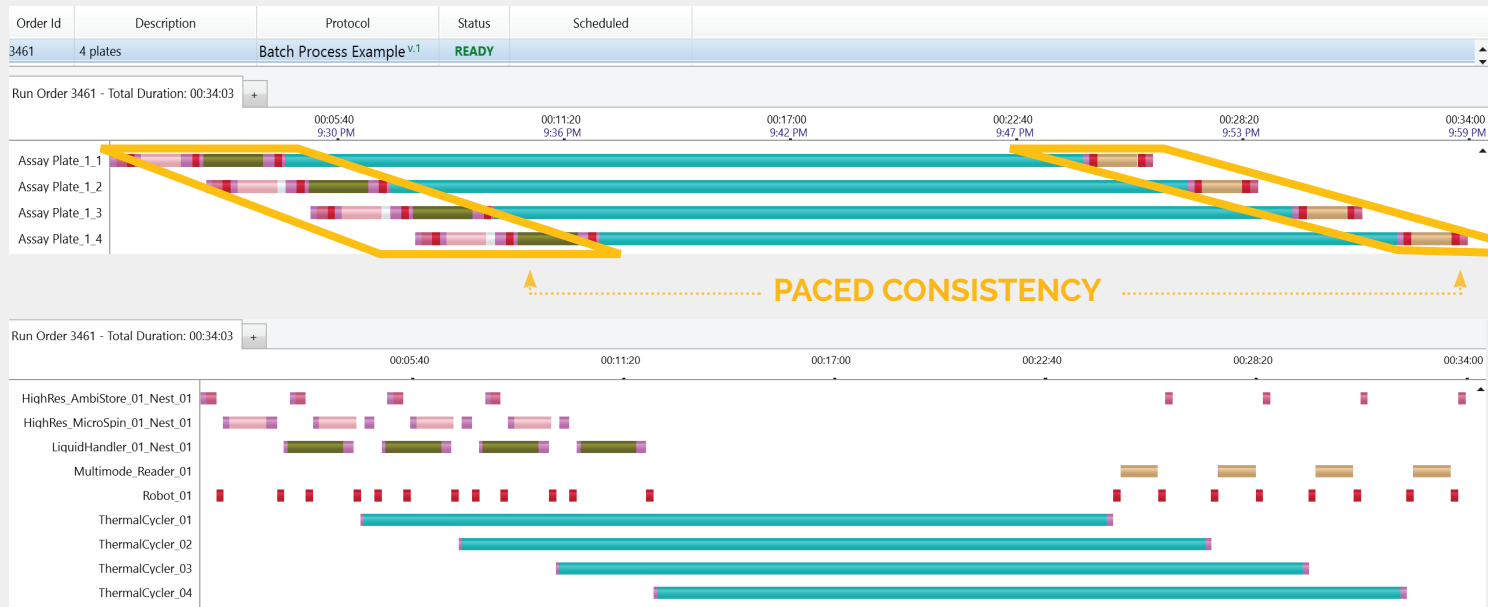
This parallel style of working typically offers tight sample uniformity and device usage as waiting times are reduced or eliminated. It also supports higher throughput capacities.

As the number of microplates scale up, the impacts to time and uniformity can grow accordingly in a batched versus streaming workflow. In the example comparison below, you can see a significant difference in plate uniformity when batch processing 100 plates, whereas the streamed process treats each plate identically. Furthermore, the batched process takes approximately twice as long to complete 100 plates as does the streamed process.

Scaling to Process 100 Plates Example

Different Timing from Plate #1 to #8

Batching (Left) can take -10.38 Hours with Poor Uniformity
While Streaming (Right) Can Take Less Than 5 Hours with Tight Uniformity

Are streaming workflows always the answer?

Of course not. There are several scenarios where batch processing is faster or makes more sense than streaming for the application at hand. Rely on hardware manufacturers to review your process and URS and make expert recommendations.

Beyond the issue of streaming versus batching, multiple liquid dispensers can help to alleviate overall workload burden and offer redundancy if one device is taken offline for maintenance. Separate dispensers can also simplify the process of delivering reagents to labware. Again, this is where the expertise of the liquid handling manufacturer or integration specialist on your team comes in handy.

REMINDERS

✓ Communicate Often

✓ Evaluate Timelines

✓ Review Budget

Exploring Other Hardware Devices

Other hardware in your proposed automated system may include one or more of the following.

Storage devices and incubators with optimized environmental controls (i.e., gas, temperature, humidity) protect and maintain sensitive assay plates, reagents, and samples while they are not being used or as part of the workflow process.

On the other hand, **storage devices with ambient environmental conditions** store and replenish consumable labware (i.e., pipette tips, microplates) without stopping the entire automated system or relying on user intervention.

Microplate and multi-mode readers rapidly and efficiently quantify biological and chemical samples. Automation-friendly models include an easily accessible plate nest with no obstructions to block robot gripper fingers and eliminate manual operations like plate clamping.

If nest access proves to be a challenge in the overall system, consider adding swappable robot gripper fingers that are designed to reach deeper plate nests.

Centrifuges, shakers, thermal cyclers, heaters, coolers, barcode scanners, and many other ancillary devices may be enlisted to complete specific tasks in the workflow.

In a semi-automated system, some of these devices may integrate onto an ALH deck.

In a robotic-based system, integrating these devices away from the ALH deck means that the devices can still be accessed for manual use while the automated process proceeds uninterrupted. It also allows for easy access during troubleshooting; again, without bringing the entire system to a halt.

IS USED HARDWARE A GOOD OPTION?

PROS
- Often less expensive
- Often faster delivery

CONS
- Hidden costs (software licenses, installation/ calibration fees)
- Vendor support availability
- Contamination
- Performance may not equal that of a new device
- Risk of incomplete or unknown service history

Final Hardware
Search Tips

Six additional factors can apply to any hardware device that you research along your automation journey.

1 **Look at the people behind the product.** One training session may not be enough for users to fully grasp the hardware's capabilities, or maybe your project would benefit from assigning superusers with a deep product understanding.

Does the provider offer basic and advanced training to meet these needs? Also, survey support services like application support, preventative maintenance, replacement parts, and on-site visits. What services can you anticipate needing and do they fit your budget?

2 **Ask for product demonstrations in your lab under your typical lab conditions.** Sample blanks and water can help to demonstrate features, but using real-world samples can help you to gauge whether the product clearly addresses your nuanced scientific requirements.

3 **How many of each device will you need?** Duplicate devices may be necessary so that all plates are treated uniformly without wait times related to overburdened devices. In this scenario, an applications analysis or software simulation can help to determine the optimal number of devices that should be included on your system. Duplicate devices may also be necessary to support current and future throughput and assay needs or to offer redundancy in the event of planned or unplanned device downtime.

4 **Anticipate how your needs may change over time.** Will your throughput increase, or will you add or change a plate type? Will additional assay types be run on the automated system?

5 **Consider how data will move to and from each device.** This is where hardware and software are strongly intertwined in context of the holistic approach. Standards in Laboratory Automation (SiLA) compliant devices with open application programming interface (API) architectures ease the flow of data and communication to and from each device in the overall system. Additional details are provided in 'Immerse Yourself in the World of Software'.

6 **Think about the level of pre- and post-sales support you would like from the integration or each hardware vendor.** Post-installation support underscores the importance of people in the trinity of hardware, software, and peopleware. Will they make device and workflow change recommendations, simulate the process to evaluate capacity needs, and allow you to test the device using actual samples in your laboratory environment?

Connect with Us Before you Take the Next Step

Embarking on an automation journey? Depend on HighRes Biosolutions to be a friendly and experienced team member! Our multi-faceted experts are on hand to provide personalized guidance, helpful insights, and actionable tips through each phase of your unique journey.

Before you take that next step into automation, including whole lab workflow automation, reach out to us at sales@highresbio.com.

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Learn More

We invite you to read the fourth e-book in this Destination Ahead series, *"Immerse Yourself in the World of Software".* Here, you will learn what a software stack is and why it is critical to your lab's success. You will also learn how to orchestrate hardware and software for maximum productivity.

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