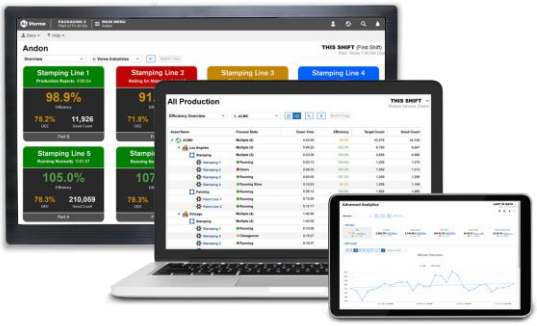

Meet XL

XL Version 2.12

Audience: This guide is for anyone that wants to get a deeper understanding of the XL platform.

Purpose: Introduces you to XL and provides a top-level view of key features.

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General Information

How to Contact Us

Need help? Contact us from 8:00 AM to 6:00 PM Monday to Friday CST (UTC-6:00).

Call: +1.630.875.3600

Fax: +1.630.875.3609

Email: sales@vorne.com, support@vorne.com

Mail: 1445 Industrial Drive, Itasca, IL 60143, USA

We also have an extensive network of international partners. View them at www.vorne.com/partners.

Important User Information

XL products are not designed or intended for control applications and MUST NOT be used for control applications under any circumstances. There are fundamental differences in the design methodology of a control product such as a Programmable Logic Controller (PLC) and a non-control product such as an XL device. Outputs (e.g., relays) are provided for annunciation only, and MUST NOT be used for control purposes.

This product is designed and intended for use solely in indoor industrial applications and MUST be installed by a qualified electrician. This product is designed and intended for use solely in a secure, private network environment. It is the responsibility of all persons applying this product to a given installation and/or application to carefully review the installation and/or application to evaluate and ensure the suitability of this product for the intended application.

This documentation, including any examples, diagrams, and drawings, is intended to provide information for illustrative purposes only. Because of the differences and varying requirements of different installations and applications, Vorne Industries, Inc. cannot assume responsibility or liability for actual use, including use based on any examples, diagrams, and drawings.

In no event will Vorne Industries, Inc. be responsible or liable for indirect or consequential damages resulting from the use or application of this product. Please carefully review the Vorne Product Warranty Statement at www.vorne.com/warranty.htm and the Vorne Sales Terms and Conditions at www.vorne.com/terms.htm. Vorne Industries, Inc. makes no warranties express or implied except as expressly stipulated in our Product Warranty Statement.

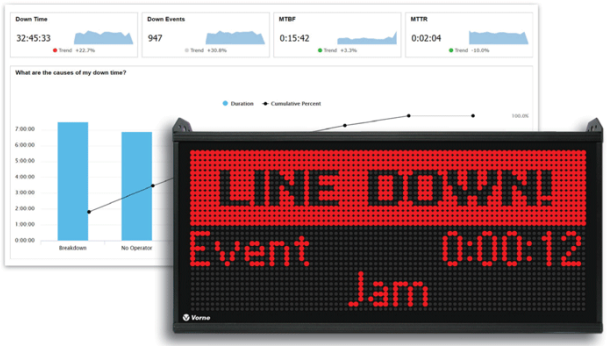
While the information in this document has been carefully reviewed for accuracy, Vorne Industries, Inc. assumes no liability for any errors or omissions in the information. Vorne Industries, Inc. reserves the right to make changes without further notice to any products described in this documentation.

What is XL?

XL is an extremely popular platform for improving productivity with over 25,000 XL devices installed across 45 countries.

The key to the popularity and effectiveness of the XL platform is that it is EASY in every way. In fact, we consider EASY to be the most important feature of XL. It is a feature that we talk about every day and is the context for everything we do. Most products fall far short of their potential because they are complex and hard to use. XL is different.

XL makes it easy for you to start small and to organically expand. Our customers love this because expanding is both comfortable and safe. Your upfront commitment is minimal – especially since we encourage every new application to start with a free 90-day trial. Simply start with a trial, expand to a department, expand to a plant, and then add more plants as time and resources permit. All in your timeframe – not ours.



As you add more XL devices, they communicate with each other using our patented technology, to provide you with complete information and integrated reporting for each asset, area, and plant. You can also connect XL devices to XL Enterprise cloud services for an even more integrated experience.

The XL Platform

The XL platform consists of three parts:

- XL Productivity Appliance™
- XL Enterprise™
- XL Integration Tools

The XL Productivity Appliance™ is an IoT device (XL810, XL610, or XL410) that monitors one manufacturing process. XL devices are unique in that they work equally well as stand-alone devices, networked devices in your internal network, or edge computing devices connected to XL Enterprise.

XL Enterprise is a cloud-based application that provides services, many of which are free, for the XL platform. These services include alerts (real-time email alerts for conditions you configure), reports (automatically delivered end-of-shift reports) and updates (software updates delivered directly to XL devices, ready to install at a time of your choosing).

XL Integration Tools make it easy for you to integrate XL with your other systems and applications. The XL platform includes built-in tools, the XL API for programmatic integrations, and third-party tools to help you create specialized integrations and customizations unique to you. Our recommendation is to start simple and add integrations once XL is firmly established and adding value to your day-to-day operations.

XL Productivity Appliance

One reason XL is EASY is because it utilizes highly integrated IoT devices that snap right onto your production line. Every XL Productivity Appliance™ includes the following features:

- Production Monitor
- Data Warehouse
- Scoreboard
- Reports
- Dashboards
- Management Console

We will cover all these features in this guide, plus we will give you some great tips on installing XL, collecting great quality data, and using that data to drive improvement. Remember – technical support is free, so please contact us with any questions.

The **production monitor** snaps onto your existing manufacturing process with just one or two sensors. From this simple integration, XL generates 120 metrics (numeric values) and 20 dimensions (descriptive values). More importantly, it delivers a comprehensive view of production and productivity.

The **data warehouse** stores the production data XL collects in a SQL database and makes that information available to you via reports, dashboards, export templates and the XL API. One of the paramount XL design goals is to always make the underlying data easily accessible and immediately available to you and your team.

The **scoreboard** provides instant feedback for your plant floor team so they can "win the shift". The only difference between XL models is the scoreboard. Every XL collects the same in-depth information and provides the same in-depth reporting.

The **reports** engine provides instant access to over 50 built-in reports organized as pages and views. Views can be built-in (shipped with the device), shared (created by a user and shared with others), or local (created for personal use).

The **dashboards** engine enables you to create an unlimited number of custom reports. Combine chart, table, chronogram, KPI, and KPI group elements in dashboards to create your own reports. Dashboards can also roll up data from multiple XL devices.

The **management console** adapts XL to your application. Think of it as providing all the knobs and levers you need to create your very own, perfect for you, XL. The management console is another key feature of XL – it quickly and easily adapts XL to your needs.

XL is continually improving – with new features released every few months. To see the latest features, visit www.vorne.com/new.

XL Enterprise

XL Enterprise™ provides free and paid cloud-based services that extend the functionality of XL. None of the services are required. It is a SaaS (Software as a Service) application developed by Vorne that runs on AWS (Amazon Web Services). XL Enterprise currently provides three free services:

Alerts monitors production in real-time to deliver email and text messages that help your team drive action when it's needed – right away. Create alerts based on metrics (e.g., OEE below 75%), production states (e.g., down more than 15 minutes), and targets (e.g., changeover 5 minutes over target time). Automatically escalate as the severity of the situation increases.

Reports emails an automated end-of-shift summary report that includes key metrics, comprehensive loss information, and a summary of all part runs for that shift. It is easy for team members to subscribe, so your entire team can work from the same set of timely and accurate information.

Updates makes it easy to take advantage of new features released for the XL Productivity Appliance™. Each time a new software update is available, the XL Productivity Appliance automatically downloads it – ready to be applied at a time of your choosing.

XL Integration Tools

The XL platform provides you with a broad range of integration tools and options. We recommend evaluating integrations between XL and other systems once XL is firmly established and adding value to your day-to-day operations. An incremental approach is almost always best as it is the fastest path to steady progress, and it ensures that your integrations are soundly based on real-world experience. When you are ready, there are three types of integrations:

Built-in tools enable XL to use information from your existing systems with minimal investment of time or money. For example, XL can be configured to respond to your existing part and job barcodes, and you can import parts and jobs using simple spreadsheets. Built-in integrations are particularly useful for smaller companies with limited IT resources.

The **XL API** is a REST-based interface that enables you to directly integrate XL with other systems and applications (e.g., ERP applications). The XL API is particularly useful for larger companies with well-staffed IT departments that want total control over integration projects.

Third-party tools are products and services offered by partner companies. Examples include PLC integration, ERP integration, and local SQL databases to integrate to your enterprise reporting platform. This is a great choice for any company that wants to leverage standard products to accelerate progress. Learn more about third-party tools at www.vorne.com/tools.

XL Productivity Appliance

Production Monitor

How XL Categorizes Time

XL assigns every moment of time to an impact value, production state, and reason. This provides a consistent way to view information, perform analytics, and generate reports.

Impact	Production State	Reasons (add as many as needed)
Run	Running	Running Normally
	Running Slow	Slow and/or Small Stops
	Running Poor Quality	Running Poor Quality
	Running Poorly	Slow with Poor Quality
Unplanned Stop	Down	Missing Reason, Breakdown, Jam, Adjustment, No Material, No Operator, Autonomous Maintenance
Planned Stop	Changeover	Material Change, Part Change, Setup
	Maintenance	Cleaning, 5S, Lubrication, General Maintenance
Not Scheduled	Meal/Break	Lunch, Break
	Meeting	Shift Handover, Safety Meeting, Team Meeting
	No Production	No Shift Scheduled
	Not Monitoried	Powered Off, Upgrading

Impact provides a top-level perspective aligned with how the time affects productivity metrics.

- Run impacts **OEE**, **TEEP**, **Target**, and **Labor** metrics (via performance and quality loss)
- Unplanned Stop impacts **OEE**, **TEEP**, **Target** and **Labor** metrics (via availability loss)
- Planned Stop impacts **OEE**, **TEEP**, and **Labor** metrics (via availability loss)
- Not Scheduled impacts **TEEP** metrics (via schedule loss)

Production State provides a standardized and uniform way for XL to describe what is happening at the manufacturing process from a "best practices" perspective. This standardization enables consistent reporting and seamless integration with third-party tools.

Reason describes time from your perspective – using terms that are familiar to your company. Reasons are particularly valuable for capturing information with a greater level of detail – enough detail to help you address losses and drive improvement. You can define an unlimited number of reasons.

XL maps every reason to a production state and an impact value. In other words, time categorization starts with a reason. Reasons can be provided by XL (e.g., Running Normally), by operators (e.g., No Material), or by integrations (e.g., from a PLC).

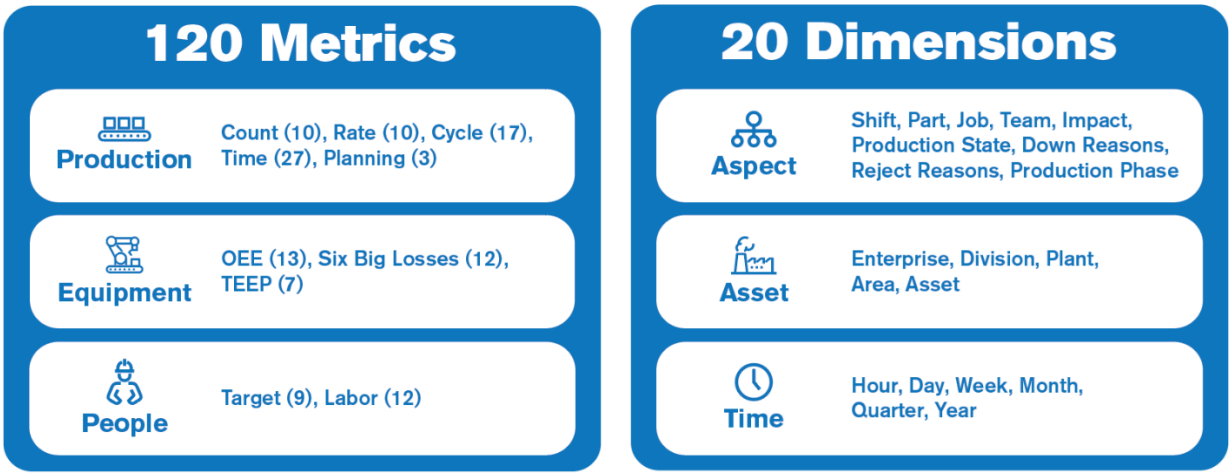
The Data Model – Metrics and Dimensions

XL organizes production data as metrics and dimensions.

Metrics are numeric values that measure a quantitative characteristic of production, such as Good Count, OEE, or Labor Efficiency. XL includes 120 metrics, organized as shown in the image below.

Dimensions are descriptive values that refer to a qualitative attribute of production, such as the Shift, Asset, or Hour. XL includes 20 dimensions, as listed in the image below.

For a complete list of metrics and dimensions along with descriptions refer to Appendix A and B.



Time-Based Dimensions

XL aligns time-based dimensions with your shift schedule to make reports more consistent and easier to understand.

Hours are captured as **shift hours** (e.g., Shift Hour 1, Shift Hour 2). Shift hours are relative to the beginning of the shift. For example, the first hour of each shift is Shift Hour 1. This makes it easy to compare information across shifts (such as that all-important first hour, which often makes or breaks a given shift). It also makes it easier to align data across time zones since even with different start times shifts can be compared hour-by-hour.

Days are captured as **production days**. Production days are based on shift boundaries to ensure that shifts that cross midnight don't get split across two days in reports. You can configure XL to begin your production day with the last shift before midnight or the first shift after midnight. You can visually see this in the time schedule, which shows each shift within its associated production day.

Weeks are captured as **production weeks**. Production weeks always run from Monday to Sunday in order to provide consistency when aggregating information across multiple time zones and geographical areas.

Run Detection and Cycles

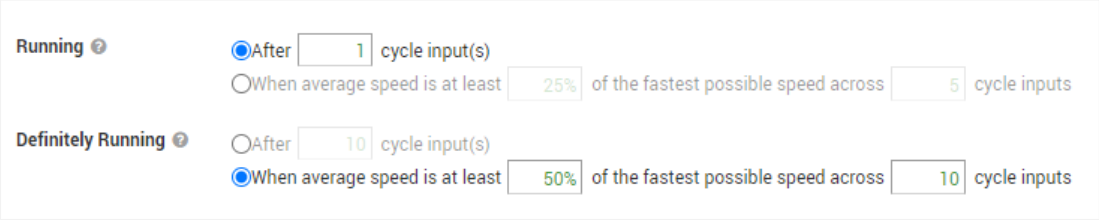
XL continually monitors and analyzes the cycle input to determine:

- Is the manufacturing process running or down?
- If it is running – how well is it running (i.e., what are the losses from slow cycles and small stops)?

There are three associated configurable thresholds (**Settings > Plant Floor > Parts and Run States**).

Threshold	Default	Description
Ideal Cycle Time	1.0 second	The theoretical fastest possible cycle time. Set for each part. It is very important that this value be accurately set as it is used to calculate OEE Performance. Refer to the **Collect Accurate Data** chapter for more information.
Small Stop	500% of ICT	Differentiates between run cycles and small stops. One value applies to all parts. Set as a percentage of Ideal Cycle Time.
Down	3 minutes	Differentiates between small stops and down. Set for each part. Note that this threshold, as well as the small stop threshold, does not affect your overall OEE score. Instead they merely change the type of cycle loss and the balance between cycle loss (OEE Performance) and down time loss (OEE Availability).

The XL run detector also monitors and analyzes the cycle input to detect transitions from down to running. This can be configured to be as simple as detecting cycles or as complex as having to maintain a configurable speed for a configurable number of cycles. The run detector also identifies "definitely running" as a higher threshold that can be used for features like automatically exiting from changeovers or detecting if a shift has started early.



If the Run Detector is a poor fit for your application (e.g. your process does not create cycles, or your cycle times span multiple hours), you can provide signal outputs from your process (or barcodes) to force XL into either a Run or Down condition. Please contact Support to request the **Deploy XL: Manual Run Detection** guide for more information.

Takt Time vs. Ideal Cycle Time

It is important to understand the difference between Takt Time and Ideal Cycle Time. Both represent the time for one cycle and are set for every part. But they have very different purposes.

Value	Drives	Description
Takt Time	Target Count	The expected time to complete one manufacturing cycle. Includes "budgeted" losses for down time, small stops, slow cycles, and rejects.
Ideal Cycle Time	OEE Performance	The theoretical fastest possible time to complete one manufacturing cycle. Includes no "budgeted" losses whatsoever.

The easiest way to calculate Takt Time is to think in terms of how many good pieces you expect to produce in one shift and how much time is available to produce those pieces. Any time where production is not expected to be running is excluded (breaks, meetings, changeovers, and planned maintenance). The benefit of this approach is once Takt Time is correctly calculated for a part, it applies every time that part is run and an Efficiency of 100% or better represents a "win" for your team.

Data Warehouse

Each XL device stores the production data it collects in its own embedded database. This means that there is no requirement for you to install a dedicated server or SQL database.

One of the paramount XL design goals is to always make the underlying data easily accessible and immediately available to you and your team. The data warehouse supports this by providing many ways for you to access your data.

Access Method	Description
Reports	XL includes a sophisticated reporting engine, which runs in your browser, and includes over 50 built-in reports organized as pages and views. Many of the reports are configurable on-the-fly with controls for exploring your data.
Dashboards	It is easy to create custom reports using point-and-click tools included in every XL. Use elements (chart, table, chronogram, KPI, and KPI group) to organize information in whatever way is most helpful to you and your team.
Export Templates	Create any number of Excel export file templates (another dashboards feature). Each export template includes the metrics and dimensions that you select organized as tabular data – ready to export as an Excel file.
XL API	Use our REST API to programmatically access information from XL devices. You can access raw "table" data as well as business-ready "channel" data. Please note that the XL API is subject to change as we continue to add to and improve the XL platform.
Backup	You can instantly create a backup of your production data with a single click from the XL browser interface (**Settings > Management > Backup and Restore**).

If you would like a centralized database that contains production data from all your XL devices you can accomplish this using the XL API (free) or third-party integration tools (fast and easy).

Scoreboard

The scoreboard always reflects the current state of your manufacturing process. It provides your operators with contextual information that guides their actions towards "winning the shift".

When **running** normally, the scoreboard shows TAED (Target, Actual, Efficiency, Down) so your operators can easily see what they have produced (Actual) and if they are winning the shift (Efficiency of 100%). If you prefer different metrics, the running screen can be configured (**Settings > Device > Scoreboard**).

When **running slow**, **running poor quality**, or **running poorly** (which is running slow with poor quality) your operators are prompted in real-time so they can respond immediately.

If the line goes **down** your operators are immediately prompted with a message that includes event down time and a reminder to scan a reason. The reason can be scanned any time before the next down event.

When a **changeover**, **maintenance**, **meal/break** or **meeting** starts, your operators are prompted with a target and remaining time (if so configured) to help them stay on target.

Reports

XL includes over 50 built-in standard reports organized as pages and views:

- Each page presents information with a different layout and visual design.
- Each view captures a different perspective on a page using the controls for that page.

For example, the **All Production** page rolls up metrics across your asset hierarchy and includes 17 built-in views, such as **Production Overview**, **Cycle Time Audit**, **OEE Factors**, and **Hidden Factory**.

Built-in report pages are featured in Appendix C and summarized below.

Report Page	Description
Advanced Analytics	Dynamically explore data through an interactive set of KPI, chart and table elements. Includes 17 built-in views.
All Production	View rolled-up real-time and historical production data for every asset, area, and plant. Includes 17 built-in views.
Andon	View the real-time status of every process with a colorful page suitable for display on a large format television or monitor. Includes 6 built-in views.
Changeover	Deep dive into changeovers with instant analytics and answers to key questions.
Down Time	Deep dive into down time and its underlying reasons.
OEE	Deep dive into OEE and its underlying factors: availability, performance, and quality.
Performance Loss	Deep dive into performance loss and its underlying constituents: cycle loss and small stop loss.
Quality Loss	Deep dive into quality loss and its underlying constituents: startup rejects and production rejects.
Six Big Losses	Deep dive into the six big losses: down time, planned stops, cycle loss, small stops, startup rejects, and production rejects.
Teams and Labor	Deep dive into teams (an analytical dimension) and labor (metrics).
TEEP (Hidden Factory)	Deep dive into TEEP, which fully exposes your "hidden factory" by extending OEE with utilization and schedule loss.
Timeline	View the state of multiple assets over time on a synchronized timeline. Includes 4 built-in views.
Top Losses	View every loss that impacts OEE, ranked and prioritized by how much production time was lost, with additional details for each loss.
Total Production Timeline	View the state of the manufacturing process over time, including production state, shifts, and part runs.

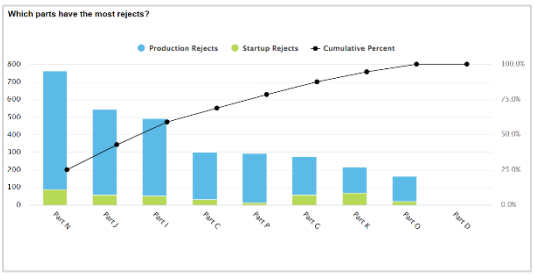
Dashboards

XL includes a powerful engine for creating custom reports, referred to as dashboards (**Main Menu > Monitor > Dashboards**). Each dashboard starts as a blank page where you add any combination of chart, table, chronogram, KPI, and KPI group elements. All dashboard elements are enterprise aware. In other words, every element can include data from one or more assets in your enterprise hierarchy.

Dashboards are also where you create data export templates. Simply create a table with the desired dimensions and metrics and XL automatically provides an option to export it as an Excel® spreadsheet.

Chart

Charts are useful for comparing, contrasting, and trending information. You can configure:



- **Assets to View** (processes to include)
- **Metrics** (quantitative values on y-axis)
- **Dimensions** (qualitative values on x-axis)
- **Filters** (restrict the underlying data)
- **Chart Type** (line, column, heat map, Pareto, stack, cluster)

Table

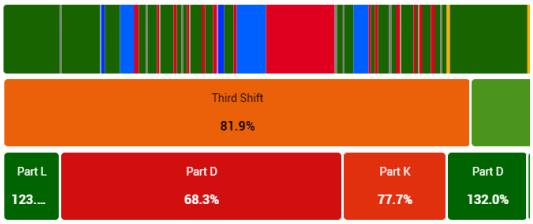
Tables show tabular information either grouped with drilldown or chronologically by event. You can configure:

Dimension	% Time	Occurrences	Total
Run	64.3%	120	5:08:35
Running	51.8%	61	4:08:32
Running Slow	8.7%	39	0:41:32
Running Poor Quality	3.2%	16	0:15:28
Running Poorly	0.6%	4	0:03:02
Unplanned Stop	17.4%	31	1:23:39
Down	17.4%	31	1:23:39
No Material	4.9%	8	0:23:41
2/4/20, 11:30:00 PM	1.1%	1	0:05:23
2/5/20, 12:53:04 AM	0.5%	1	0:02:18

- **Assets to View** (processes to include)
- **Rows** (dimensions that establish row values)
- **Columns** (metrics and additional dimensions)
- **Filters** (restrict the underlying data)

Chronogram

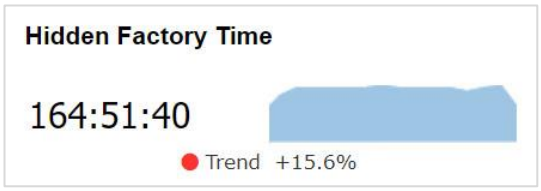
Chronograms are useful for visually showing category values over time (e.g., whether the process is running or down). You can configure:



- **Assets to View** (processes to include)
- **Dimension** (information to be visualized)
- **Bar Height** (short, medium, or tall)

KPI

KPIs provide detailed information about a single metric. You can configure:



- **Assets to View** (processes to roll up)
- **Metric** (quantitative value to be visualized)
- **Filters** (restrict the underlying data)
- **Trend** (show trend for selected time range)

KPI Group

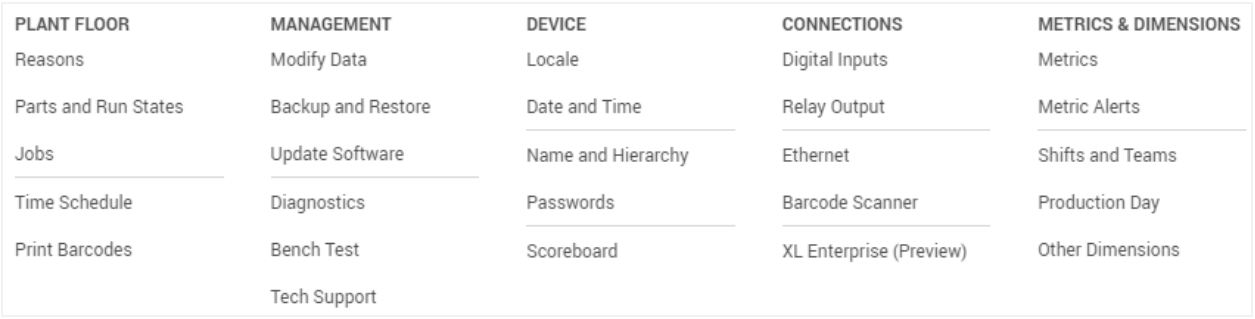
KPI Groups show multiple metrics organized in a tabular fashion. You can configure:

- **Assets to View** (processes to roll up)
- **Field** (up to 30 metrics and formatting components)
- **Formatting** (blank lines and headings)

Management Console

XL can be easily adapted to your application through a broad range of configurable settings, all of which are available through the management console. You must be logged in to access the management console (Settings menu).

- The **Supervisor** role has partial access: Parts and Run States, Jobs, Time Schedule, Print Barcodes, Modify Data, and Diagnostics.
- The **Administrator** role has full access (as shown below).



The **Configure XL** guide provides detailed instructions on how to best adapt XL to your application and we are also happy to provide guidance through free XL technical support.

XL Enterprise

XL Enterprise™ is a cloud application that provides free and paid services that extend the functionality of XL. None of the services are required. XL can fully function without XL Enterprise. Free services include:

- Alerts (real-time email alerts for conditions you configure).
- Reports (automatically delivered end-of-shift reports).
- Updates (software updates delivered directly to XL devices).

XL Enterprise receives real-time production information from your XL devices. However, it does not store this production data for any extended period. Once the alert or report is sent, the associated data is automatically deleted from XL Enterprise. Refer to the **Configure XL** guide for information on how to link XL devices to XL Enterprise.

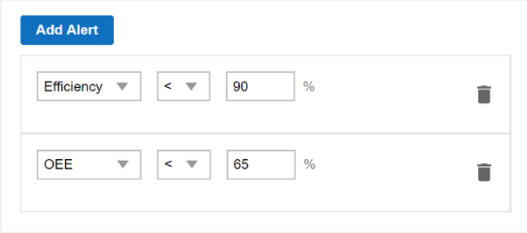
Alerts

The alerts service monitors production in real-time and delivers notifications to your team in order to help you drive immediate action. There are three types of alerts:

Alert Type	Description	Example
Metric	Monitor normalized metrics such as Efficiency and OEE for the current shift. A typical application is to be alerted if your team is not on track to win the shift.	Efficiency < 95%
Production State	Monitor duration of production state events. A typical application is to be alerted to long down events.	Down > 15 minutes
Target	Compare duration of an event to its target. A typical application is to be alerted to changeovers that take longer than expected.	Changeover 5 minutes over target

Setting up alerts in XL Enterprise is easy:

- Administrators implement an alert policy for the organization by defining standardized alerts that are available for every XL device and user.
- Users subscribe to the alerts and assets that are most relevant to their area of responsibility.



All assets are available to all users in an organization. If you want to restrict access to a smaller group, simply create one organization for each group. In the future, XL Enterprise will support groups within an organization.

We recommend that you start with a small number of alerts that represent critical scenarios where attention is clearly needed. Otherwise alerts can quickly become "noise" that is ignored.

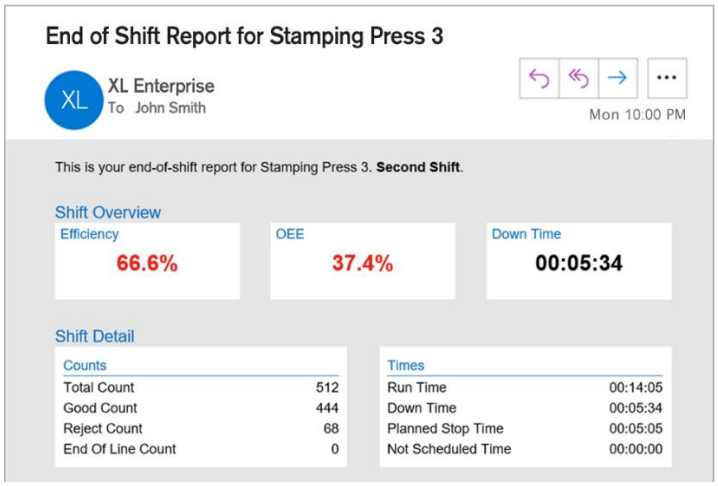
We also recommend configuring XL Enterprise to deliver alerts as emails, as email alerts provide valuable contextual information. Although XL can deliver text message alerts via email gateways provided by mobile carriers, not all carriers provide this service and some carriers only provide it as a premium service. Also, message and data rates from your mobile carrier may apply to text messages sent by XL Enterprise.

Reports

The reports service delivers an end-of-shift summary report via email for every XL device to which a user subscribes. The report is emailed immediately when the shift ends and includes four sections:

Section	Description
Shift Overview	Large format KPIs (Efficiency, OEE, and Down Time).
Shift Detail	Six groups of metrics (Counts, Times, OEE, Labor, Cycle Analytics and Quality Analytics).
Availability Analytics	The top 10 reasons, ranked by lost time, for unplanned and planned stops (e.g., down events and changeovers).
Part Runs	An overview of every part that was run within the shift.

With the initial release of XL Enterprise, the report is fixed format (not editable).



Updates

The update service makes it very easy to keep your XL Productivity Appliance devices up to date with the latest version of software. You can always see the latest version and features at www.vorne.com/new.

XL Enterprise hosts software updates and the XL Productivity Appliance downloads these updates in the background. Then, you apply updates at a time of your choosing.

XL Integration Tools

We recommend implementing integrations between XL and other systems once XL is firmly established and adding value to your day-to-day operations (i.e., collecting high-quality data and using that data to drive improvement). Otherwise, it is far too easy to get hung up on technical projects and lose sight of how much you can accomplish with XL right out of the box. When you are ready though, the XL platform offers a wide range of integration tools.

Built-In

Built-in integration tools use information from other systems without having to establish direct connections to those systems. They are particularly useful for smaller companies with limited IT resources. Built-in integration tools include:

- **Part Lookup**: If your product packaging or work order includes a barcode representing the unique part, XL can be configured to automatically start a part run when that barcode is scanned.
- **Job Lookup**: Alternately, if your work order includes a job barcode generated by your ERP/MES system, XL can be configured to automatically start that job when that barcode is scanned OR to simply add that job ID to the currently running part run.
- **Import Parts and Jobs**: It is very easy to export parts or jobs from XL as a spreadsheet, make any desired updates, and then import the updated parts or jobs back into XL.

XL API

The XL API is a REST-based interface that enables you to directly integrate XL with other systems and applications. You can use this API to push information to XL (e.g., job parameters) or to retrieve information from XL (e.g., job metrics). The XL API can also be used to encode information into 2D barcodes that can be scanned to start jobs with information directly generated by your ERP/MES system.

The XL API is particularly useful for larger companies with well-staffed IT departments that have the resources to create and maintain custom integrations. The **XL API** guide provides detailed instructions on how to programmatically interact with XL. Please note that the XL API is subject to change as we continue to add to and improve the XL platform.

Third-Party

Third-party integration tools are products and services offered by partner companies. This is a great choice for any company that wants to leverage standard products to achieve fast progress and avoid maintaining custom IT projects. Examples of third-party tools include:

- **Data Collector**: Automatically harvest data from multiple XL devices into an SQL database.
- **Data Link ERP**: Transmit production standards from your ERP system to XL, and transfer production data for completed shifts and jobs from XL to your ERP system.
- **Data Link PLC**: Transmit information from PLCs to XL devices (e.g., down reasons).
- **PiXL**: Display custom graphics or messages on the XL scoreboard based on various triggers.

To learn more about third-party tools visit www.vorne.com/tools.

Installation Tips

Each XL device monitors one manufacturing process. We recommend starting with a single sensor (see **Get Started**) and refining your installation over time with additional sensors (see **Track Quality** and **Focus on the Constraint**). A single sensor is EASY and still generates a huge amount of actionable information, including detailed information about down events, changeovers (OEE Availability), cycle losses and small stops (OEE Performance). And the benefit is you get started quickly.

Get Started

You only need four things to get started:

1. **In Count Sensor** – A single sensor that XL uses to calculate counts and track cycles. Take this input from wherever it is easiest to access a signal that represents the cyclical flow of parts. If each cycle produces multiple parts XL can apply a count multiplier (**Settings > Connections > Digital Inputs**).

2. **Barcode Scanner** – The operator typically uses a barcode scanner to start new part runs and to tag reasons on down events automatically detected by XL. If desired, the operator can use the barcode scanner to start jobs (instead of parts), changeovers (instead of changeovers automatically starting with part runs), and breaks (instead of using the time schedule), etc.

3. **Ethernet** – Connect XL to your network and use a browser to configure XL and to access its powerful integrated reporting capabilities (including rollup of metrics across multiple devices).

4. **Power** – The scoreboard is powered off mains voltage (100 to 240 VAC) so you will need power where you plan to hang the scoreboard.

Track Quality

Once you are collecting data and using that data to drive improvement actions, the logical next step is to collect quality information (OEE Quality). You can add a Reject Count or Good Count sensor or alternately you can use a barcode scanner to enter reject counts with reasons. Either way, your OEE score will now be complete with the addition of OEE Quality.

Focus on the Constraint

If you are monitoring a manufacturing process with multiple steps, it is a best practice to measure down time and cycle losses from the perspective of the constraint. To do so, bring a dedicated cycle input to XL from the constraint step of the line. Learn more about constraints at www.vorne.com/constraint.

For an in-depth review of different installation scenarios refer to the **Install XL** guide.

Navigation Tips

XL includes a very powerful web interface for reporting and configuration. This chapter highlights key features of the **App Bar** that appears at the top of every page, which includes navigation, information and actions. The dark grey band pertains to the entire application, while the light grey band is specific to the current page.

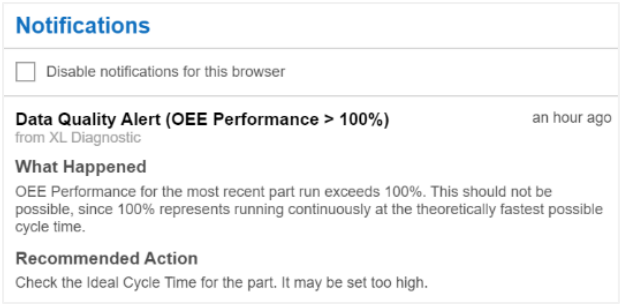
Navigation

Navigation is divided between the **Main Menu** (includes reports and learning content as shown below) and **Settings** (adapts XL to your application as described earlier).

Information

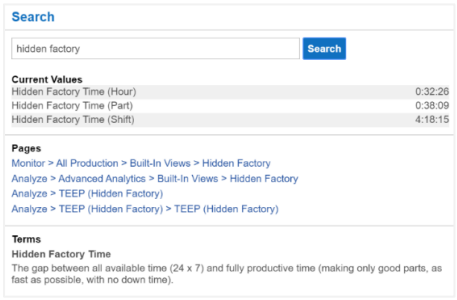
The **Asset Identifier** shows the name of the asset you are browsing, as well as its plant and time zone.

Notifications provides important information about data collected by XL. Data Quality Alerts notify you when XL identifies a potential problem with your data (e.g., an ideal cycle time that is set too high). Metric Alerts notify you when XL identifies an aspect of production that is not performing to expectations (e.g., OEE < 70%). Metric alert thresholds are fully configurable (**Settings > Metrics & Dimensions > Metric Alerts**).



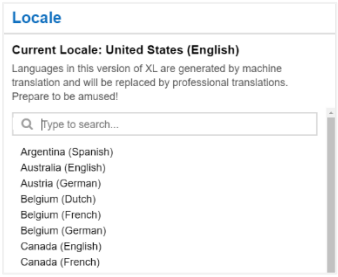
Actions

Search is extremely useful as it is the quickest way to find detailed information about a metric. Type the metric name (or other term) and search will show you:

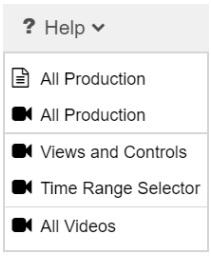


- Current values of the metric (hour, part, and shift).
- Pages whose title include the term you typed (with navigation links).
- Terms whose definition include the term you typed.

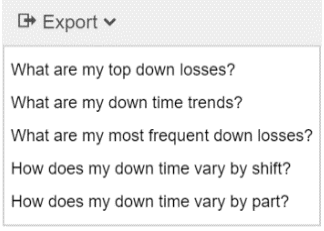
Locale enables you to override the device locale (**Settings > Device > Locale**) with a locale that applies to just you (i.e., just your browser). Locale controls data formatting and language.



Help provides options for learning more about the current page. Most pages have help videos, which are the easiest and fastest way to master a given topic.

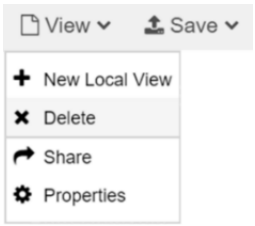


Export lists all exportable (tabular) elements on the page. Selecting any of the listed tables will generate an Excel file with the data from that table. Data can also be exported from within a table element by accessing the Export action from the upper-right dropdown menu (reverse caret symbol).



Views

The **View** and **Save** dropdowns access actions for working with views.



As a quick summary:

- Report views provide different perspectives on a given report page (via element controls) while maintaining the existing page layout and visual design.
- Dashboard views create entirely new page layouts and visual designs by adding any combination of table, chart, chronogram, KPI, and KPI group elements.

Views can be built-in, shared, or local.

Type	Description
Built-In	Views that are shipped with the device. They cannot be modified or deleted to ensure that certain reports are always available.
Shared	Views that are created by a user and made available to others. They are stored in the device.
Local	Views that are created by a user for personal use. They are stored in browser-based local storage, and as such can only be accessed from that computer and browser. Local views are deleted if you clear cookies and site data in the browser.

The actions you can take with views include:

- **New Local View** creates a new dashboard. It starts with an empty view, to which you can add any combination of chart, table, chronogram, KPI, and KPI group elements.
- **Delete** permanently deletes a local or shared view. You must be logged in to delete a shared view.
- **Share** transfers a local view to the XL device, where others can access it. You must be logged in to share a view.
- **Properties** configures the name (local views) or name and visibility (shared views).
- **Save** stores changes to a local or shared view. You must be logged in to save a shared view.
- **Save As...** creates a copy of the current view as a local view.

Collect Accurate Data

Establishing an accurate data foundation is essential to making effective decisions. This chapter provides tips on how to collect accurate data – based on real-world experience across thousands of applications.

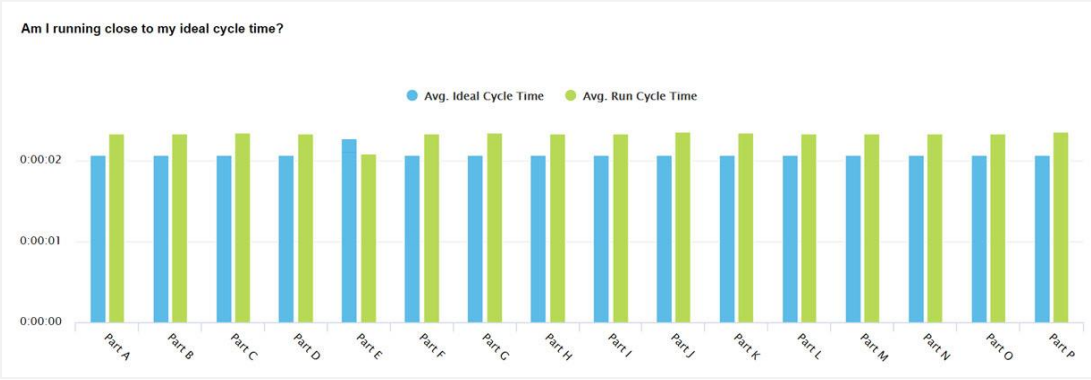
Start Simple and Iterate

One of the biggest mistakes companies make when deploying any kind of system is adding complexity that reduces adoption by users. So, we recommend starting with a simple deployment and iterating over time to add more detail to the data you collect with XL. Here are tips to help you simplify your initial deployment, while still collecting highly accurate and actionable data.

Setting	Recommendation
Inputs	Start by measuring only **In Count**, preferably at the process constraint. Just this one input will generate a huge amount of actionable information.
Down Threshold	Set down thresholds that create no more than 25 down events per shift. This makes it much easier to train operators to scan a reason for EVERY down event.
Down Reasons	Create no more than 25 down reasons (it's easy to add more later). Spend time carefully naming and organizing reasons to make it easy for operators to select and scan the right reason.
Parts	If you have more than 50 parts, either group them into product families to give operators fewer barcodes to scan (see **Group Parts into Product Families** below) or use built-in integration tools to enable operators to scan existing part barcodes (see the **XL Integration Tools** chapter).
Scoreboard	Configure the scoreboard to show metrics that are meaningful to operators. For example, Efficiency is more intuitive than OEE. We recommend TAED (see **Set Clear Targets** in the next chapter).

Confirm and Validate Ideal Cycle Times

Having an accurate ideal cycle time (ICT) for each part is essential for generating a meaningful OEE score. ICT is the theoretical fastest possible cycle time for the part. It represents perfect production – no cycle losses at all. Many companies base their ICTs on a budget or standard time that is significantly higher (slower) than it should be. This hides production losses and artificially inflates OEE.



To quickly identify if your ICTs are correct, navigate to the **Main Menu > Analyze > Performance Loss** page. Look at the chart titled "Am I running close to my ideal cycle time?" If any of the left (blue) bars are taller than the right (green) bars – the ICT for that part is set too high (slow).

Hide Erroneous Information

When starting with XL it's common to collect some erroneous data as configuration is refined and operators are trained. We recommend that you clear early data so that it doesn't affect your reports.

1. Log in as Administrator.
2. Navigate to Settings > Management > Modify Data.
3. Click on the **Clear Data** tab.
4. Use the Time Range control in the upper right of the page to select the appropriate time period.
5. Use the dropdown to select the granularity of data to clear (typically **Shift** or **Production Day**).
6. Place a checkmark next to each interval to be cleared.
7. Click the **Clear Data** button at the bottom of the page.

Regularly Review Data Quality Alerts

XL continually monitors incoming production data to identify instances where data quality can be improved. For example, IF:

- OEE Performance > 100% THEN the ideal cycle time is likely too high.
- 25% or more down events are missing reasons THEN operators aren't consistently scanning reasons.
- Efficiency >= 110% THEN the takt time is likely too high.

We recommend reviewing data quality alerts at least once per week and taking action to correct any unresolved issues. To review data quality alerts:

1. Log in as Administrator.
2. Navigate to Settings > Management > Diagnostics.
3. Click on the Data Quality Alerts Tab.

Simplify Down Reason Capture

Down time is the largest source of lost production time for almost all companies. So understandably, most companies want to capture very detailed down time information. This often leads to complexity that ironically results in less accurate data. To start simple, we recommend:

- Define no more than 25 down reasons, which will fit nicely on two barcode pages for the operator.
- Set down thresholds for each part that are high enough that XL captures no more than 25 down events per shift (e.g., start with 5 minutes). Shorter down events will still be captured as small stops.

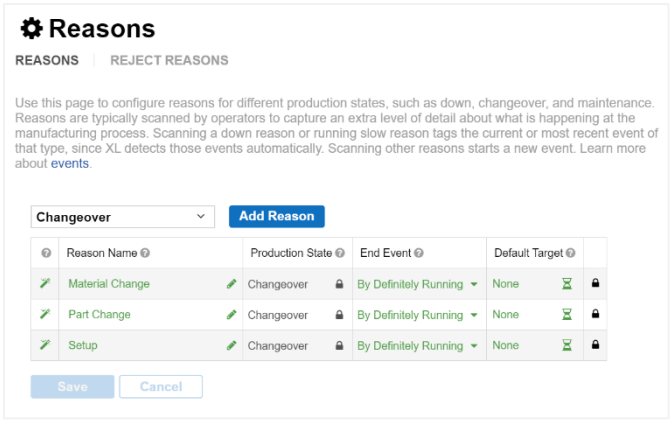
Doing this will create actionable information without distracting operators from running their equipment. Once operators are accurately scanning a reason for each down event, cautiously consider lowering the down threshold and adding reasons.

Capture Planned Stops

It is important to differentiate between unplanned stops (Down) and planned stops (Changeover and Maintenance). All three are OEE Availability losses, but they have very different improvement strategies.

We recommend creating Changeover and Maintenance reasons (**Settings > Plant Floor > Reasons**). If any have expected durations set a **Default Target**. This will enable the scoreboard to show operators the remaining time. Then, decide how you want to trigger each event. For example:

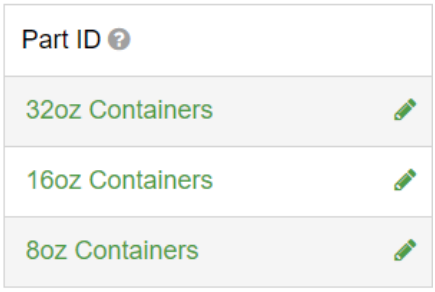
- **Settings > Plant Floor > Time Schedule** (for fixed duration events with a known start time).
- **Settings > Plant Floor > Parts and Run States** (for part runs that always start with a changeover).
- **Settings > Plant Floor > Print Barcodes** (print barcodes for the operator to scan).



Group Parts into Product Families

If you have more than 50 SKUs for a manufacturing process, chances are that they can be grouped into logical families for the purposes of tracking them with XL. This makes it easier to configure XL and for operators to scan part barcodes. Simply create parts in XL named with their family name, making sure that all parts covered by a family share the same ideal cycle time and takt time. If you find you need more detail for a given family, you can expand it into individual part numbers.

A more advanced option is for an XL integration partner to help you establish a direct connection between your ERP system and XL that will automatically transfer job and part parameters to XL during production. To learn more, refer to www.vorne.com/tools.

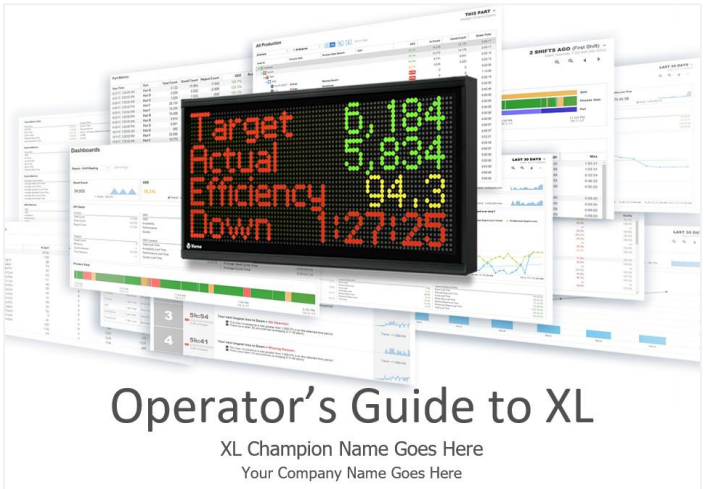


Invest in Operator Training

Deploying XL introduces change for operators. Typically, you will be asking operators to scan barcodes to start part runs and to capture down reasons. In return, the scoreboard will provide your operators with a much better sense for how well production is running and when to address and escalate emergent issues.

There are two particularly important things you can do to help your operators:

- Invest some time optimizing barcode pages (**Settings > Plant Floor > Print Barcodes**) to make it easier for operators to select and scan the correct barcodes.
- Invest time in training. To help with training, we created the **Operator's Guide to XL** as a PowerPoint® presentation that you can easily modify to best fit your application.



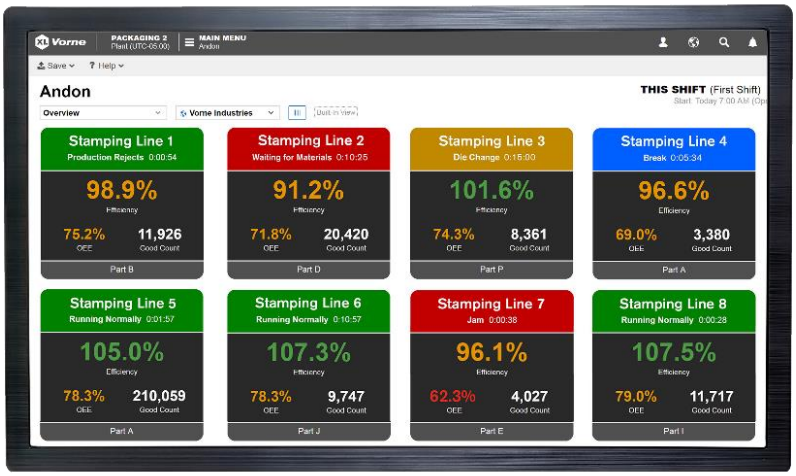
Quick Wins with XL

Once you are collecting accurate data the next step is to leverage that data to drive improvement. This chapter presents proven ways to quickly leverage data from XL to drive action and improvement.

Visualize Your Plant

It is easy to create a beautiful real-time view of production for offices, meeting rooms, and the factory floor. A view that brings a strong focus on productivity to all levels of your company.

Display the real-time **Andon** report on televisions or monitors using the standard XL browser interface. In the example below, we instantly see that **Stamping Line 2** is stopped (red) and will likely miss their production target with only 91.2% Efficiency – time to help them get back on track.

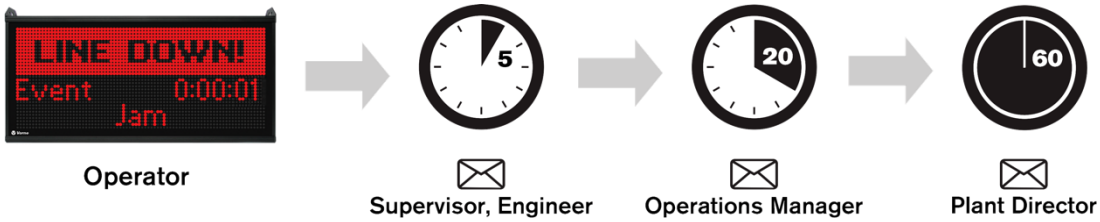


Escalate with Alerts

The XL scoreboard lets your operators know when action is needed. But what about your support and management teams? Configure XL Enterprise to send your support and management teams alerts for specific conditions, such as a manufacturing process being down for an extended time. Use escalation to let the right people know at the right time when action is needed.

Start by setting up a very small number of critical alerts. You can always add more later, but when you start you want to be very sure that anyone receiving alerts finds them to be extremely valuable.

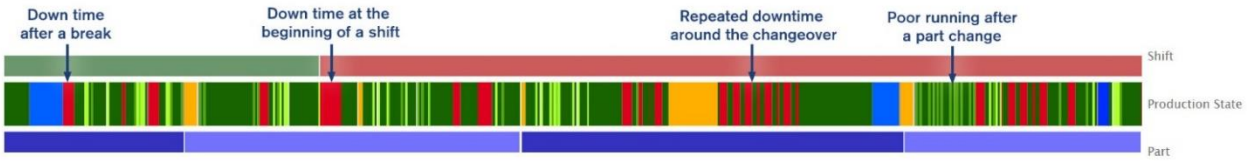
To learn more about configuring alerts, refer to the **Configure XL** guide.



Focus on Transitions

Transitions in production, such as breaks, shifts, changeovers, and part runs often provide significant opportunities for improvement. The **Main Menu > Monitor > TPT** page provides a visually impactful way to spot problematic transitions. Here are some key things to look for:

- **Breaks** – Slivers of uncategorized down time (red) before or after breaks (blue). These often suggest extended break periods rather than verifiable (legitimate) down time issues.
- **Shifts** – Similarly, slivers of down time (red) at the beginning and end of shifts.
- **Changeovers** – Down time (red) immediately before changeovers (amber). This is often time that should be part of the changeover. XL automatically detects this and intelligently joins down events to changeovers (**Settings > Metrics & Dimensions > Other Dimensions**).
- **Part Runs** – Patterns of down time (red) or poor running (light green) after starting new part runs and after changeovers. These patterns typically indicate opportunities to improve startups.

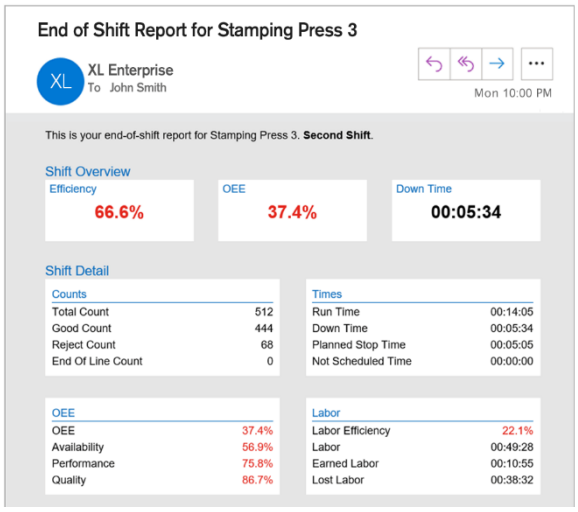


Share Information

Accurate and timely information is a powerful tool. Empower others on your team by sharing information with them. An easy way to do this is to have XL Enterprise send end-of-shift reports to key employees. Who at your plant will benefit from a detailed shift report in their inbox as soon as the shift ends?

If XL Enterprise has not yet been configured with an organization and linked XL devices refer to the **Configure XL** guide for instructions. Once you have linked XL devices:

1. Login to XL Enterprise as an Admin and navigate to the **Users** page.
2. Create accounts for anyone that will benefit from end-of-shift reports.
3. As new users receive their email invites and log in, all they need to do is select the assets they want to monitor (**Assets** page) and opt in to end-of-shift reports (**Reports** page). It's that easy!

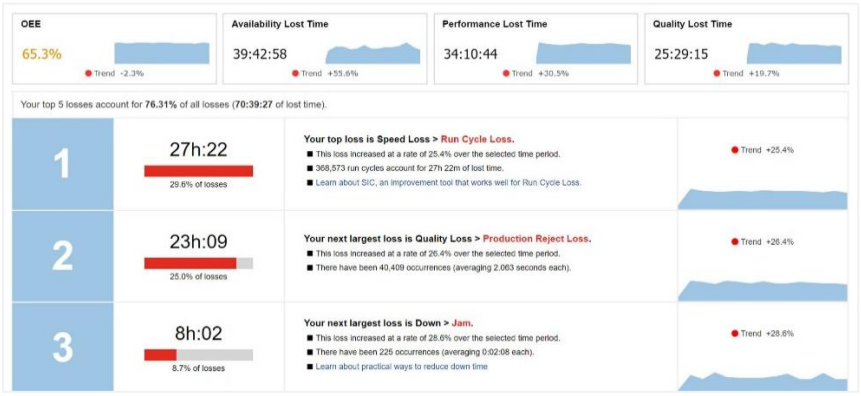


Work on the Right Things

It's often difficult to know where to start. What should you focus on improving?

The **Main Menu > Improve > Top Losses** page is designed to make it much easier to answer this question. It ranks all losses from largest to smallest and includes detailed information for each loss.

A simple and effective way to select your next improvement project is to focus on the largest loss where your team has ideas on actions they can take, minimal external resources are required, and actions can be taken straightaway. Then the real fun begins – taking action.



Set Clear Targets

People perform best when you establish clear expectations. Make it simple and fun for your operators by giving them an opportunity to "win the shift". We recommend TAED on the scoreboard:

- **Target** (target for good pieces; based on takt time; **Settings > Plant Floor > Parts and Run States**)
- **Actual** (actual good pieces)
- **Efficiency** (the ratio of actual to target)
- **Down Time** (the largest OEE loss for most companies)

An Efficiency of 100% or higher means your team is winning the shift. Many companies see an immediate improvement in productivity simply by setting a challenging but attainable target (via takt time) and showing operators status in real-time through the XL scoreboard. Learn more about setting takt times in the earlier **Takt Time vs. Ideal Cycle Time** section.

Appendix A: Metrics

This appendix lists all the metrics that are generated by XL, along with their units of measure and descriptions. Some metrics are directly measured by XL, while others are derived through calculations. When metrics are derived the calculation is shown as part of the description.

Metrics and dimensions are fundamental to how XL tracks production information. Metrics are numeric values that measure a quantitative characteristic of production, such as Good Count, OEE, or Labor Efficiency. Dimensions are descriptive values that refer to a qualitative attribute of production, such as the Shift, Asset, or Hour.

Counts

Core Counters

Metric	Units	Description
In Count	Pieces	Number of pieces that have entered the manufacturing process.
Good Count	Pieces	Number of good pieces that have been manufactured.
Reject Count	Pieces	Number of reject pieces that have been manufactured.
End of Line Count	Pieces	Typically used to count product at the end of the line. Product might be pieces, boxes, or pallets.

Additional Counters

Metric	Units	Description
Total Count	Pieces	Total number of pieces that have been manufactured. Calculated as Good Count + Reject Count.
Startup Rejects	Pieces	Number of reject pieces that have been manufactured during and immediately after a changeover.
Production Rejects	Pieces	Number of reject pieces that have been manufactured during steady-state production (after startup). Calculated as Reject Count - Startup Rejects.
WIP Count	Pieces	Number of pieces between the In Count sensor and Good Count sensor. Calculated as in Count - Good Count.

Count Percentages

Metric	Units	Description
Percent Good	Percent	Percentage of manufactured pieces that are good. Same as the Quality metric. Calculated as Good Count / Total Count.
Percent Reject	Percent	Percent of manufactured pieces that are reject. Calculated as Reject Count / Total Count.

Cycles

Number of Cycles

Metric	Units	Description
Run Cycles	Cycles	Number of "normal" cycles – cycles that are shorter than the small stop threshold.
Small Stops	Cycles	Number of "longer" cycles – cycles that are longer than the small stop threshold.
Partial Cycles	Cycles	Number of "boundary" cycles – cycles that are on the boundaries of run events. Each run event has one partial cycle. Whereas Run Cycles and Small Stops are measured from input to input, each partial cycle includes time from the start of the run event to the first input plus time from the last input to the end of the run event.
Total Cycles	Cycles	Total number of cycles. Calculated as Run Cycles + Small Stops + Partial Cycles.
Equipment Cycles	Cycles	Total number of cycles across ALL production states. All other cycle metrics are ONLY measured during run events. This metric is particularly useful for cycle-based asset care programs.

Cycle Loss

Metric	Units	Description
Run Cycle Lost Time	Seconds	Time in excess of ICT for Run Cycles (waste). If this number is negative the ICT is set too high.
Partial Cycle Lost Time	Seconds	Time in excess of ICT for Partial Cycles (waste).
Cycle Lost Time	Seconds	Time in excess of ICT for Run Cycles and Partial Cycles (waste). One of the Six Big Losses. Calculated as Run Cycle Lost Time + Partial Cycle Lost Time.
Small Stop Lost Time	Seconds	Time in excess of ICT for Small Stops (waste). One of the Six Big Losses.

Cycle Times

Metric	Units	Description
Ideal Cycle Time	Seconds	Theoretical fastest possible time to complete one cycle for the currently running part. Configured on a part-by-part basis.
Ideal Time	Seconds	Theoretical fastest possible time that it should have taken to complete all cycles. Used to calculate other metrics and not usually of direct interest to users.
Current Cycle Time	Seconds	Time spent so far in the current cycle. Restarts at zero with every new cycle.
Previous Cycle Time	Seconds	Time it took to complete the most recent cycle.
Total Cycle Time	Seconds	Accumulated time for all cycles. Equals Run Time. Calculated as Ideal Time + Run Cycle Lost Time + Partial Cycle Lost Time + Small Stop Lost Time.

Average Cycle Times

Metric	Units	Description
Avg. Cycle Time	Seconds	Average time for a cycle. Includes all cycles during run time. Calculated as Total Cycle Time / Total Cycles.
Avg. Ideal Cycle Time	Seconds	Theoretical fastest possible time for one cycle as averaged across a time period. Calculated as Ideal Time / Total Cycles.
Avg. Run Cycle Time	Seconds	Average time for each run cycle. Does not include small stops or partial cycles (i.e., it is analogous to the speed of your process when it is running). Calculated as Avg. Ideal Cycle Time + Run Cycle Lost Time / Run Cycles.
Avg. Small Stop Time	Seconds	Average time for each small stop. Calculated as Avg. Ideal Cycle Time + Small Stop Lost Time / Small Stops.

Labor

Team Size

Metric	Units	Description
Current Team Size	People	Number of people currently working at the asset. Used to generate labor time metrics. Note that labor time is accumulated unless production is "not scheduled".
Team Size	People	Average number of people working at the asset. Calculated as Total Labor / Production Time.

Labor per Piece

Metric	Units	Description
Current Target Labor per Piece	Seconds	Expected labor time to manufacture one good piece. Configured on a part-by-part basis.
Target Labor per Piece	Seconds	Expected labor time to manufacture one good piece as averaged across a time period. Calculated as Earned Labor / Good Count.
Labor per Good Piece	Seconds	Actual labor time to manufacture one good piece. Calculated as Total Labor / Good Count.
Labor per Piece	Seconds	Actual labor time to manufacture one piece. Calculated as Total Labor / Total Count.

Pieces per Labor Hour

Metric	Units	Description
Good Pieces per Labor Hour	Pieces	Good pieces manufactured per hour of labor time. Calculated as Good Count / Total Labor Hours.
Pieces per Labor Hour	Pieces	Pieces manufactured per hour of labor time. Calculated as Total Count / Total Labor Hours.

Labor Efficiency

Metric	Units	Description
Earned Labor	Seconds	Labor time "earned" by manufacturing good pieces. Each time a good piece is manufactured the Current Target Labor per Piece is added to Earned Labor.
Lost Labor	Seconds	Labor time "lost" by taking longer than expected to manufacture good pieces. If this number is negative, pieces are taking less than the target labor time to manufacture. Calculated as Total Labor - Earned Labor.
Total Labor	Seconds	The total of labor time on this asset. Note that labor time is accumulated unless production is "not scheduled".
Labor Efficiency	Percent	How actual labor time compares to the target, expressed as a percentage. This is the preferred metric for comparisons as it is normalized. In other words, 100% is meeting expectations and better than 100% is exceeding expectations. Calculated as Earned Labor / Total Labor.

OEE

Core OEE

Metric	Units	Description
Availability	Percent	Percentage of planned production time where the process is running. 100% Availability means the process is always running during planned production time. Calculated as Run Time / Production Time.
Performance	Percent	Percentage that compares the theoretical maximum speed (based on ideal cycle time) to the actual speed (based on accumulated run time). 100% Performance means when the process is running it is running as fast as possible. Calculated as Ideal Time / Run Time.
Quality	Percent	Percentage of manufactured pieces that do not meet quality standards. 100% Quality means there are no rejects. Calculated as Good Count / Total Count.
OEE	Percent	Percentage of planned production time that is fully productive. 100% OEE means perfect production (always running, as fast as possible, manufacturing only good pieces). Calculated as Availability × Performance × Quality.

OEE Loss Percentages

Metric	Units	Description
Availability Loss	Percent	Percentage of planned production time lost to the process not running. Accounts for planned and unplanned stops. Calculated as 100% - Availability.
Performance Loss	Percent	Percentage of planned production time lost to running slower than the theoretical maximum speed. Accounts for cycles longer than the ideal cycle time. Calculated as (100% - Performance) × Availability.
Quality Loss	Percent	Percentage of planned production time lost to manufacturing pieces that do not meet quality standards. Accounts for defects (including parts that need rework). Calculated as (100% - Quality) × Availability × Performance.
OEE Loss	Percent	Percentage of planned production time that is not productive. Calculated as 100% - OEE.

OEE Lost Times

Metric	Units	Description
Availability Lost Time	Seconds	Planned production time lost to the process not running. Calculated as Availability Loss × Production Time.
Performance Lost Time	Seconds	Planned production time lost to the process running slower than the theoretical maximum speed. Calculated as Performance Loss × Production Time.
Quality Lost Time	Seconds	Planned production time lost to manufacturing pieces that do not meet quality standards. Calculated as Quality Loss × Production Time.
OEE Lost Time	Seconds	Planned production time lost to all sources. Calculated as Production Time - Fully Productive Time.
Fully Productive Time	Seconds	Represents perfect production (i.e., the time it would have taken to manufacture only good pieces as fast as possible). Calculated as Percent Good x Ideal Time.

Planning

Metric	Units	Description
Goal Count	Pieces	Production goal for the current part run in terms of good pieces.
Good Count Left	Pieces	Number of good pieces remaining to reach the production goal for the current part run. Calculated as Goal Count - Good Count.
Percent Done	Percent	Progress towards production goal for the current part run. Calculated as Good Count / Goal Count.

Production Times

Impact Times

Metric	Units	Description
Run Time	Seconds	Time the process has been in the run state (e.g., running).
Down Time	Seconds	Time the process has been in the unplanned stop state (i.e., down).
Planned Stop Time	Seconds	Time the process has been in the planned stop state (e.g., changeover).
Not Scheduled Time	Seconds	Time the process has been in the not scheduled state (e.g., no production).

Combined Times

Metric	Units	Description
Manufacturing Time	Seconds	Time the process is expected to be running. Calculated as Run Time + Down Time.
Production Time	Seconds	Time the process is scheduled for production. Calculated as Manufacturing Time + Planned Stop Time.
All Time	Seconds	Accounts for all time. Calculated as Production Time + Not Scheduled Time.

Impact Percentages

Metric	Units	Description
Percent Run	Percent	Percentage of production time that the process has been running. Calculated as Run Time / Production Time.
Percent Down	Percent	Percentage of production time that the process has been in an unplanned stop. Calculated as Down Time / Production Time.
Percent Planned Stop	Percent	Percentage of production time that the process has been in a planned stop. Calculated as Planned Stop Time / Production Time.

Last Impact Event Times

Metric	Units	Description
Last Run Time	Seconds	Duration of the most recent (or current) run event.
Last Down Time	Seconds	Duration of the most recent (or current) unplanned stop event.
Last Planned Stop Time	Seconds	Duration of the most recent (or current) planned stop event.
Last Not Scheduled Time	Seconds	Duration of the most recent (or current) not scheduled event.

General Events

Metric	Units	Description
Duration	Seconds	Duration of a given event (e.g., a shift, part run, or production state).
Start Time	Date Time	Date and time a given event started.
End Time	Date Time	Date and time a given event ended.

Production State Events

Metric	Units	Description
Elapsed Time	Seconds	Time accumulated thus far in the current production state (e.g., changeover time).
Target Time	Seconds	Expected time of the current production state (e.g., changeover target).
Remaining Time	Seconds	Expected time until the current production state ends (e.g., remaining time for a changeover). Calculated as Target Time - Elapsed Time.
Remaining Percent	Percent	Percentage of time expected to be remaining for the current production state (e.g., percent remaining for a changeover). Calculated as Remaining Time / Target Time.

Quality Times

Metric	Units	Description
MTBF	Seconds	How long on average the process runs before it is stopped by a fault (Mean Time Between Failures). Calculated as Run Time / Down Events.
MTTR	Seconds	How long on average it takes to get the process running once it is stopped by a fault (Mean Time to Repair). Calculated as Down Time / Down Events.

Days

Metric	Units	Description
Calendar Day	Days	Identifies the calendar day of an event (calendar day changes at midnight).
Production Day	Days	Identifies the production day of an event (production day changes on shift boundaries).

Six Big Losses

Six Big Losses Times

Metric	Units	Description
Down Lost Time	Seconds	Production time lost to down events (same as the Down Time metric).
Planned Stop Lost Time	Seconds	Production time lost to planned stop events (same as the Planned Stop Time metric).
Cycle Lost Time	Seconds	Production time lost to cycles longer than the ideal cycle time and shorter than the small stop threshold. Only time in excess of the ICT is considered lost. Calculated as Run Cycle Lost Time + Partial Cycle Lost Time.
Small Stop Lost Time	Seconds	Production time lost to cycles equal to or longer than the small stop threshold. Only time in excess of the ICT is considered lost.
Startup Reject Lost Time	Seconds	Production time lost to manufacturing rejects during startup. Calculated as Startup Reject Loss × Production Time.
Production Reject Lost Time	Seconds	Production time lost manufacturing rejects during steady-state production. Calculated as Production Reject Loss × Production Time.

Six Big Losses Percentages

Metric	Units	Description
Down Loss	Percent	Percentage of production time lost to down events. Calculated as Down Lost Time / Production Time.
Planned Stop Loss	Percent	Percentage of production time lost to planned stop events. Calculated as Planned Stop Lost Time / Production Time.
Cycle Loss	Percent	Percentage of production time lost to cycles longer than ideal cycle time and shorter than the small stop threshold. Only time in excess of the ICT is considered lost. Calculated as Cycle Lost Time / Production Time.
Small Stop Loss	Percent	Percentage of production time lost to cycles equal to or longer than the small stop threshold. Only time in excess of the ICT is considered lost. Calculated as Small Stop Lost Time / Production Time.
Startup Reject Loss	Percent	Percentage of production time lost manufacturing rejects during startup. Calculated as Startup Rejects / Total Count × Availability × Performance.
Production Reject Loss	Percent	Percentage of production time lost manufacturing rejects during steady-state production. Calculated as Production Rejects / Total Count × Availability × Performance.

Speed

Metric	Units	Description
In Speed	PPH, PPM	Current speed that pieces are entering the manufacturing process.
Good Speed	PPH, PPM	Current speed that good pieces are being manufactured.
Reject Speed	PPH, PPM	Current speed that reject pieces are being manufactured.
Total Speed	PPH, PPM	Current speed that pieces are being manufactured.
End of Line Speed	PPH, PPM	Current speed that product is exiting the line.

Target

Takt Time

Metric	Units	Description
Takt Time	Seconds	Expected pace of manufacturing for the currently running part. Set on a part-by-part basis (as a cycle time). Includes "budgeted" losses for down time, cycles, and rejects. Does NOT include time where production is not expected to be running (breaks, meetings, changeovers, and planned maintenance). Drives the target counter and efficiency calculations.
Avg. Takt Time	Seconds	Average takt time across any time period. Calculated as Manufacturing Time / Target Cycles.
Pace Timer	Seconds	Paces production by takt time. Each cycle the value starts at the takt time and counts down.

Targets

Metric	Units	Description
Target Count	Pieces	Real-time target for good pieces. Each time the takt time elapses the target count increases. Often shown on the scoreboard together with good count to show operators where they are at as compared to expectations.
Target Cycles	Cycles	Increments each time the takt time elapses. Used to calculate other metrics and not usually of direct interest to users.

Efficiency and Variance

Metric	Units	Description
Efficiency	Percent	How production is doing as compared to expectations. 100% or higher means your team is "winning". Calculated as Good Count / Target Count.
Percent Variance	Percent	How far ahead or below expectations production is doing (as a percentage). Calculated as (Good Count - Target Count) / Target Count.
Time Variance	Seconds	How far ahead or below expectations production is doing (in terms of time). Calculated as Percent Variance × Manufacturing Time.
Count Variance	Pieces	How far ahead or below expectations production is doing (in terms of pieces). Calculated as Good Count - Target Count.

TEEP

Core TEEP

Metric	Units	Description
TEEP	Percent	Percentage of ALL time that is truly productive. Often used for capacity planning. Calculated as OEE × Utilization.
Utilization	Percent	Percentage of ALL time that is used for production. Calculated as Production Time / All Time.
Schedule Loss	Percent	Percentage of ALL time that is NOT used for production. Calculated as 100% - Utilization.
Production Loss	Percent	Percentage of ALL time that is taken up by lost production time (OEE Lost Time). Primarily used when presenting information from the perspective of all time (100%) being the sum of time not scheduled for production (Schedule Loss), time that is scheduled and productive (TEEP) and time that is scheduled and not productive (Production Loss). Can be calculated as OEE Lost Time / All Time OR 100% - Schedule Loss - TEEP.

TEEP Lost Times

Metric	Units	Description
Schedule Lost Time	Seconds	Time lost to not being used for production. Calculated as Schedule Loss × All Time
Production Lost Time	Seconds	Time lost to all sources of lost productivity during planned production time (this is simply another name for OEE Lost Time – a name which aligns with the Production Loss metric).
Hidden Factory Time	Seconds	Untapped capacity of your manufacturing process. The maximum amount of additional production that can be unlocked without capital investment. Fully utilizing this time means around-the-clock perfect production – manufacturing only good pieces, as fast as possible, with no downtime, every hour of every day. Calculated as OEE Lost Time + Schedule Lost Time.

Appendix B: Dimensions

This appendix lists all the dimensions that are tracked by XL. Metrics and dimensions are fundamental to how XL tracks production information. Metrics are numeric values that measure a quantitative characteristic of production, such as Good Count, OEE, or Labor Efficiency. Dimensions are descriptive values that refer to a qualitative attribute of production, such as the Shift, Asset, or Hour.

Aspects

Dimension	Description
Impact	Four mutually exclusive states that provide a top-level perspective of manufacturing: Run, Unplanned Stop, Planned Stop, and Not Scheduled.
Job	A work order identifier or other categorization that best identifies a specific part run. XL applies a dimension value of "Unknown Job" when production is detected but there is no job identifier.
Part	A part identifier for a specific part run. XL applies a dimension value of "Unknown Part" when production is detected but there is no part identifier.
Production Phase	Three mutually exclusive states that identify sequential phases of a part run: Changeover, Startup (time immediately following the changeover), and Steady State. These phases are important because they often have different loss characteristics.
Production State	A standardized and uniform way for XL to describe what is happening at the manufacturing process: Running, Running Slow, Running Poor Quality, Running Poorly, Down, Changeover, Maintenance, Meal/Break, Meeting, No Production, and Not Monitored.
Reason	A fully customizable way for you to describe what is happening at the manufacturing process from your perspective using terms that are familiar to your company. Reasons are particularly valuable for capturing information that will help you address losses and drive improvement.
Reject Reasons	A fully customizable way for you to describe the underlying reasons for quality loss. Reject reasons are particularly valuable for capturing information that will help you address losses and drive improvement.
Shift	A shift identifier. XL applies a dimension value of "Unknown Shift" when production is detected but no shift is scheduled.
Team	An identifier for who is operating the process. Can refer to a single operator, a lead operator, or a crew. XL applies a dimension value of "Unknown Team" when production is detected but there is no team identifier.

Assets

Dimension	Description
Enterprise	The entire organization. Metrics for all assets monitored by XL are rolled up to the Enterprise.
Division	Divisions within your organization. May be a physical region or a logical collection of plants.
Plant	Manufacturing plants.
Area	Subdivisions within manufacturing plants. May be a physical area or a logical collection of assets.
Asset	The manufacturing processes being monitored.

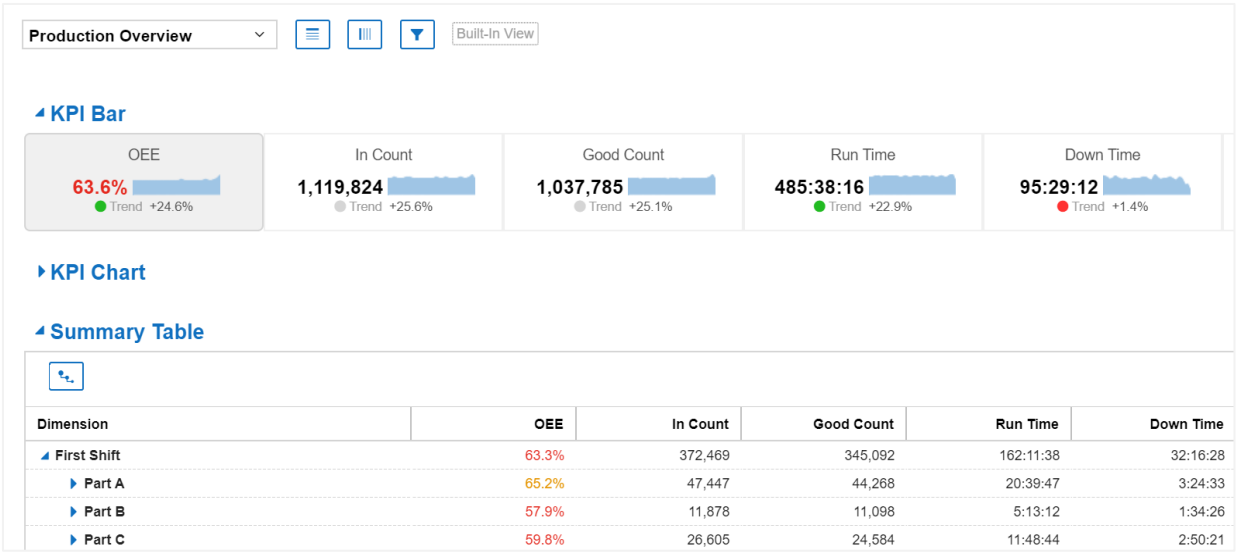
Time

Dimension	Description
Hour	Shift hours, which are relative to the beginning of the shift (e.g., Shift Hour 1, Shift Hour 2).
Day	Production days, which are aligned to shift boundaries to ensure that shifts that cross midnight stay within one day for reporting purposes.
Week	Production weeks, which always run from Monday to Sunday to provide consistency when aggregating information across multiple time zones and geographical areas.
Month	Calendar months (on production day boundaries).
Quarter	Calendar quarters (on production day boundaries).
Year	Calendar years (on production day boundaries).

Appendix C: Built-In Report Pages

Advanced Analytics

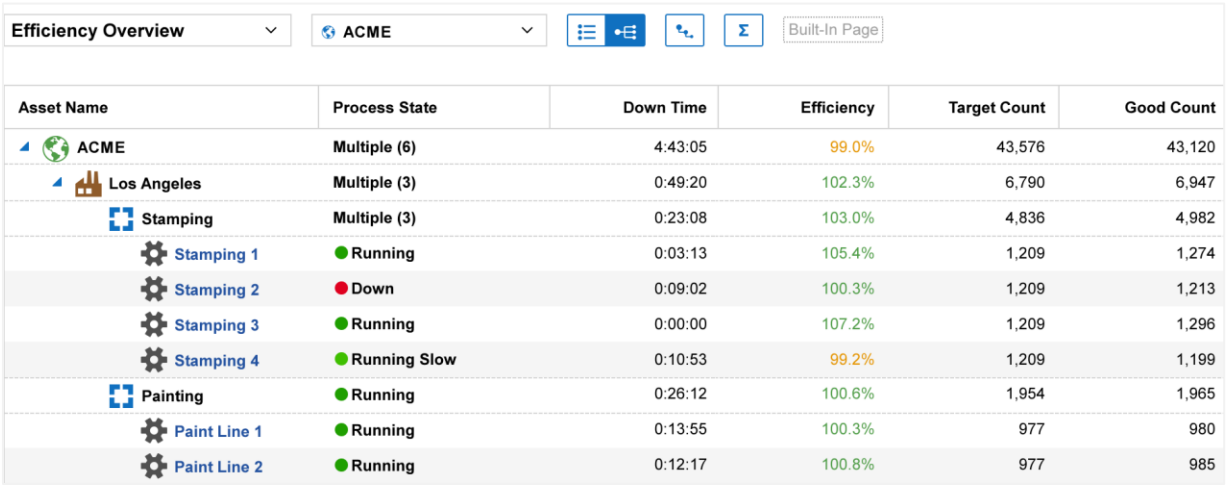
Dynamically explore data through an interactive set of KPI, chart and table elements. Drag and drop dimensions to slice and dice your data in different ways. Ideal for deep data exploration across multiple dimensions and KPIs for a single manufacturing process.



Dimension	OEE	In Count	Good Count	Run Time	Down Time
First Shift	63.3%	372,469	345,092	162:11:38	32:16:28
Part A	65.2%	47,447	44,268	20:39:47	3:24:33
Part B	57.9%	11,878	11,098	5:13:12	1:34:26
Part C	59.8%	26,605	24,584	11:48:44	2:50:21

All Production

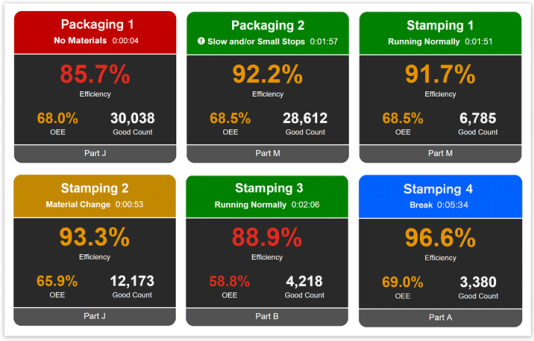
View rolled-up real-time and historical production data for every asset, area, and plant. Ideal for quickly viewing and comparing any portions of your manufacturing operation across any combinations of metrics.



Asset Name	Process State	Down Time	Efficiency	Target Count	Good Count
ACME	Multiple (6)	4:43:05	99.0%	43,576	43,120
Los Angeles	Multiple (3)	0:49:20	102.3%	6,790	6,947
Stamping	Multiple (3)	0:23:08	103.0%	4,836	4,982
Stamping 1	Running	0:03:13	105.4%	1,209	1,274
Stamping 2	Down	0:09:02	100.3%	1,209	1,213
Stamping 3	Running	0:00:00	107.2%	1,209	1,296
Stamping 4	Running Slow	0:10:53	99.2%	1,209	1,199
Painting	Running	0:26:12	100.6%	1,954	1,965
Paint Line 1	Running	0:13:55	100.3%	977	980
Paint Line 2	Running	0:12:17	100.8%	977	985

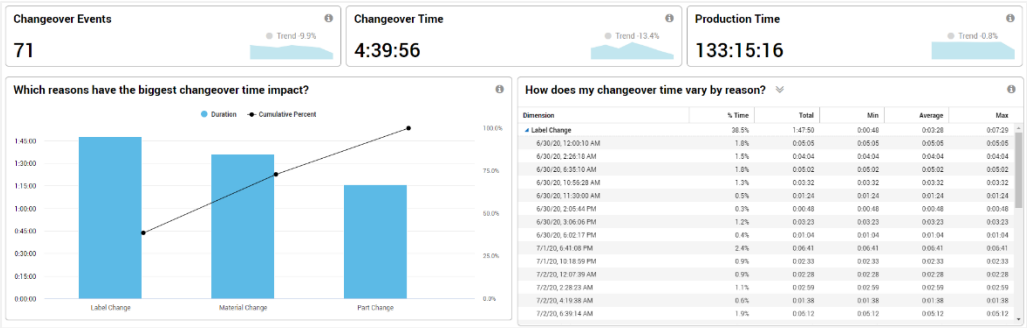
Andon

View the real-time status of every process with a colorful page suitable for display on a large format television or monitor. Ideal for communicating KPI's in meeting rooms and offices to ensure that all personnel understand the current state of production.



Changeover

Deep dive into changeovers with instant analytics and answers to key questions. Ideal for gaining a better understanding of changeovers and how they compare across parts and part runs.

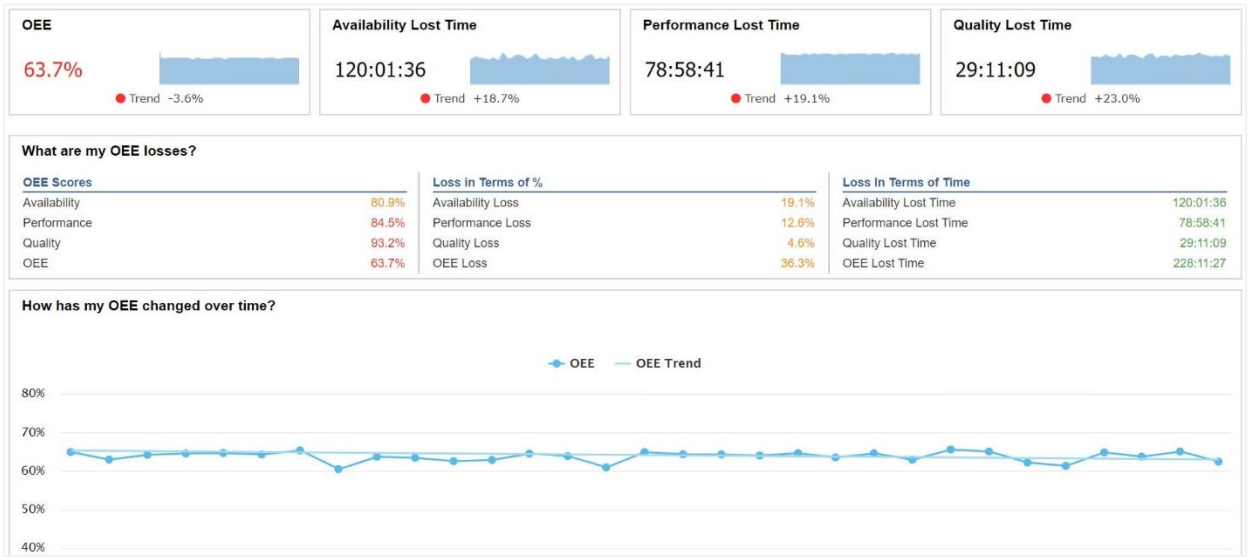


Down Time

Deep dive into down time and its underlying reasons. Ideal for identifying which sources of down time are most important to address (e.g., emergent problems, problems related to specific parts, or by largest overall losses).

OEE

Deep dive into OEE and its underlying factors: availability, performance, and quality. Ideal for quantifying the major causes of lost productivity using OEE (a best practice metric) and identifying which OEE factor is most important to address.

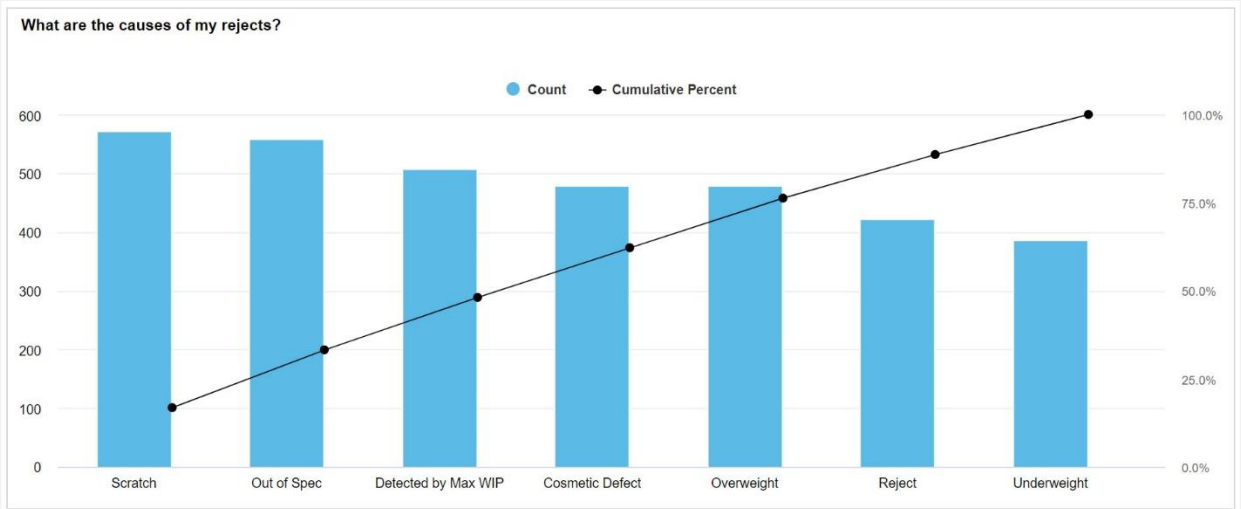


Performance Loss

Deep dive into performance loss and its underlying constituents: cycle loss and small stop loss. Ideal for identifying which parts and shifts are most affected by cycle losses, and for validating your ideal cycle time settings against actual production data.

Quality Loss

Deep dive into quality loss and its underlying constituents: startup rejects and production rejects. Ideal for identifying how each part is affected by quality losses and to better understand the underlying reasons.



What are my reject reason trends?

Reject Reason	Trend
Overweight	57.1%
Reject	5.3%
Cosmetic Defect	2.8%
Out of Spec	-24.7%
Detected by Max WIP	-32.9%

What are my reject reason occurrences?

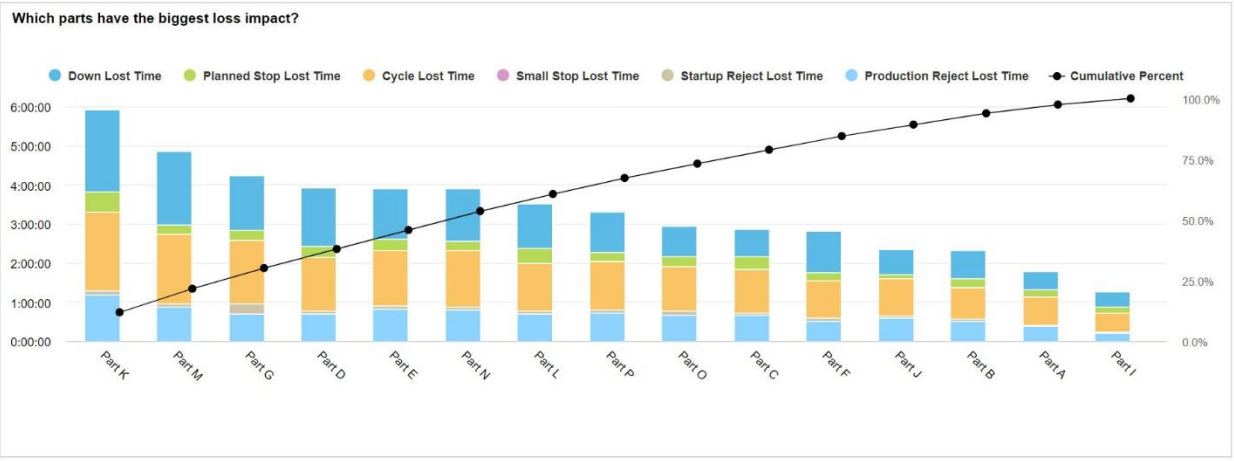
Reject Reason	Count
Scratch	572
Out of Spec	559
Detected by Max WIP	507
Cosmetic Defect	480
Overweight	479

Six Big Losses

Deep dive into the six big losses: down time, planned stops, cycle loss, small stops, startup rejects, and production rejects. Ideal for gaining a deeper understanding of lost production time using a lean

What are my OEE and Six Big Losses?

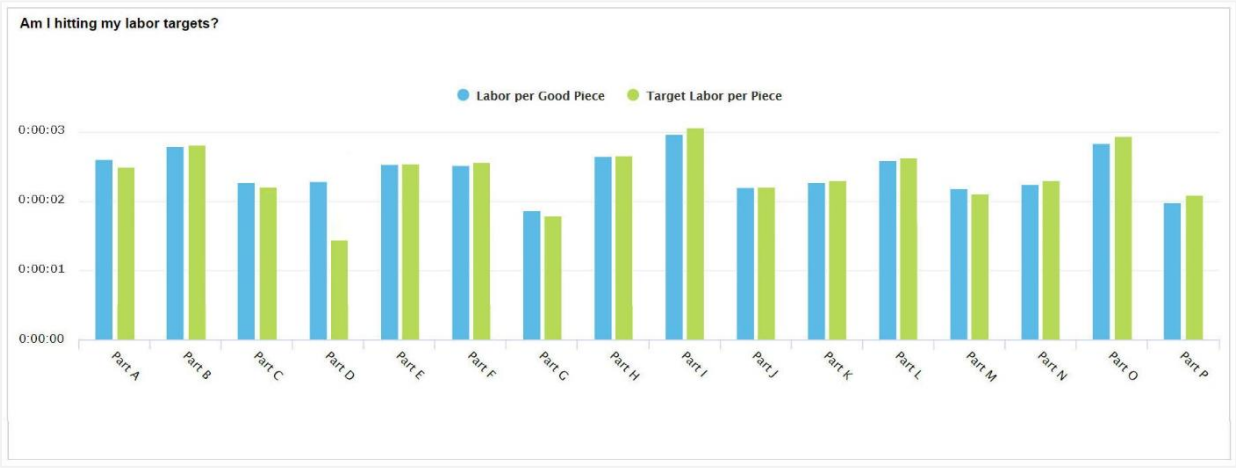
OEE Scores		Loss in Terms of %		Loss in Terms of Time	
Availability	85.0%	Down Loss	12.1%	Down Lost Time	16:29:44
		Planned Stop Loss	2.8%	Planned Stop Lost Time	3:51:36
Performance	84.1%	Cycle Loss	13.5%	Cycle Lost Time	18:22:23
		Small Stop Loss	0.0%	Small Stop Lost Time	0:00:00
Quality	88.4%	Startup Reject Loss	0.8%	Startup Reject Lost Time	1:09:19
		Production Reject Loss	7.4%	Production Reject Lost Time	10:07:07
OEE	63.2%	OEE Loss	36.8%	OEE Lost Time	50:00:19



manufacturing framework that extends OEE into loss categories that each have a different set of countermeasures.

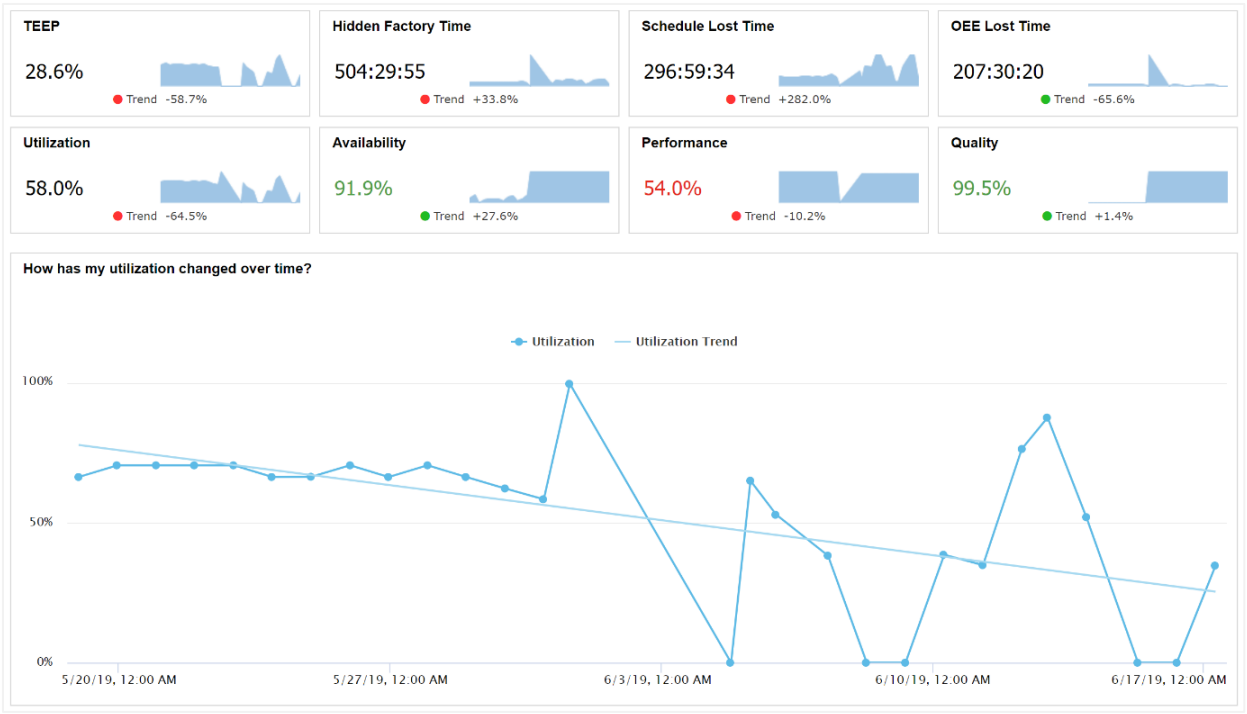
Teams and Labor

Deep dive into teams (an analytical dimension) and labor (metrics). Ideal for identifying best practices and creating standardized work that captures knowledge and transfers that knowledge between teams, as well as evaluating how actual labor efficiency compares to company standards.



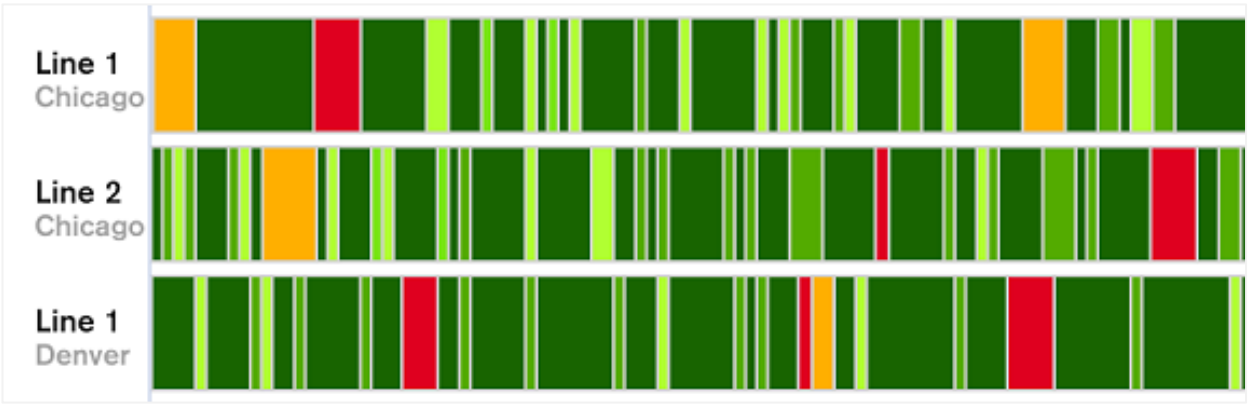
TEEP (Hidden Factory)

Deep dive into TEEP, which fully exposes your "hidden factory" by extending OEE with utilization and schedule loss. Ideal for identifying additional capacity that exists within with your current manufacturing processes. Often evaluated as a precursor to new capital investments.



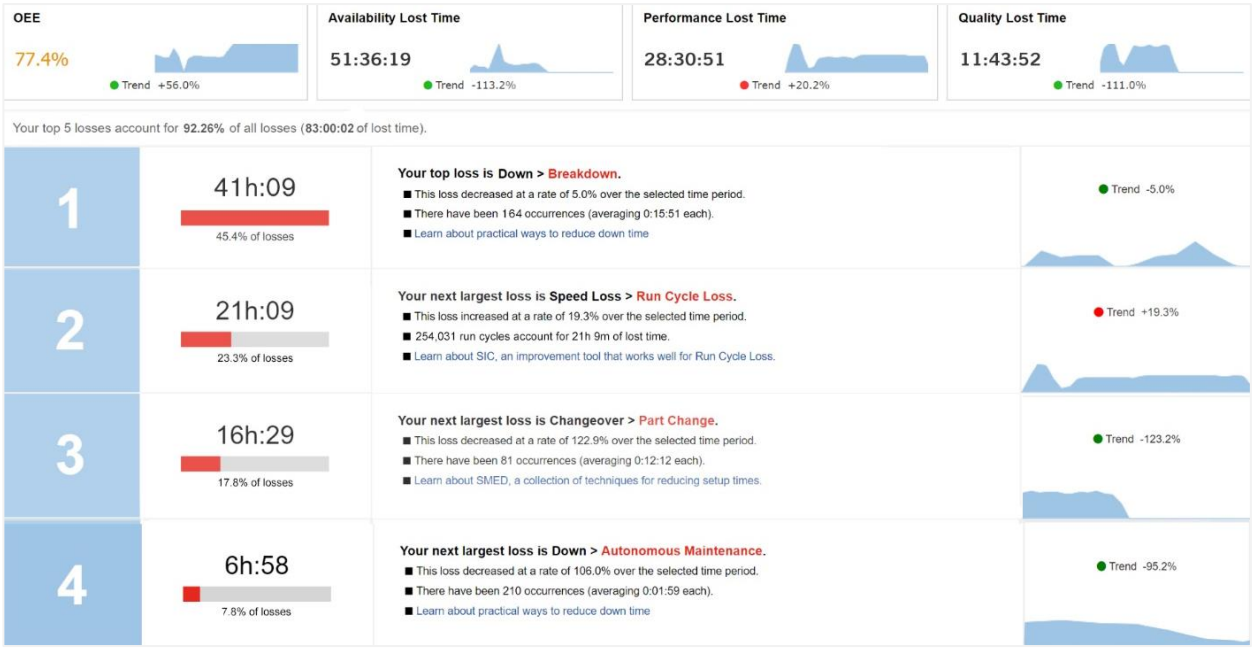
Timeline

View the state of multiple assets over time on a synchronized timeline. Ideal for getting a quick picture of production in an area or plant, and for finding patterns that exist across multiple assets (e.g. down time before or after breaks).



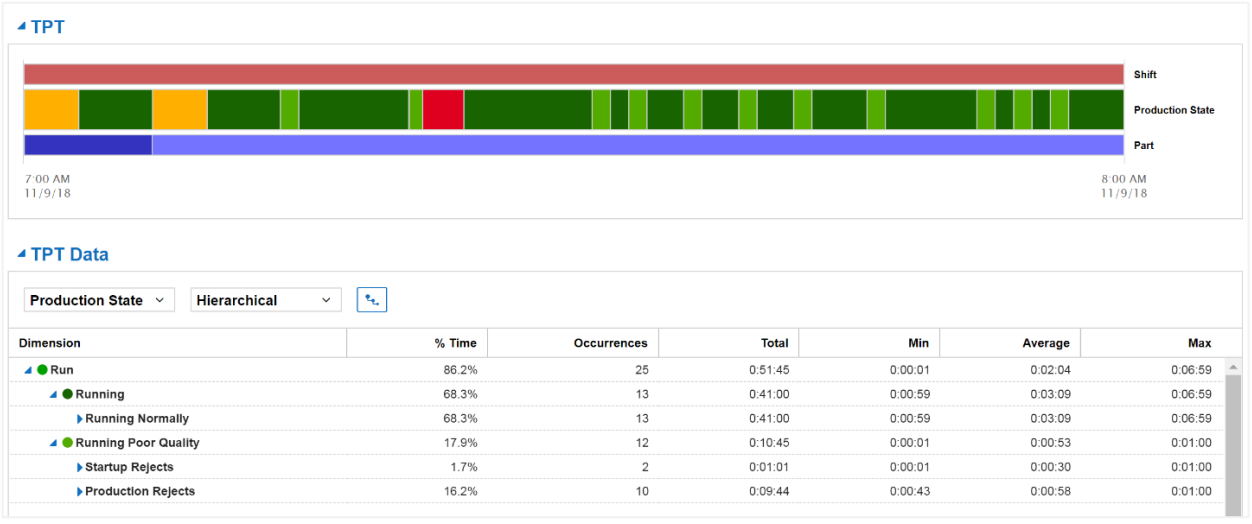
Top Losses

View every loss that impacts OEE, ranked and prioritized by how much production time was lost, with additional details for each loss. Ideal for identifying, prioritizing, and evaluating the effectiveness of improvement projects.



Total Production Timeline

View the state of the manufacturing process over time, including production state, shifts, and part runs. Ideal for spotting patterns and problematic transitions, such as rough running after a changeover.



Dimension	% Time	Occurrences	Total	Min	Average	Max
Run	86.2%	25	0:51:45	0:00:01	0:02:04	0:06:59
Running	68.3%	13	0:41:00	0:00:59	0:03:09	0:06:59
Running Normally	68.3%	13	0:41:00	0:00:59	0:03:09	0:06:59
Running Poor Quality	17.9%	12	0:10:45	0:00:01	0:00:53	0:01:00
Startup Rejects	1.7%	2	0:01:01	0:00:01	0:00:30	0:01:00
Production Rejects	16.2%	10	0:09:44	0:00:43	0:00:58	0:01:00

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