Accelerating Process Chemistry

How Data Management is Enhancing Pharmaceutical Development

Summary

Process chemists are responsible for developing a synthetic method that efficiently synthesizes a drug substance while avoiding the formation of process impurities. However, many process chemists do not have software designed to meet their needs and must use a patchwork of tools to manage their experimental results. Information is spread across many systems, which leads to considerable time spent managing data.

This eBook explores how process chemists can increase their efficiency with the support of Luminata, which allows research teams to access process, analytical, and chemical data from across their organization. The software also offers tools designed to accelerate process chemistry tasks, such as parameter mapping, preparing process control justification (PCJ) reports, and sharing experimental data between teams.

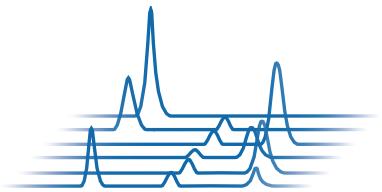
AbbVie is an example of a pharmaceutical company that has experienced considerable efficiency gains with the help of Luminata. An internal study assessed the time needed to manage data when completing an experiment using a laboratory reactor. A Luminata-based workflow could reduce the data management time by 84%, leading to hundreds of hours saved per step in a synthetic process.

Table of Contents

Data Challenges in Pharmaceutical Process Development

Process chemists are responsible for identifying the synthetic route used in pharmaceutical manufacturing. A key obstacle in API process development is managing experimental data, which is frequently distributed among multiple systems, including vendor software, ELNs, and CDSs. Many process chemists do not have software designed to consolidate and interpret their experimental results. Scientists must navigate a patchwork of incompatible data management tools, which is often inefficient, error-prone, and tedious.

This eBook explores how chemists can solve their data challenges and increase efficiency. This section addresses three issues: parameter mapping, assembling Process Control Justification reports, and technology transfer. It also lays out the qualities of a data management tool that would meet these needs.



Parameter Mapping and Visualization

One of the critical functions of the process chemistry department is parameter mapping, which involves repeating each synthetic reaction hundreds of times, varying factors such as temperature, pH, and solvent. These data-rich experiments are often carried out in a laboratory reactor, allowing tight monitoring and control of the synthetic conditions. The performance of each method is assessed by monitoring yield and levels of impurities, which are determined using analytical techniques such as chromatography.

However, laboratory reactors are disconnected from analytical chemistry instruments. Managing the data generated from these hundreds of parameter mapping experiments requires considerable time investment. Process chemists often rely on Excel to perform this assembly and visualize results, but this comes with its own challenges.[1] Building and managing spreadsheets requires considerable manual transcription, which is time-consuming and error-prone. Excel does not allow users to search by chemical structure, cannot access live analytical data, and is ill-suited for collaborative projects.

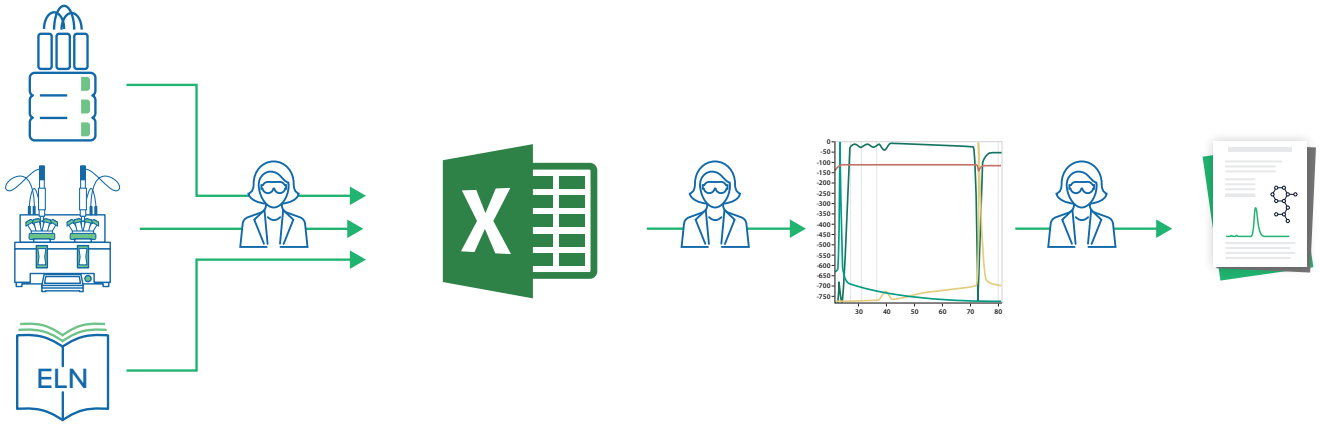


Figure 1: Data flows for creating a parameter map during process development using an Excel-based workflow. Transfer of data between each stage is manual, which is both time-intensive and error-prone.

Overall, data management has become a significant challenge when conducting parameter mapping experiments. Process chemists need a data management tool that consolidates analytical and process results in a single interface and allows scientists to visualize results in a manner that supports effective decision-making.

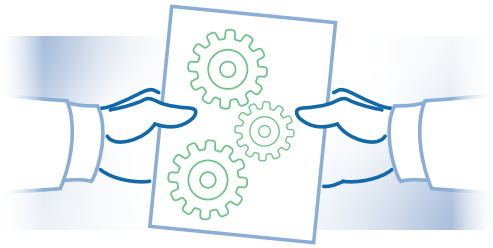
Compiling the Process Control Justification Report

Once development is complete, members of the process chemistry team must prepare a Process Control Justification (PCJ) report. The regulatory affairs team uses this document to prepare filings submitted to the FDA. The PCJ report describes:

- The method used to synthesize the drug substance and drug product
- Critical Process Parameters (CPPs)
- Critical Quality Attributes (CQAs)
- Methods and instrumentation used to monitor the CPP and CQA

Compiling this document requires gathering information from several teams, including early and late development, process chemists, analytical chemists, and contract research organizations. Traceability is also a concern since regulatory affairs teams rely on the PCJ report when preparing documentation for regulatory agencies. Assembling this information is time-consuming and may require repeating experiments because of lost files.

Process chemistry teams need a software tool to bring together data from across multiple teams and generate documentation for PCJ reports. This will save time and decrease the risk of errors.



Technology Transfer Assembly

Manufacturing sites need information about the synthetic process before they can begin production. This information is shared through technology transfer. According to ICH Q10, the goal of technology transfer is to "transfer product and process knowledge between development and manufacturing and within or between manufacturing sites to achieve product realization."[2]

Chemical information found in this package includes:

- Reaction schemes
- Process control measures
- Molecular structures and safety information for intermediates and relevant impurities
- Chemical data about intermediates, including solubility data and solid-form data

Process chemistry teams are involved in preparing these technology transfer packages. Data is stored in multiple locations and file formats, meaning that team members must gather the relevant information, consolidate it into an accessible format, and then share it with the manufacturing team. Not only does this take considerable time for the process chemistry team, but the manufacturing team may not be able locate all the information they need, leading to delays.

This challenge could be resolved with a cheminformatics tool compatible with many types of chemical data and designed to support collaboration. This would allow the process chemists to share relevant information with the manufacturing team directly in the platform, reducing the reliance on technology transfer documentation.

Upgrading Your Process Chemistry

These concerns around data management in process chemistry have a common cause—disconnected tools that do not meet the needs of pharmaceutical development. Scientists must spend time handling and transcribing data rather than on research. These inefficiencies are frustrating for the chemists and expensive for their business.

Luminata has been designed to bridge the data management gaps in process development and includes several features that simplify analysis and decision-making. In the following sections, we will explore the ways Luminata addresses these challenges and how pharmaceutical companies use the software to accelerate their research.

How Luminata Accelerates Process Control Data Management

Data management has become a significant time investment for many chemists. A 2022 survey of chemical researchers by ACD/Labs found that over 92% of respondents collect data on numerous instruments, use multiple techniques, and rely on several software tools for processing analytical data. Managing these multiple data sources is a real challenge—68% of respondents said using or sharing data was hard.[3]

These data management issues are magnified in pharmaceutical development, where multiple teams collaborate to complete their work. Process chemistry, analytical chemistry, and regulatory CMC teams must all coordinate to be successful. Many organizations also recruit contract organizations (CXOs) to complete some of the necessary research. Information cannot freely flow between these teams, leading to data becoming siloed or lost.

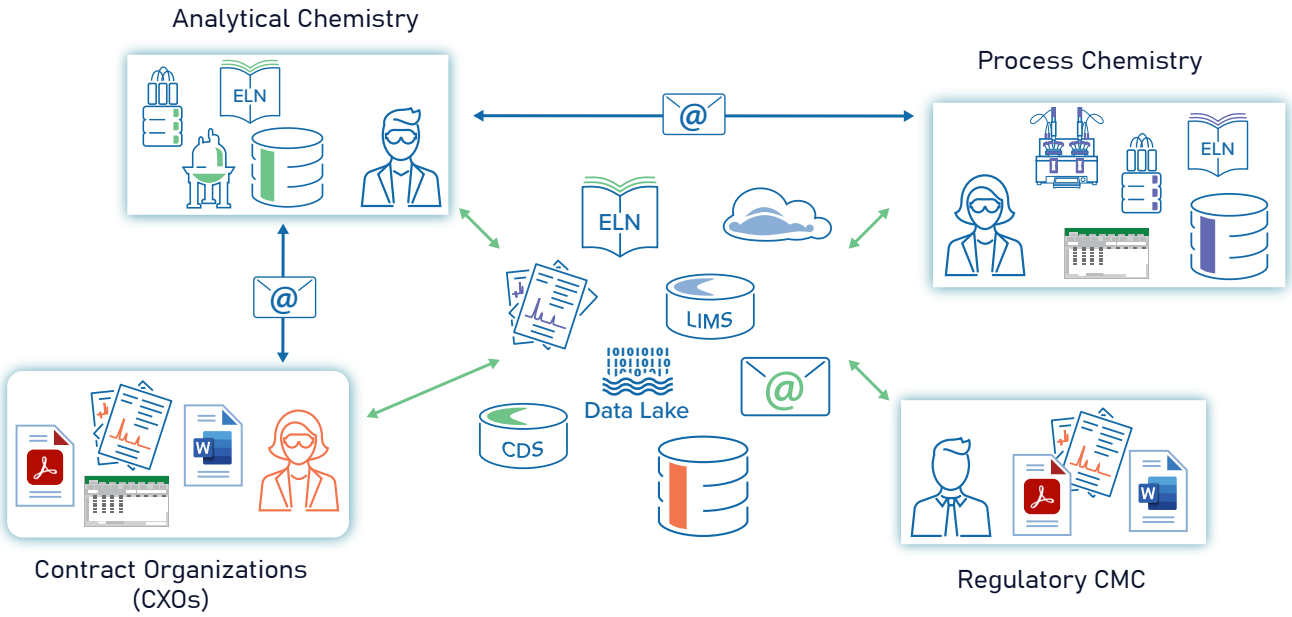


Figure 2: Current state of data management in pharmaceutical development

To overcome these challenges, pharmaceutical companies will need to embrace digital transformation. Information needs to be stored in a vendor-neutral format that enables collaboration. Companies also need to be prepared for artificial intelligence, which is disrupting and accelerating conventional pharmaceutical research and development.

Luminata upgrades how research teams access chemical and process data, allowing anyone to access many streams of information from a single interface. Luminata was built on the following principles:

Chemically intelligent platform: Luminata understands chemical structures and reaction schemes. Analytical and chemical data are connected to structures, allowing users to make better decisions. Users can also perform structure-based searches to see if a chemical has been identified previously.

Live analytical data: Access all your chromatograms, mass spectra, NMR spectra, and more in a single interface. Reprocess your data to better understand your results without juggling spreadsheets and multiple file formats.

Collaborative science: Share results with your entire development team, no matter if they are down the hall or across the world. Put an end to endless email chains or file-sharing dumping grounds.

FAIR data principles: Luminata adheres to FAIR data principles, meaning stored data is findable, interoperable, and reusable.[4]

This significantly increases the range of use for your experimental results, including supporting data science and machine learning initiatives. But what does this mean in practice? How does consolidating data into one interface improve process development? One company that has implemented this tool is AbbVie. Their experiences demonstrate how Luminata accelerates process chemistry research.

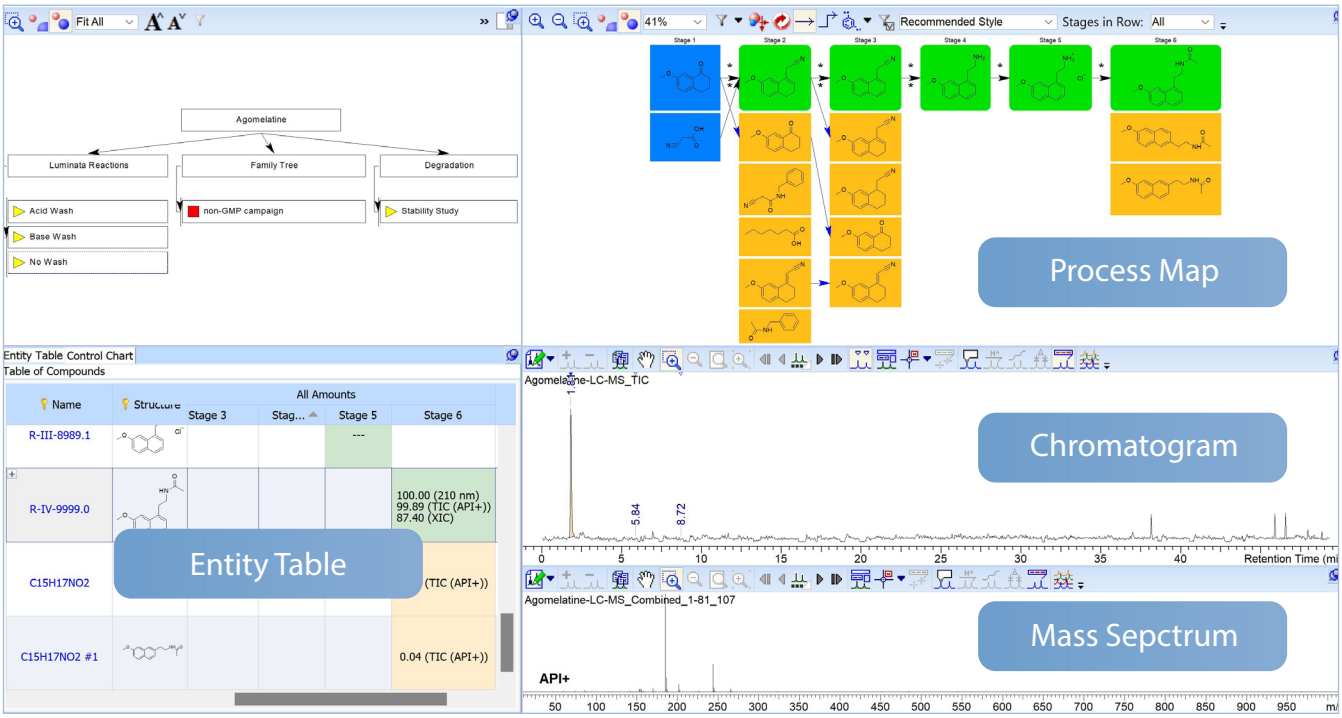


Figure 3: Luminata allows users to access process and analytical data and information in one interface.

Case Study: AbbVie Reduces Process Chemistry Data Management Time Investment by 84%[5,6]

AbbVie's development team wanted to transform how they used their data, aspiring to evolve into a digitally integrated organization that views data as a vital asset. The group wanted to enable better scientific decision-making and to realize substantial efficiency gains. The objectives of this initiative included:

- Reducing the reliance on unstructured tools, such as SharePoint, Excel, or OneNote
- Creating a central database that is accessible to everyone
- Minimizing the time spent on manual transcription and verification
- Automating scientific reporting
- Creating and leveraging predictive models

This project would involve many steps, so it was decided to break it into individual use cases. One of the first goals was automating parameter mapping.

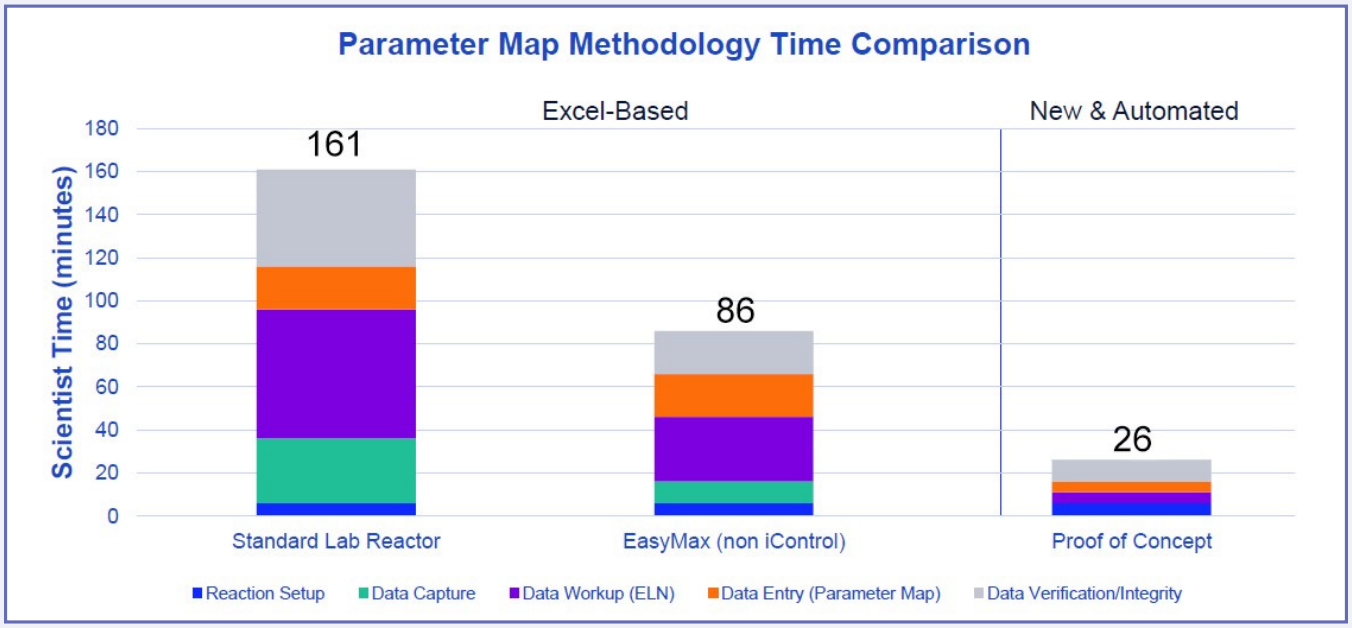


Figure 4: Efficiency gains from using Luminata in parameter mapping experiments. Proof of concept conditions used Luminata to capture and process the analytical and process data.[6]

AbbVie's process development team uses the Mettler Toledo EasyMax laboratory reactor to conduct experiments, which can track the reaction's many physical and chemical conditions as it progresses.

Unfortunately, managing all the data generated by the EasyMax laboratory reactor has become a challenge. “These reactors are gathering information from multiple probes, and they are doing that every 2 seconds,” said Mathew Mulhern, a Principal Scientist at AbbVie. “These data-rich experiments can very easily become data-paralyzing. We gather all this information and try to think of a use for it later.”

The team decided to implement Luminata to address this challenge. Luminata would read data from the laboratory reactor and the Empower CDS. The iControl tool allows users to visualize the reactions without the need to export to a spreadsheet. Data would then be exported to a data warehouse, where it could be analyzed with statistical tools such as JMP and Spotfire.

When the new workflow was implemented, a test was run to determine overall time savings. Preparing a parameter map using a standard laboratory reactor took over 160 minutes, primarily due to time spent on data capture, workup, and verification. If the scientist switched to the EasyMax reactor while continuing to use Excel, the time investment dropped to 86 minutes, a 45% decrease. When implementing the Luminata-based workflow, the time investment fell to 26 minutes, an 84% reduction in overall time investment.

In addition to the efficiency gains, Luminata allows scientists to find data more efficiently and compare results between researchers, no matter where they are in the company. “That’s where the beauty of Luminata really comes into play—it’s that data accessibility,” said Mulhern, “that ability to look at that single source of truth.”

Overall, Luminata has led to real efficiency gains within AbbVie’s process chemistry department and will be an important part of their ongoing initiative to upgrade their data management.

Upgrading your Process Control with Luminata

Luminata allow users to combine their analytical, process, and chemical data in a single interface. Once the data is in the software, there are many features that have been designed to support the work of process chemists. This includes the iControl tool for parameter mapping, the ability to export data for assembling PCJ reports, and composition-centric views for technology transfer.

Parameter Mapping with iControl

Process chemists need software to visualize their process and analytical data simultaneously. Physical (such as temperature, pressure, and stirring speeds) and chemical conditions (such as pH and concentrations) ultimately control a reaction's yield and impurity profile. However, bringing together this information and offline analytical chemistry results has traditionally been cumbersome, with each type of data being stored in its own siloed system.

Luminata allows users to bring together that data in one interface and visualize how these physical and chemical factors influence the performance of the reaction. This type of visualization helps identify trends, such as changes in temperature or concentration, which may lead to the formation of impurities.

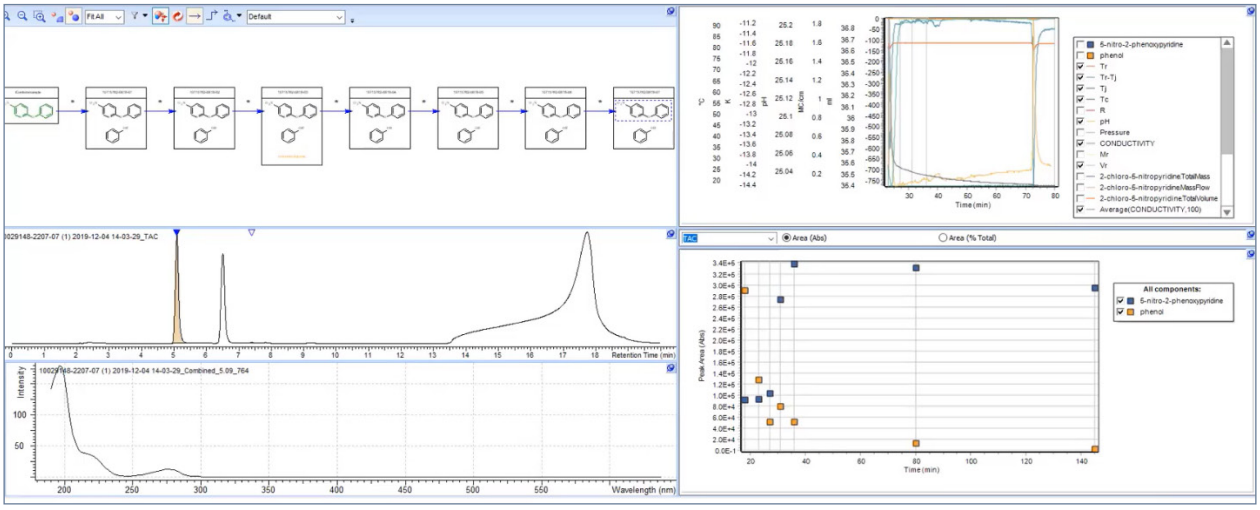


Figure 5: Example process data in the iControl tool. Top left contains process map, top right displays parameter trend data from the EasyMax reactor, bottom left shares the analytical results, and bottom right displays concentration as a function of time.

Support for Process Control Justification Reports

Luminata efficiently manages and tracks data from its origin, linking it directly to ELNs as source documents. This feature is beneficial when preparing a PCJ report, as it provides an audit trail for experimental data. The software also allows users to filter information to build summary tables based on the parameter mapping data. These tables can then be used directly in a PCJ report.

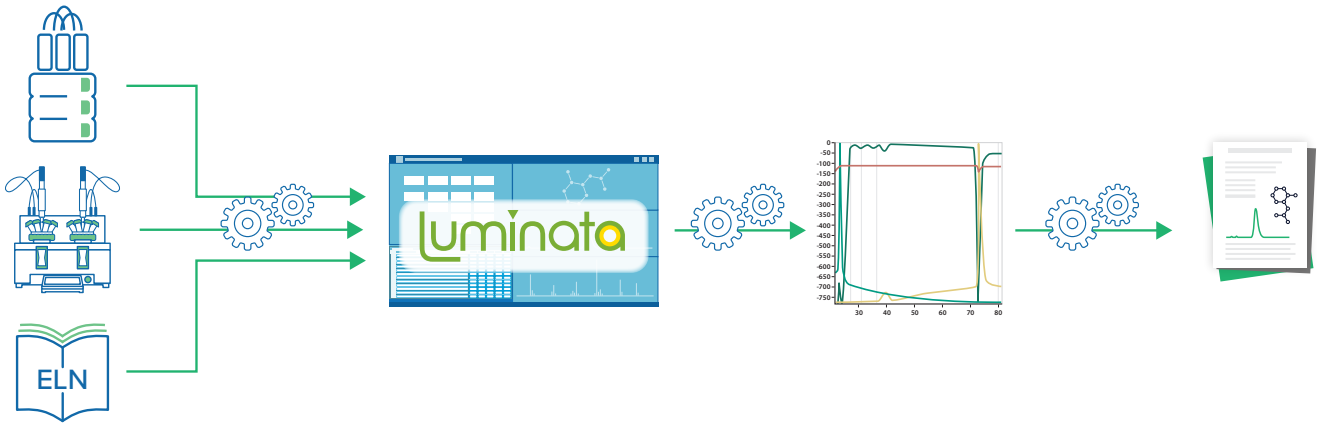


Figure 6: Data flows for creating a parameter map during process development using Luminata-based workflow. Transfer of data between each stage is automated, which saves time, and reduces the risk of error.

Researchers have reported significant efficiency improvements when preparing PCJ reports, estimating a 33% increase in productivity.[7] This efficiency gain is attributed to the reduced need for managing spreadsheets and searching for data across multiple locations. This consolidation saves time and reduces the potential for errors, ensuring a more streamlined and reliable process for preparing PCJ reports.

Technology Transfer

Luminata streamlines the assembly of technology transfer packages, particularly in managing chemical information. Reaction and degradation schemes, molecular structures, chemical properties, analytical reference data, and safety information are all available within the software. This integration simplifies the process of transferring knowledge between facilities.

Users can view where a molecule appears in a process or a batch using the analytical data that has been collected, as seen in Figure 7. This layout helps identify where impurities have been observed within a process.

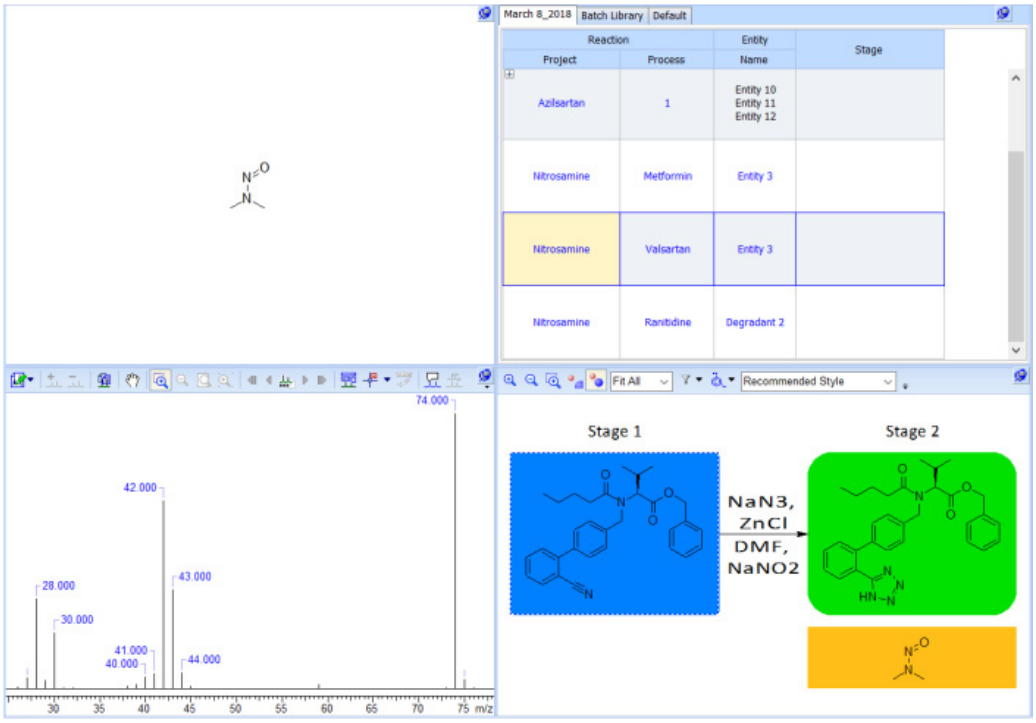


Figure 7: Composition centric view of analytical data, with a table displaying where genotoxic impurity is observed within a project.

In addition to tracking where a specific impurity is observed, the software also allows users to track which batches have come into contact with an impurity. This functionality enables the manufacturing team to access the development team's knowledge.

Are You Luminata Ready?

Many of the world's top biopharma companies are using Luminata to enhance their development work. Luminata changes the way scientists access and share data, leading to better, more efficient product development. This includes several tools that have been developed to support process control.

Is your organization ready for Luminata? Here are some questions to consider:

1. Are your process chemists and engineers spending considerable time on data handling tasks?
2. Are you storing analytical and chemical data in multiple data silos that cannot communicate effectively?
3. Does your research team spend significant time preparing Process Control Justification reports or technology transfer packages?
4. Does your process development research take place at multiple sites, or involve contract organizations?
5. Do you rely on Excel spreadsheets to consolidate your process development data?
6. Is your organization attempting to "digitally transform" your research and development?
7. Would team leaders or management benefit from more information about the progress of your project?
8. Do you have the necessary IT infrastructure to deploy an advanced chemical data management solution?

If you answered "yes" to some or all these questions, Luminata may be an effective tool for enhancing your research. To learn more about how Luminata can support research at your company, contact us to talk with one of our representatives.

Contact Us

Additional Resources

Watch now

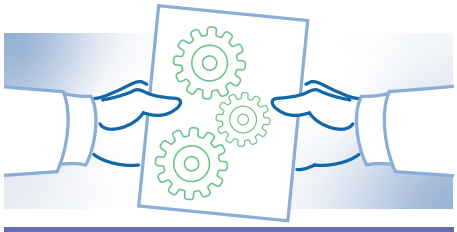
Webinar: Dealing with Data Paralysis in Pharmaceutical Process Development

Data management in process chemistry and engineering can feel like a full-time job without the right tools. Watch our webinar, where Mathew Mulhern (AbbVie Pharmaceuticals) and Joe DiMartino (ACD/Labs) present how Luminata from ACD/Labs simplifies data management.

Read now

Case Study: Bridging Data Management Gaps

See how a process development team at a top biopharmaceutical company streamlines chemical and process data management and lowered their dependence on unreliable spreadsheets with the help of Luminata.



Read now

Application Note: Enhancing Technology Transfer with Data Management Technology

Explore how Luminata enables pharmaceutical technology transfer, ensuring efficient, integrated data management from early to late-stage development.

References:

1. Moser, A., Waked, A.E., DiMartino, J. (2021). Consolidating and Managing Data for Drug Development within a Pharmaceutical Laboratory: Comparing the Mapping and Reporting Tools from Software Applications. OPRD, 25(10), 2177-2187.
2. International Council for Harmonisation (ICH). (2008). Pharmaceutical Quality System Q10. Read the report.
3. Bhal, S. (2022). The Analytical Data Management Report 2022. ACD/Labs. Read the report.
4. Wilkinson, M.D., et al. (2016). The FAIR Guiding Principles for scientific data management and stewardship. Scientific Data, 3(1), 1-9.
5. Mulhern, M. (April 2021). Dealing with Data Paralysis in Pharmaceutical Process Development. ACD/Labs. Watch the presentation.
6. Agnihotri, M. (March 2023). Applying Innovative Platform Solutions to Support Scientists. Lab of the Future.
7. Harris, J. (2021). Real Results from Bridging Gaps in Data Management. ACD/Labs. Read the Case Study.