EMERSON EXCHANGE 2025

ACCELERATING INNOVATION

ACCELERATING INNOVATION

5-1168 Real-time Adaptive Solutions to Optimize Global Manufacturing Networks

EMERSON EXCHANGE 2025
ACCELERATING INNOVATION

Disclaimer

The information and/or opinions expressed in this presentation are those of the authors and do not necessarily represent official policy or permission of Emerson or Emerson Exchange.

Important Reminders

Photography and audio/video recording is not permitted in any session, or in the exhibition areas, without press credentials or written permission from Emerson or Emerson Exchange.

Inquiries should be directed to:
EmersonExchange@Emerson.com

Ron Rossbach

Assoc Dir, Digital Manufacturing

Merck & Co., Inc., Rahway, NJ, USA

ron.rossbach@merck.com

Merck & Co., Inc., Rahway, NJ, USA Forward-Looking Statement

This presentation includes “forward-looking statements” within the meaning of the safe harbor provisions of the U.S. Private Securities Litigation Reform Act of 1995. These statements are based upon the current beliefs and expectations of the company’s management and are subject to significant risks and uncertainties. There can be no guarantees with respect to pipeline candidates that the candidates will receive the necessary regulatory approvals or that they will prove to be commercially successful. If underlying assumptions prove inaccurate or risks or uncertainties materialize, actual results may differ materially from those set forth in the forward-looking statements.

Risks and uncertainties include but are not limited to, general industry conditions and competition; general economic factors, including interest rate and currency exchange rate fluctuations; the impact of pharmaceutical industry regulation and health care legislation in the United States and internationally; global trends toward health care cost containment; technological advances, new products and patents attained by competitors; challenges inherent in new product development, including obtaining regulatory approval; the company’s ability to accurately predict future market conditions; manufacturing difficulties or delays; financial instability of international economies and sovereign risk; dependence on the effectiveness of the company’s patents and other protections for innovative products; and the exposure to litigation, including patent litigation, and/or regulatory actions.

The company undertakes no obligation to publicly update any forward-looking statement, whether as a result of new information, future events or otherwise. Additional factors that could cause results to differ materially from those described in the forward-looking statements can be found in the company’s Annual Report on Form 10-K for the year ended December 31, 2024 and the company’s other filings with the Securities and Exchange Commission (SEC) available at the SEC’s Internet site (www.sec.gov).

EMERSON EXCHANGE 2025
ACCELERATING INNOVATION

Setting the Stage

Our Strategic Priorities

Invest in, augment and accelerate our pipeline to deliver life-changing products	Demonstrate value to our stakeholders and extend access to solutions that address unmet medical needs	Drive innovation and productivity, enabled by digital and data	Invest in the growth, success and well-being of our people

2025 Manufacturing Priorities

• Develop and launch our **complex and diverse pipeline**, ensuring **speed** to market and **robustness** to enable **predictably reliable, compliant supply** • Execute **CMC Launch Preparedness** workstreams to enhance enterprise capabilities, infrastructure, partnerships, systems, and talent • Continue execution of **capital builds**, **technology platforms** and the advancement of **strategic partnerships**	• Generate value through world class **resilient** supply chains sustaining **reliable, compliant supply** and top quartile **quality** and **compliance** performance • **Expand access** for a targeted, segmented portfolio by improving product cost • Meet ambitious **sustainability** goals for internal sites and supply partners • Deliver on Total Cost Base and P&L to enable **sustained growth**	• Improve **agility** through **lead time adherence** for prioritized supply chains with proactive **risk management** • Deliver on **process standardization and simplification** initiatives utilizing digital capabilities and MPS • Drive **focused prioritization** and deliver the transformation portfolio achieving **value realization**	• Advance our commitment to the **safety, well-being** and **engagement** of our employees. • Build **critical enterprise leadership skills** and **technical capabilities** • Cultivate our diverse workforce and inclusive culture which allows us to **attract, develop** and **retain** talent

Anticipate, shape and navigate the evolving landscape and pivot as needed

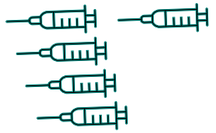
Maintain unwavering focus on safety, quality, compliance and sustainability

Understanding the Challenge

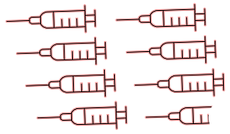
Let’s consider the output of a facility with increased demand and capacity constraints

Capacity

5.0 MM
units/month

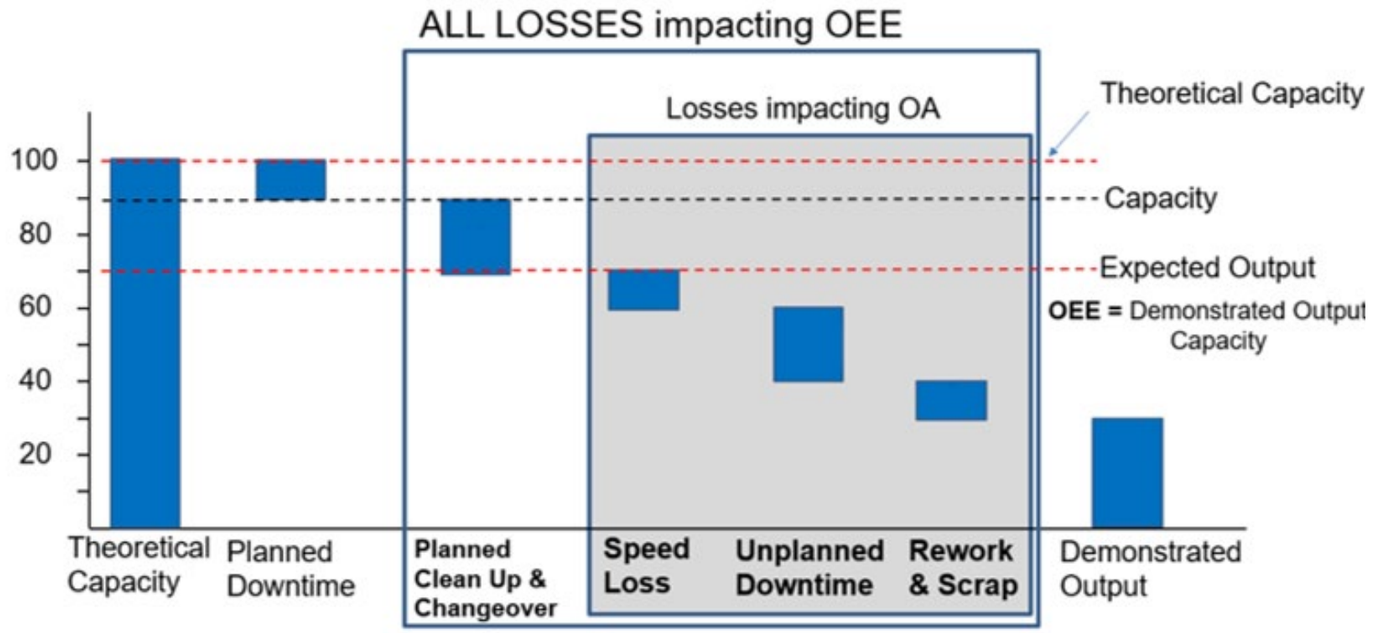


7.5 MM
units/month



Capacity Visualization

At the core of the **OA/OEE** digital tool is MPS capacity Waterfall Chart visualization & KPI's:



$$OA = \frac{\text{Demonstrated Output}}{\text{Expected Output}}$$

$$OEE = \frac{\text{Demonstrated Output}}{\text{Capacity}}$$

$$OR = \frac{\text{Demonstrated Output}}{\text{Theoretical Capacity}}$$

MERCK

OA/OEE Digital Tool

Production Effectiveness Measurement

The **OA/OEE** digital tool that measures, monitors and visualizes losses and calculates OA, OEE and OR.

Understand Current State	Target Improvement Areas	Measure Impact of Improvements

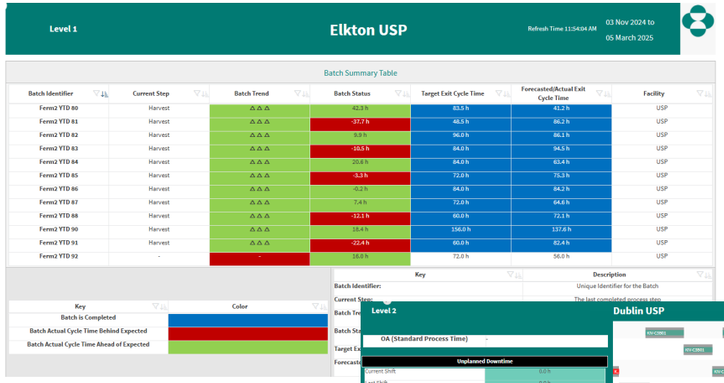
'Measurement is the first step that leads to control and eventually to improvement. If you can't measure something, you can't understand it. If you can't understand it, you can't control it. If you can't control it, you can't improve it.' – James Harrington

Measuring and monitoring **OA/OEE** in conjunction with a process improvement program

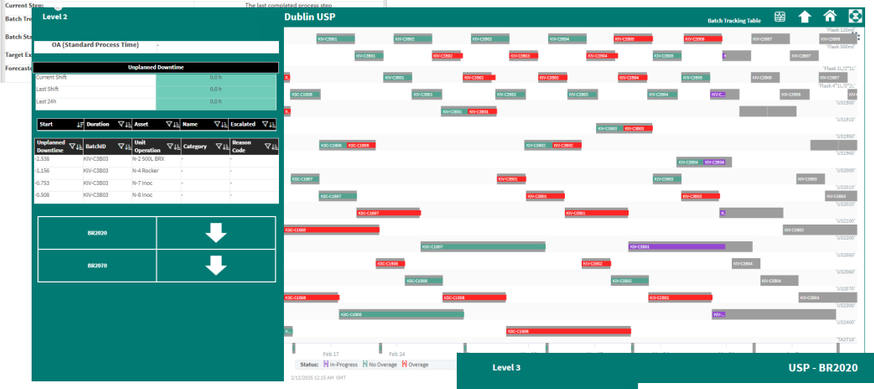
- ✓ Unlocks capacity
- ✓ Decrease time to produce
- ✓ Better manage equipment/capital

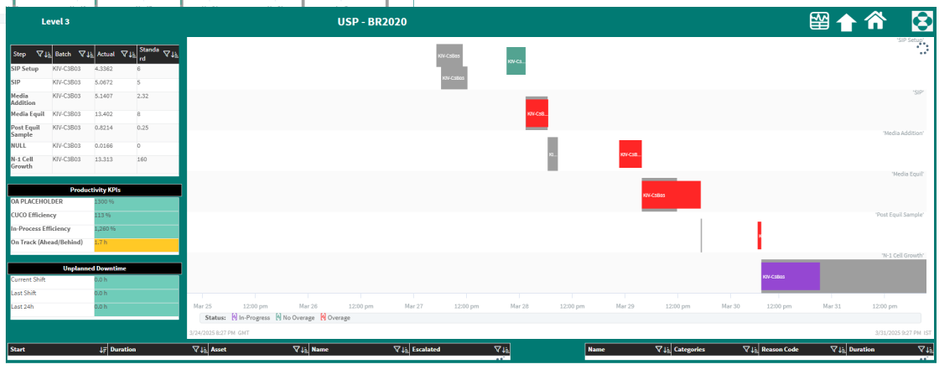
MERCK

Level 1, 2 & 3 Real-Time Efficiency Views, for RtB, Real-Time Monitoring



Level 1 Manufacturing Facility View





Performance Management Process with Standardised Real-Time KPIs

- On Track/Off Track
- Downtime (Shift/Last 24 Hours)
- Downtime Table (Reason codes)
- OA (Equipment Efficiency)
- CUCO (Clean-up & Changeover)

Level 2
Area / Unit Operation View

Level 3
Asset / Processing steps View

More Granular Detail

The L1, L2, L3 Views represent scale:

Level 1 View
- Airport Terminal
- “Flight Status” on Terminal Board.

Level 2 View
- Area View Batch Status
- Unit Operations.

Level 3 View
- Asset / Equipment View visualising
- More Granularity with Plan vs Actual cycle time performance on each processing step.

EMERSON EXCHANGE 2025
ACCELERATING INNOVATION

The Foundation

Real-Time Adaptive Scheduling with DeltaV RTS

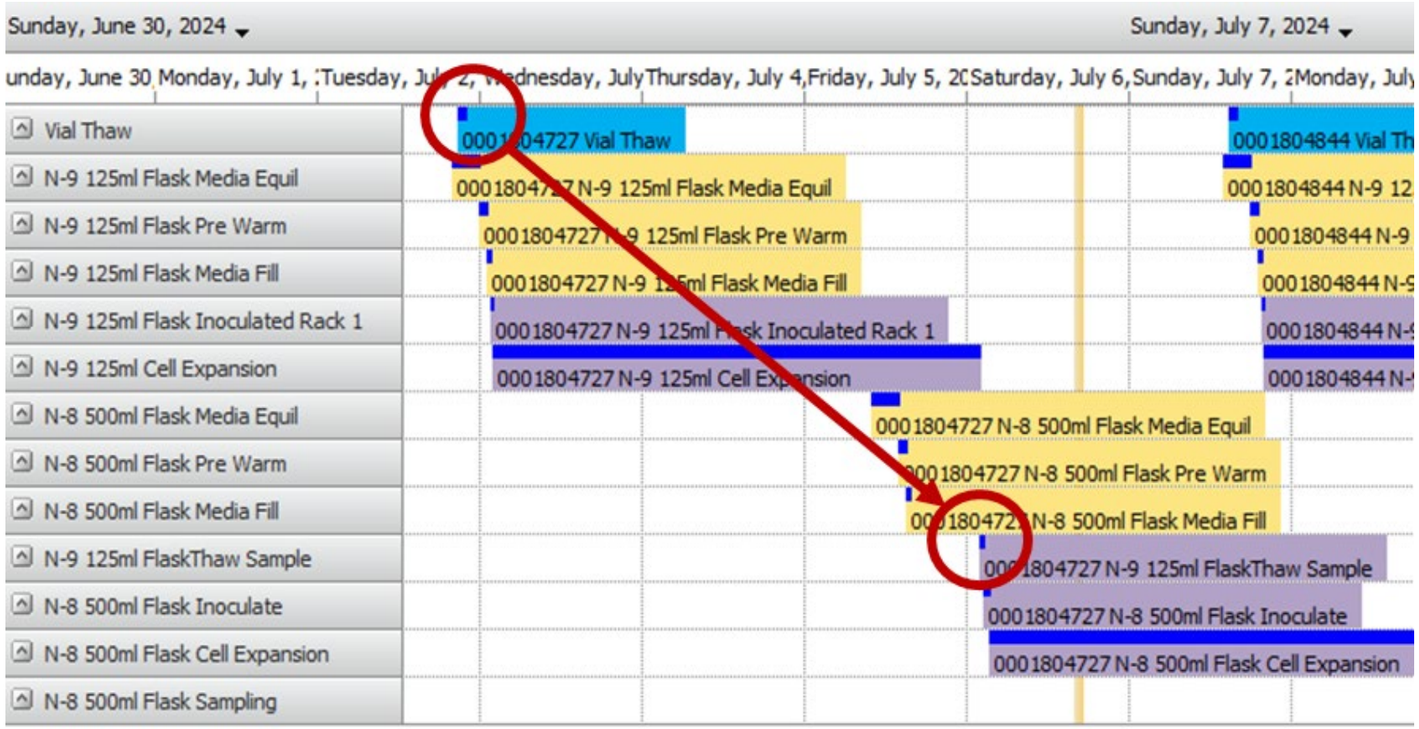
Data Foundation with DeltaV RTS

L2 Views summarize granular schedule tasks into “segments” along the process path

The baseline duration of each segment is the sum of the chosen planning durations of its granular tasks

For example, the “Start Vial Thaw” segment in this process covers 77.92hrs, the standard time from start of Vial Thaw to the end of N-9 Sample

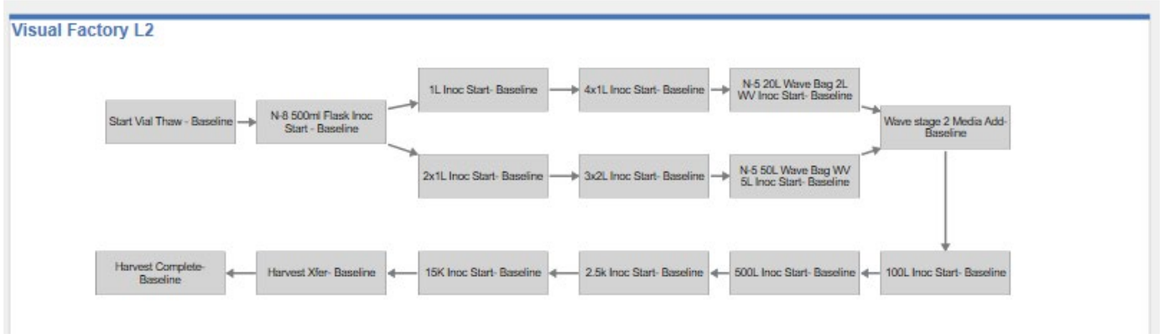
The next segment begins with the start of N-8 Inoc, and so on

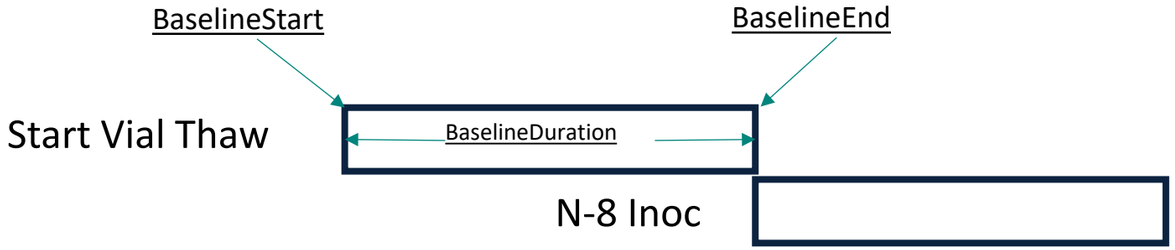


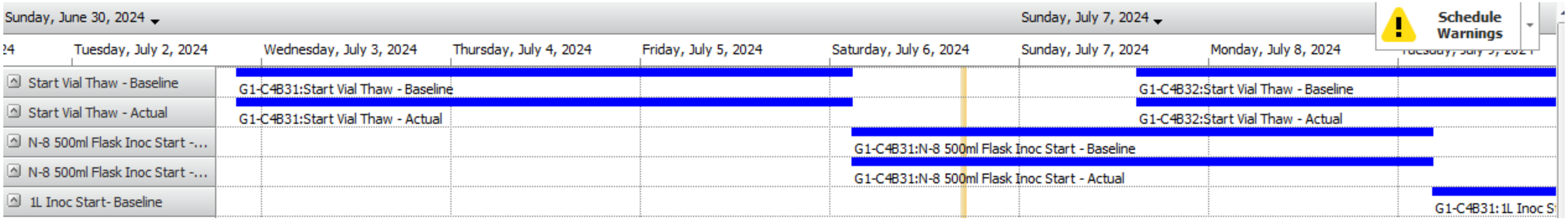
Example

The batch start times plus the standard durations of each critical path segment allows RTS to generate the Baseline Schedule Data.

RTS also generates the current Dynamic Schedule Data. The batch hasn't started yet, so the current actual data is the same as the baseline.
Baseline = Expected = Actual



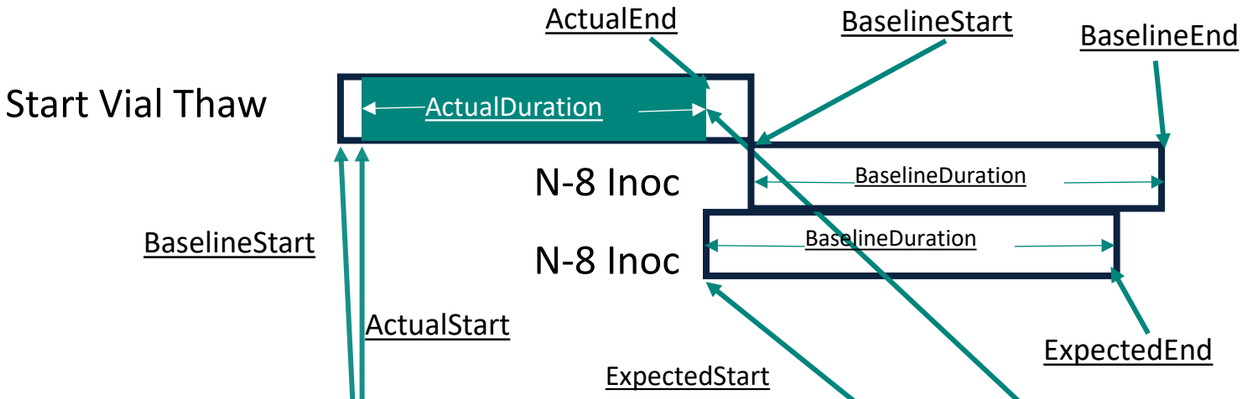


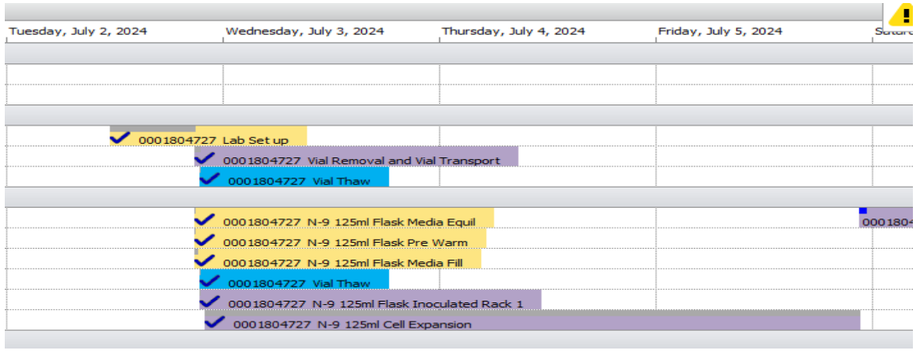


Example – cont'd

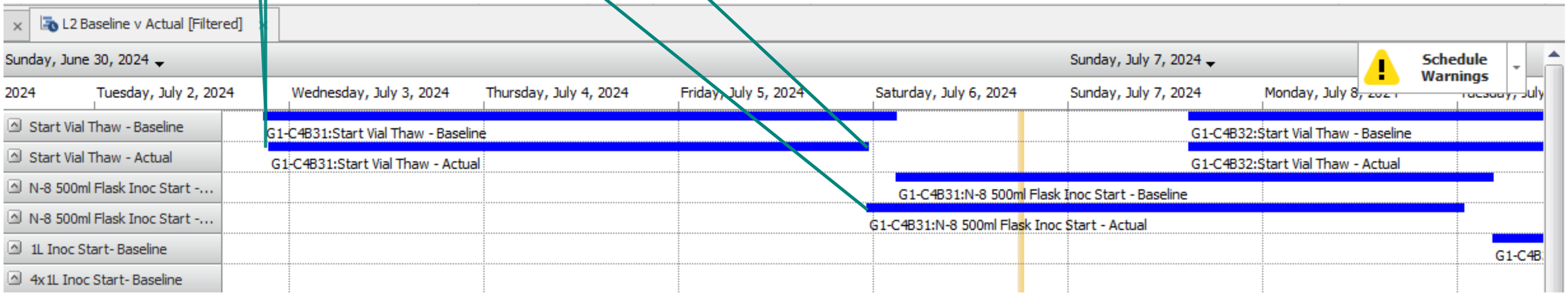
The batch starts! RTS receives actual start times, end times, and/or durations for the batch activities that comprise the critical path segments. With each update, RTS re-calculates the Dynamic Schedule Data. In this case, Vial Thaw started slightly later than planned, but other activities ran faster than planned; so net effect is the segment finishes early.

The baseline remains fixed since it is not linked to the underlying batch activities

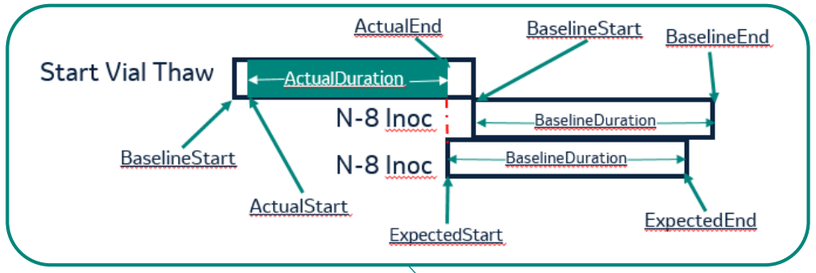




RTS calculates new "expected start" of the following segment based on the actual end of the preceding segment, to reflect dynamic conditions. Baseline remains unchanged



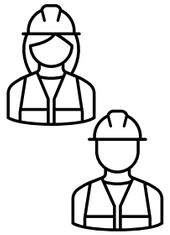
Resulting Back-end data flow



PAS|X

OSI PI & MES

Actual Data



Data Interaction & Inputs (Scheduler)

DeltaV RTS

Baseline Data Expected Data

Data Flow

Seeq

Data Flow

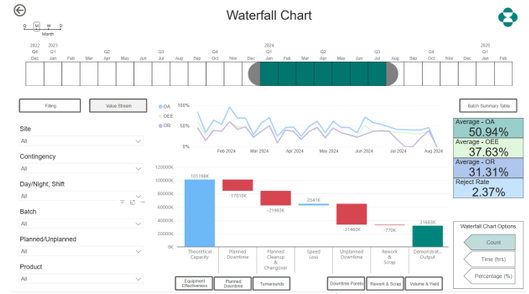
Waterfall Data Packet

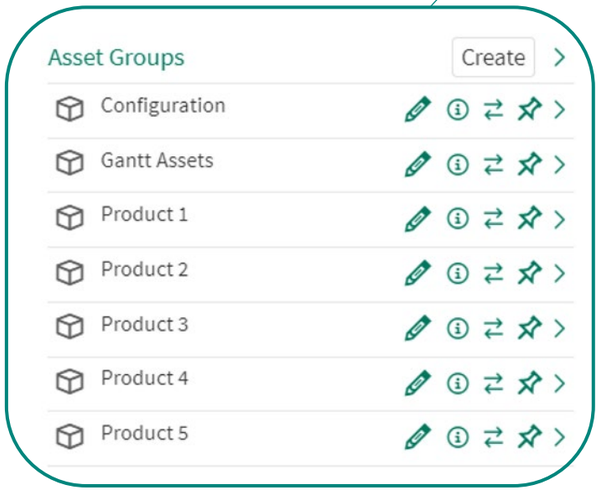
VSM Data Packet

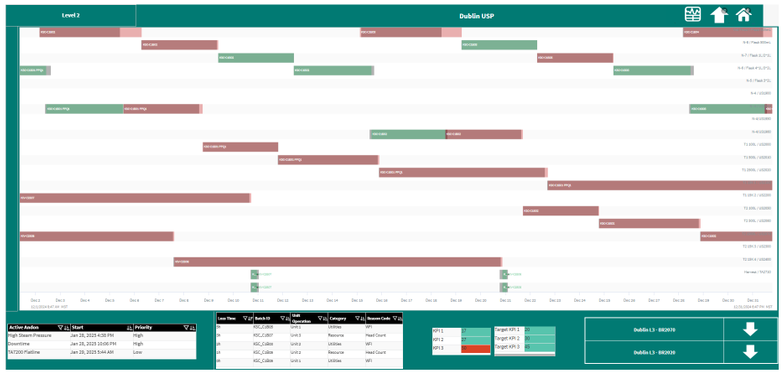
Turnaround Data Packet

Data Flow

Power BI







Modular Data Configuration: Assets, Products

Advantage: Easily add NPI Data (Product Steps, Start Times & End Times)

EMERSON EXCHANGE 2025
ACCELERATING INNOVATION

Value Realization

Example value from Drug Product facility

DeltaV RTS

Unlocks Capacity

Baseline:

- Downtime categories collected manually
- No Minor Stops Visibility
- 6 different sources of Downtime
- Fill efficiency **61%** .

Digital Tools Deployment:

- Real Time Triggers & Actions
- Automated Downtime Categorisation
- Single Source of Downtime Data

Result:

- Accelerated NPI
- 80% reduction in significant equipment downtime
- Full Potential Mindset
- Fill Efficiency **75%**
- **~10% Increase Capacity**

Example value from Drug Substance facility

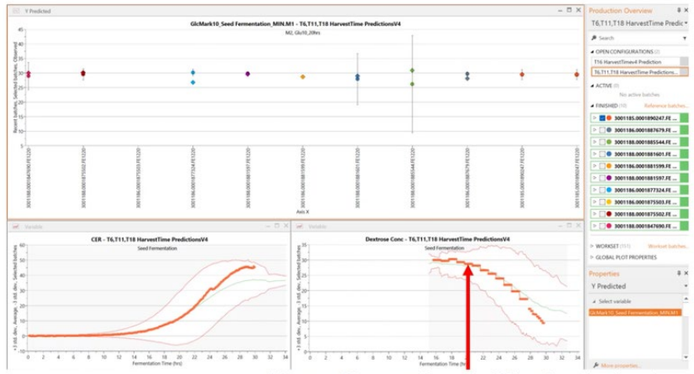
MPS + DeltaV RTS + MVDA Online Multivariate Data Analysis + Seeq = **Unlocks Capacity**

Baseline:

- Significant effort + lead time (frequent in-process samples, offline testing, waiting for results)
- No advance prediction of optimum harvest point within CPP; reactive only
- Low labor & process efficiency; extra lab utilization

Digital Tools Deployment:

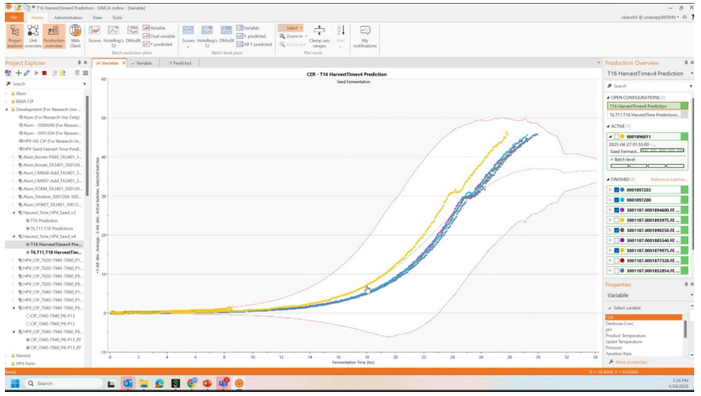
- Online MVDA model to predict optimum harvest point within CPP
- Automated feed into DeltaV RTS to predict harvest date/time and labor needs



Harvest Time predicted at 20hrs into the batch

Result:

- Advance forecasting of harvest date/time, enabling advance labor scheduling
- Reduced sampling & lab time
- Improved yield consistency!



MERCK

Related Sessions
(you don’t even have to move rooms!)

[5-1834] Unlock Business Insights with DeltaV Real-Time Scheduling Data

[5-1280] RTS Digital Plant enabling IE43 Operational Excellence

EMERSON EXCHANGE 2025
ACCELERATING INNOVATION

Thank You