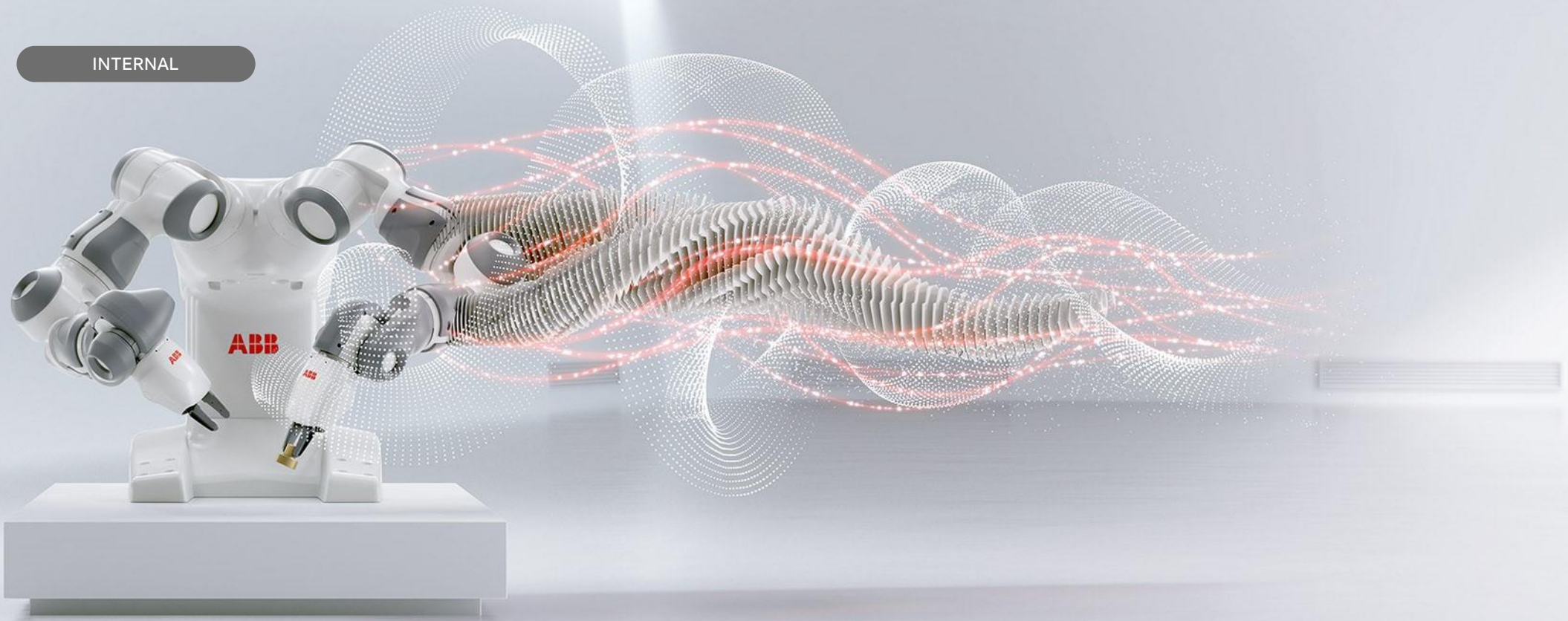
INTERNAL



Visualization for Discrete Manufacturing

A part of the PADME project

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 Document ID.: Rev.:

This presentation is the report for the visualization of the maintenance view in discrete manufacturing, in the PADME project. PADME is a part of the strategic innovation program Produktion2030, a joint venture by VINNOVA, Formas and the Swedish Energy Agency.

Summary

Fault finding and correcting them is one of the key responsibilities of maintenance personnel.

Operators quite commonly call the maintenance personnel to get them down to the shop floor to solve problems that caused the production line to stop. Some of these problems, such as signal or sensor faults may not be visible to the human eye, and could cause unnecessary delays in the production.

By incorporating both historical information from different equipment and data sources, as well as creating situation awareness, maintenance personnel could conclude and fault find more effectively.

Before visiting the shop floor, or while talking on the phone, maintenance personnel could get a sense of the current situation, as well as go back in time to find earlier problems that might be related.

After talking to maintenance personnel and incorporating knowledge and experience form the process industry and 800xA, a visualization has been created to attempt to show how these situations could be helped.

Introduction

”ABB’s 800xA, is a network of interconnected sensors (IoT-devices), actuators, controllers and computers that continuously control and monitor processes such as paper mills, steel works, oil & gas plants”. The level of automation in process industries is high in comparison to discrete manufacturing.

How could the knowledge and experiences from 800xA be adapted to decrease cycle times, optimize work in process and increase throughput?

This report describes the methods and results of the work to attempt to visualize a maintenece view in the discrete manufacturing industry, by applying knowledge and experience from the process industry and 800xA.

Content and Methods

Task Analysis

Input to task analysis was gathered by visiting the factory and face to face meetings with persons in the intended group as well as people with insight in the field. The task analysis result was used as input to the use cases and scenarios.

Target User Group

The target user group presented in this report is the intended audience for the Mockup. Input to this was gathered by visiting the factory and face to face meetings with persons in the intended group as well as people with insight in the field.

Use Cases

The Use Cases describe the findings from the task analysis and intends to target the business value in the form of decreased cycle times, increased throughput, or optimize work in progress.

Scenarios

The Scenarios tells the story of the use cases, where the user tries to reach their goal, in context, using the application. This is a way to see the full picture and to make the visualization easier to understand.

Mockup

A mockup was created to bring the use cases to life, in order to better understand the business value by getting a sense of the potential of the final application, and also as a start for further improvements and functionality.

Automation Maintenance

Target User Group

Target User Group

Automation Maintenance [Maintenance]

Goals

- Preventive and immediate maintenance
- Responsible to solve complex problems in the assembly line that the operators cannot solve themselves.
- Being able to use the app in other location than the shop floor, such as in the office, or by the coffee machine.
- Smoothly and seamlessly navigate between information I am looking for within the system.

Frustrations

- Unclear and difficult to find the product or cell in the system that the operator wants help with.
- Difficult to find and navigate to related information needed to solve problems
- Slow load speed

Target User Group

Automation Maintenance [Maintenance]

Behaviour

Maintenance takes calls from operators daily, requesting their help in solving problems in the assembly line.

They spend in the office and out in different places in the factory and would benefit from getting operational status and some history as background, as input in solving the immediate problem. It would also be helpful to bring the laptop down to the shop floor, in case some investigation is required after visual assessment.

Motivation

- View current status of operation, including current step, and previous, for a specific workstation
- For a specific product, view ongoing steps, and previous
- Track products through several workstations

Possible Use Cases

For Automation Maintenance

Alarm Analysis

Alarm Analysis

Alarms for operators vs maintenance

Alarms in process systems, or in this case discrete manufacturing, notifies the operator about abnormal situations, so that the operator can decide whether direct action is required.

For Maintenance, alarms would be viewed at historically, with the purpose of being able to work with preventive maintenance to optimize the manufacturing process, rather than by acting on alarms instantly, as an operator would.

Alarm Management

Alarm management targets to optimize the amount of alarms an operator sees. It is quite common i today's process systems, that operators face too many irrelevant alarms, due to poor alarm management. And by finding these alarms, and removing them, the operator can work more efficiently and safely.

So "alarm management" is more about making the operator efficient, and reduce the risk of missed alarms to prevent accidents and loss in production, but can also be used by maintenance/others to optimize the production.

UC1 Shift Change

Alarm Analysis

Description

The maintenance personnel talks to the previous shift's maintenance personnel and/or operators to get an overview of the general process status along with specific problem areas to be aware of during the shift coming up. The information about problem areas is documented through the HMI as well as traceable in logs, as well as in Maintenance HMI alarm analysis.

Prerequisities

- There is an overlap between shifts
- There is information to share related to maintenance

Context

- The maintenance personnel is experienced in manufacturing and has mechanical knowledge.

UC1 Shift Change

Alarm Analysis

Change Shift workflow

- During manufacturing, the Maintenance /Operators are provided a way to store important information about the manufacturing
- The operators can add pictures and information that is of value for the maintenance personnel for the next shift or over time
- The next shift arrives
- Notes and alarms during shift are available and summarized, including critical parameter changes
- The new shifts maintenance has constant access to information and can add new notes during their shift for the next handover

Users Goals and Concerns

- There is an overlap between shifts
- There is information to share related to maintenance

Exceptions due to user (missing prerequisites, safety hazards, etc.)

- The maintenance personnel is experienced in manufacturing and has mechanical knowledge.

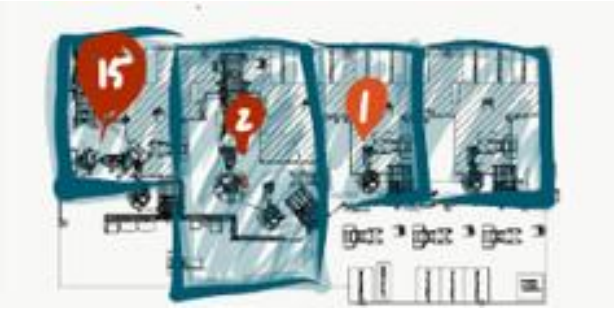
Solution Proposals

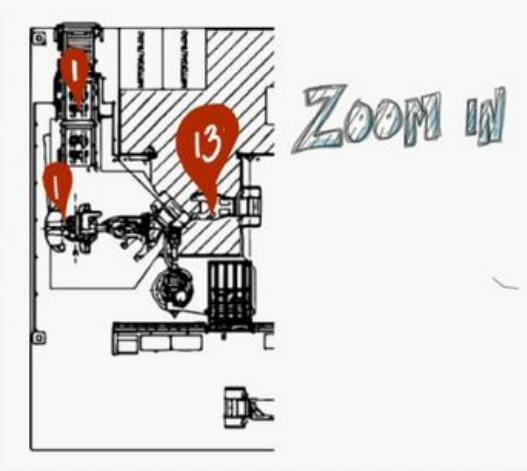
UC1 Shift Change

Shift Alarm Overview

A filtered alarm list could be accompanied by a contextual alarm view, where the location of the alarms are visualized along with severity and the density per workstation. The maintenance could zoom in on a workstation to get a more detailed view.

View of total alarms for a Shift/day/week per workstation

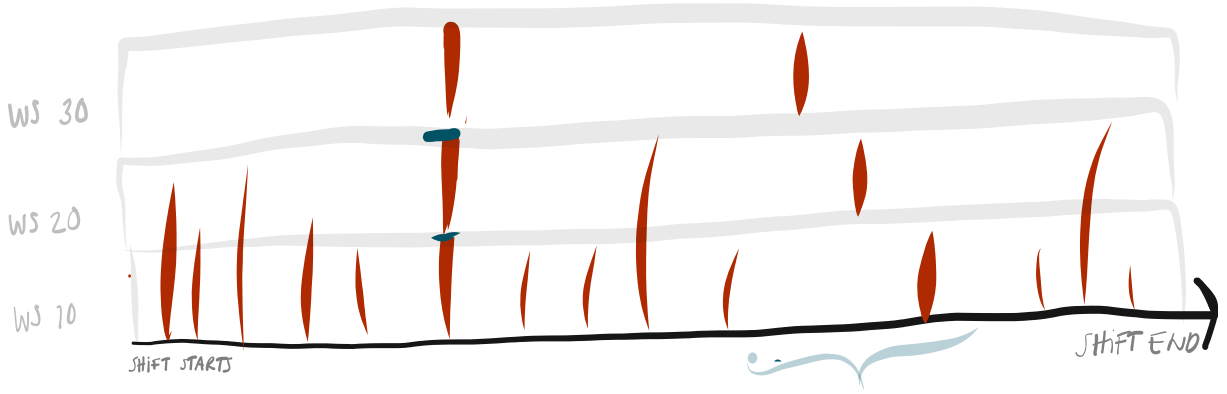




Spotting alarm consequences between different stations

Some alarms or stops are due to manufacturing problems further down the line.

In a view like below, the Maintenance can see patterns, such as alarms occurring at the same time in different workstations, or that an alarm further down the line triggers problems in previous stations.



Solution Proposals

UC1 Shift Change

Maintenance Notes

Today, Maintenance use a separate tool for making maintenance notes and documenting discussions during the shift.

Suggested improvement could be to include this functionality in the system (although not available in 800xA today), and the notes could be assigned directly to the object or/and alarms within the system through the HMI. No visualization has been done for this.

UC2 Preventive Maintenance

Alarm Analysis

Description

Automation maintenance staff discusses regularly within the group to get an overview of the general process status along with specific problem areas to see if there are any patterns that can be addressed with preventive maintenance. The information about possible patterns is documented in logs and verbally.

Prerequisities

- There is enough information relevant for maintenance available to be able to spot patterns

Context

- The maintenance personnel is experienced in manufacturing and has mechanical knowledge.

UC2 Preventive Maintenance

Alarm Analysis

Preventive Maintenance workflow

- The Maintenance Group have their regular meeting to set up a plan for preventive maintenance.
- The group go through the application to spot alarm patterns that should be fixed by preventive maintenance.
- The responsible makes notes and creates a schedule.

Users Goals and Concerns

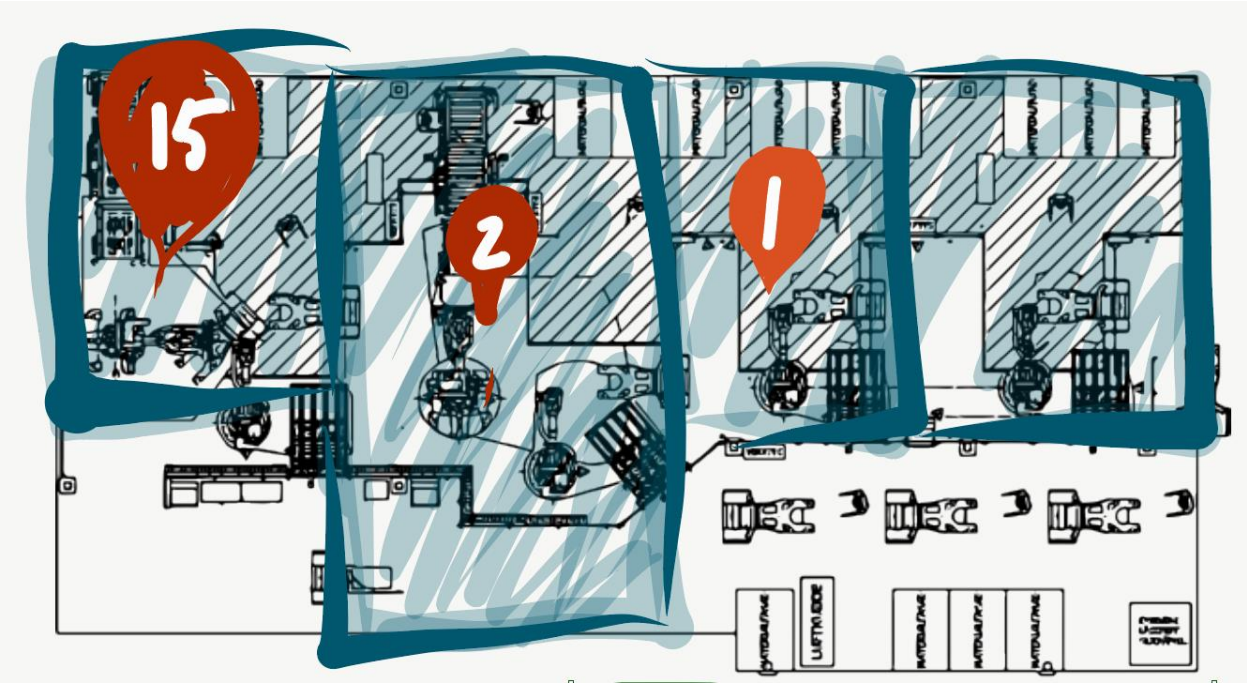
- He/she is concerned if there are any recurring problem areas that he/she needs to pay extra attention to.
- Get an overview of potential problems to spot patterns, in order to optimize the manufacturing over time, by preventing that same situations occur over and over.

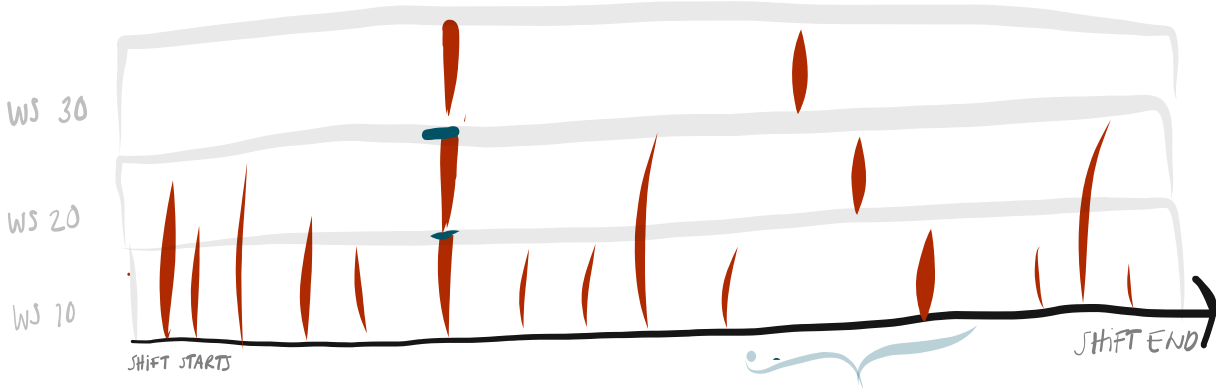
Solution Proposal

UC2 Preventive Maintenance

Alarm Overview for preventive maintenance

Add time filters to the alarm views, so Maintenance can view the alarms in different times perspectives, such as shift, day, week, month, depending on how much historical data is available.





UC3 Safety Status

Alarm Analysis

Description

If a scanner has indicated a problem for an unknown reason, the Maintenance wants to get an overview of the scanner status and the surrounding devices as input in solving the problem.

Prerequisities

- There is a problem with a scanner

Context

Maintenance has knowledge about the system and its equipment.

Ideas

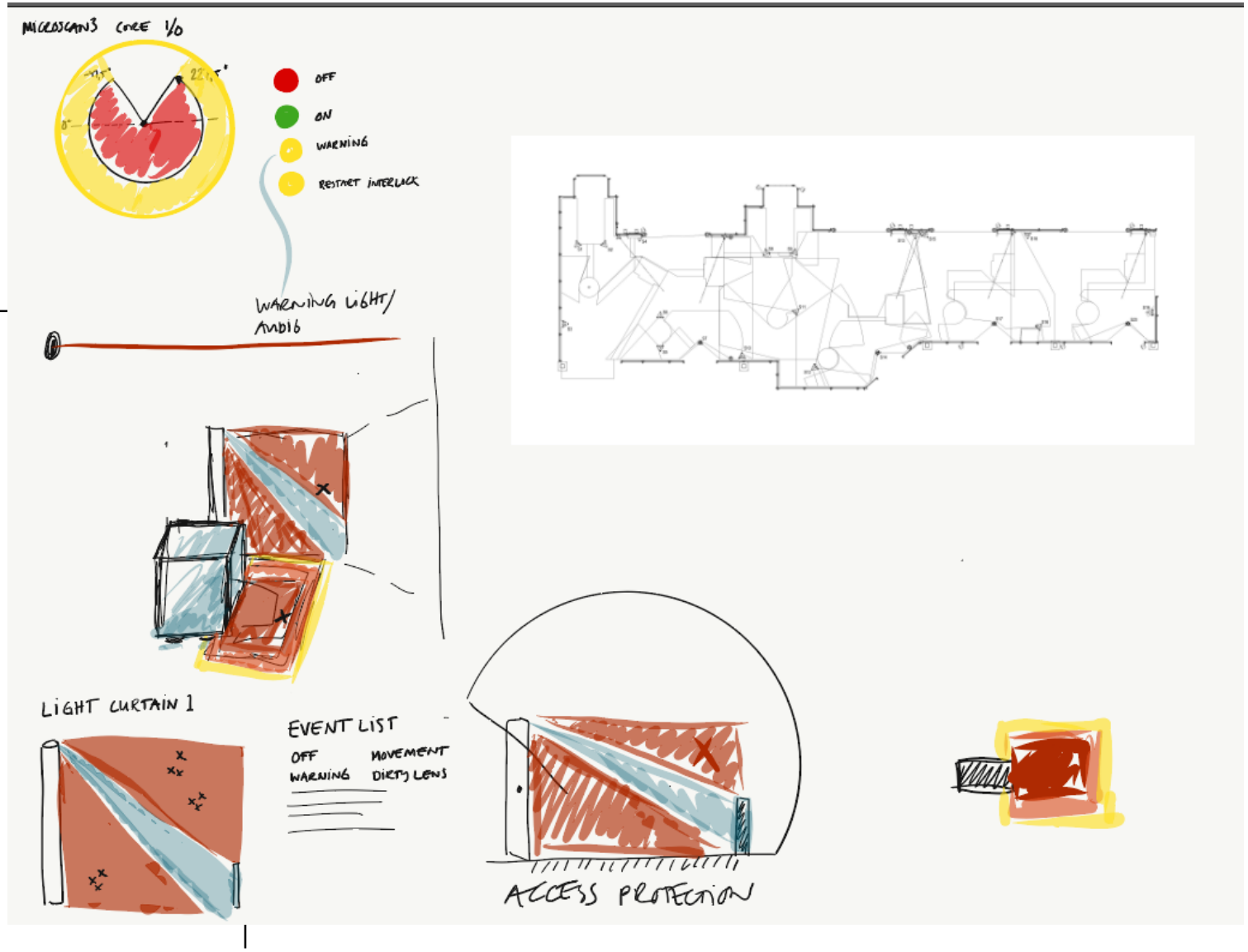
UC3 Safety Status

Safety overview

Safety Overview were briefly discussed, and also the subject of scanner status were touched.

One idea is to include visulizations of the safety Areas, where the movement detections and other Statuses can be seen.

Here are some rough idea sketches on the subject.



UC4 Product Manufacturing Status

Alarm Analysis

Description

Maintenance gets a call from the operator regarding a malfunction that just occurred and he/she needs assistance to solve the problem. For example the vision system might have malfunctioned without any obvious reason to the operator, or the same bolt keeps breaking for a certain product model. Maintenance needs to investigate what has happened, to solve the immediate problem and to prevent it from recurring if possible.

Prerequisities

- The operator discovers the problem
- Maintenance is contacted
- There are pictures available

Context

- The maintenance is experienced in manufacturing and has knowledge about the manufacturing equipment and stages.

UC4 Product Manufacturing Status

Alarm Analysis

Product Manufacturing Status workflow

- A problem occurs the operator contacts the maintenance by phone
- Maintenance is provided a way to view manufacturing status and solve the problem from the office
- The operator takes pictures or does facetime with a mobile phone and sends it directly to Maintenance responsible to provide more input
- The operator is informed by phone on how to solve the issue or maintenance visits the manufacturing to solve the issue if needed.

Users Goals and Concerns

- He/she is concerned if there are any problems in the tasks that the robots has completed that might have led to errors further down the line in manufacturing, or immediate problems in the vision system, that need to be solved immediately.
- Get an overview of potential problems to ensure effective manufacturing, and preventing that abnormal situations occur.

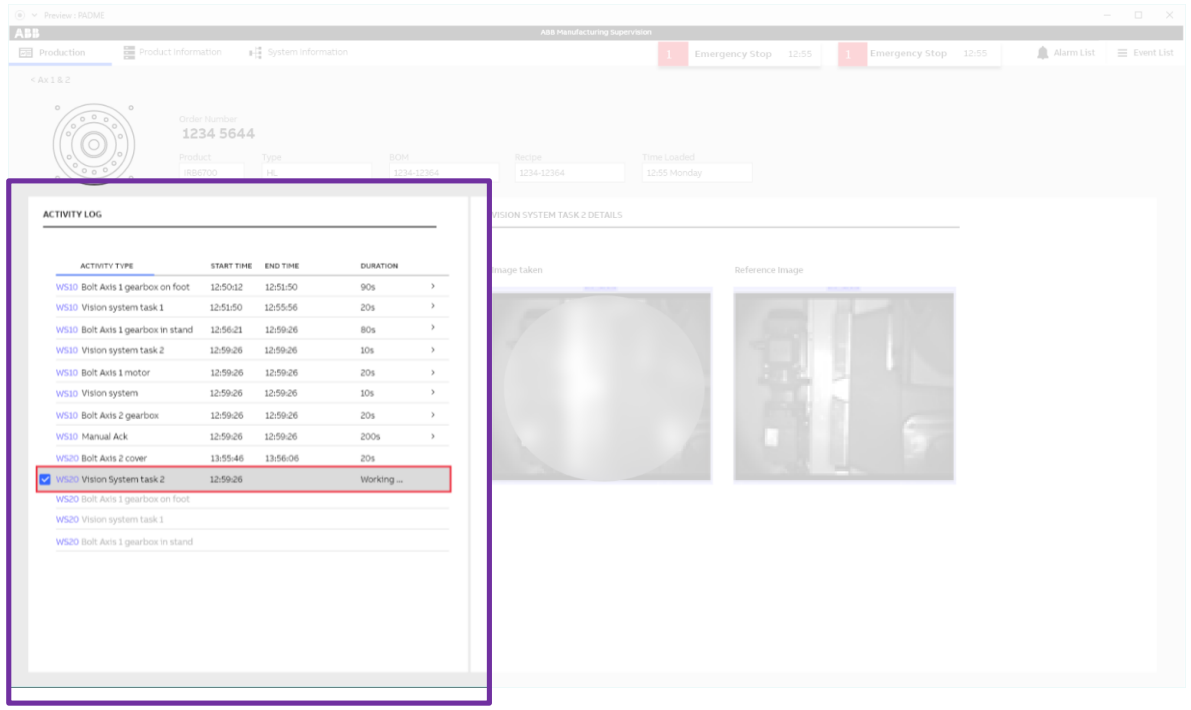
Exceptions due to user (missing prerequisites, safety hazards, etc.)

- Operator managed to solve the problem himself and did not contact maintenance.

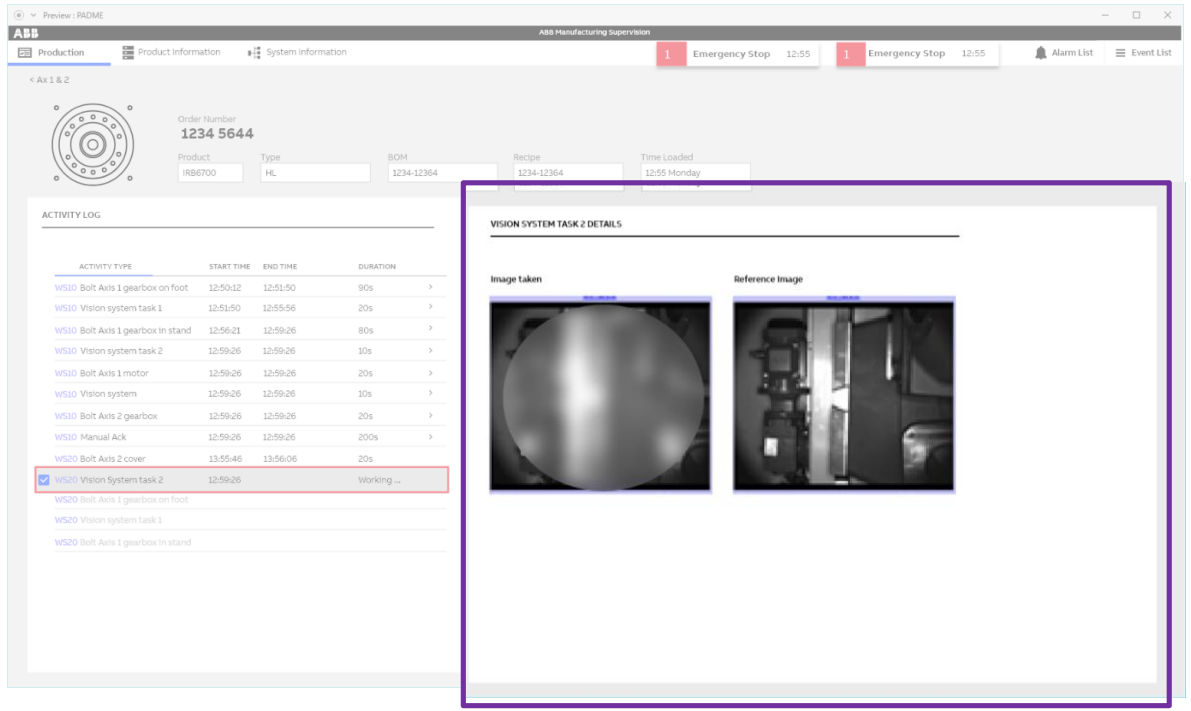
Solution Proposal

UC4 Product Manufacturing Status

Overview of Automatic Tasks



View of automatic task details



Reading Links for Alarm Analysis

https://www.sciencedirect.com/science/article/pii/S1474667016358505

www.youtube.com/watch?v=dmEIQgrJjgA

https://www.intelligentplant.com/Products/alarm-analysis.html

Scenarios

Scenarios for the Mockup

What is the mockup useful for?

Today, Maintenance gets calls from operators when abnormal situations occur, and are expected to solve the problem. To get an idea of current status of assembly and its problems, the Operator briefs the Maintenance and together they visually inspect the equipment and workstation when needed.

Historical assembly status might be available in some cases, but since it is available in different and disconnected systems, can make it difficult and time consuming to follow the assembly and the data from the automatic operations, which is needed to get detailed information about current status.

Some problems might not be visible to the human eye, for example signaling and sensor problems, which make them difficult to discover.

A mockup has been created to attempt to visualize the solution for some of these problems.

Each scenario that follows tells a story about a possible situation that the Maintenance might encounter, including how to solve this situation and problem using a future HMI. A part of the problem solving workflow is then visualized through the mockup.

Scenarios for the Mockup

Scenario 1 - Vision system malfunction

Use Case:UC4 Product Manufacturing Status

Maintenance, sitting at his desk in the office, gets a call from the operator regarding a malfunction that just occurred and the he/she needs assistance to solve the problem. The operator noticed that the vision system malfunctioned without any obvious reason.

While on the phone, Maintenance opens the Discrete Manufacturing Application, and locates the current workstation with the problem.

He/She can see the automatic tasks that are completed, and that the assembly has stopped on the vision task. He/She compares the reference image with the image taken, and can instantly see that there is a reflection in the image, that makes the robot mistakenly think that the AGV is positioned wrongly, and therefore the automatic operation is stopped. So the operator is instructed to clean the lens and the material, and start the process again.

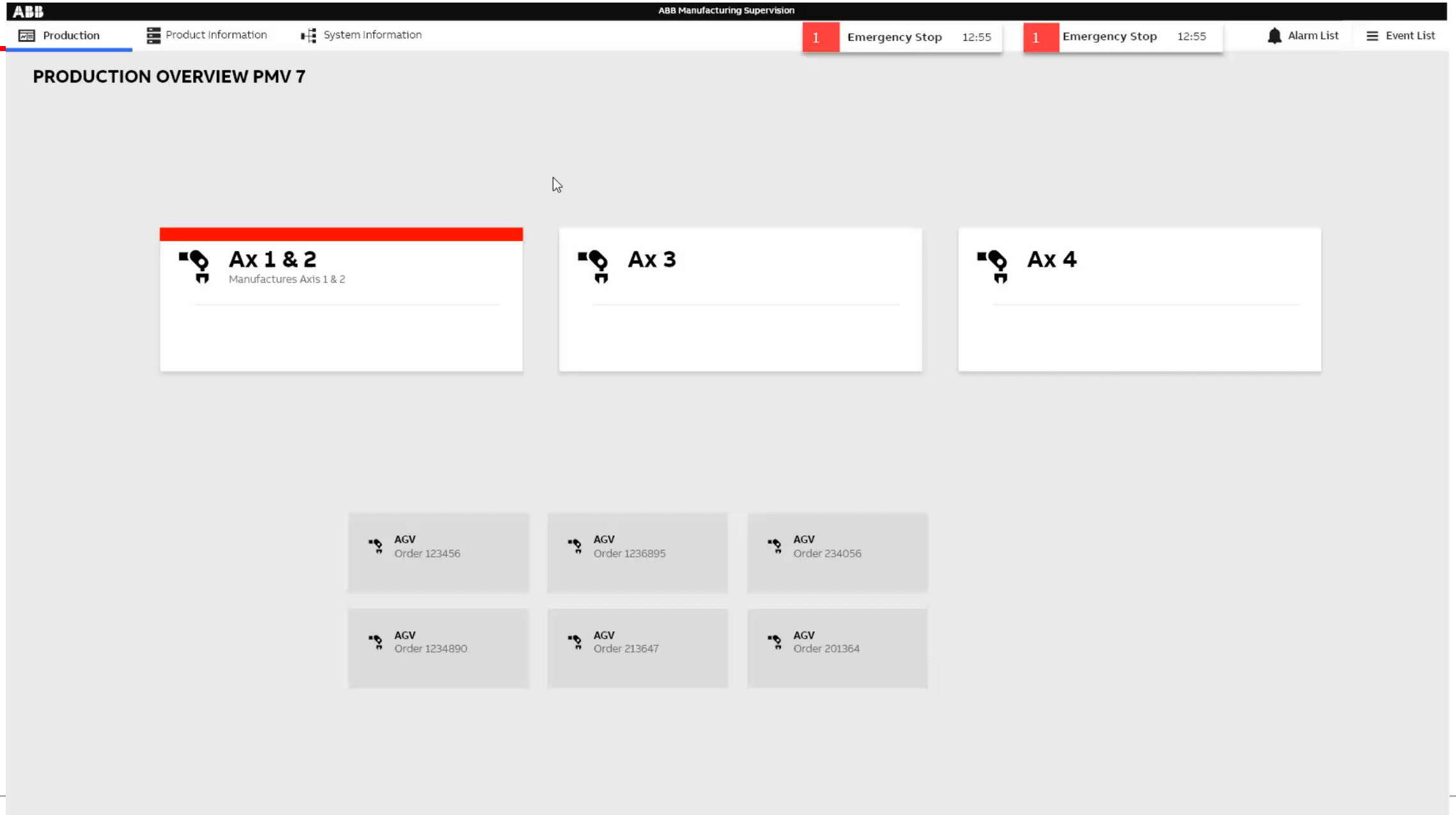


ABB
ABB Manufacturing Supervision
Production
Product Information
System Information
1 Emergency Stop 12:55
1 Emergency Stop 12:55
Alarm List
Event List
PRODUCTION OVERVIEW PMV 7
Ax 1 & 2
Manufactures Axis 1 & 2
Ax 3
Ax 4
AGV
Order 123456
AGV
Order 1236895
AGV
Order 234056
AGV
Order 1234890
AGV
Order 213647
AGV
Order 201364

Scenarios for the Mockup

Scenario 2 – Bolt Breakage

The operator notices that the same bolt keeps breaking for a certain product model. The operator informs Maintenance to get attention on the problem. It is the Maintenance responsibility to investigate and solve the immediate problem and to prevent it from recurring if possible.

So the Maintenance, sitting by the desk, working on the laptop, opens up the application to view the automatic bolting operations.

He/she can see that this particular bolt have been re-tightened many times, before the operator finally manually tightened the bolt.

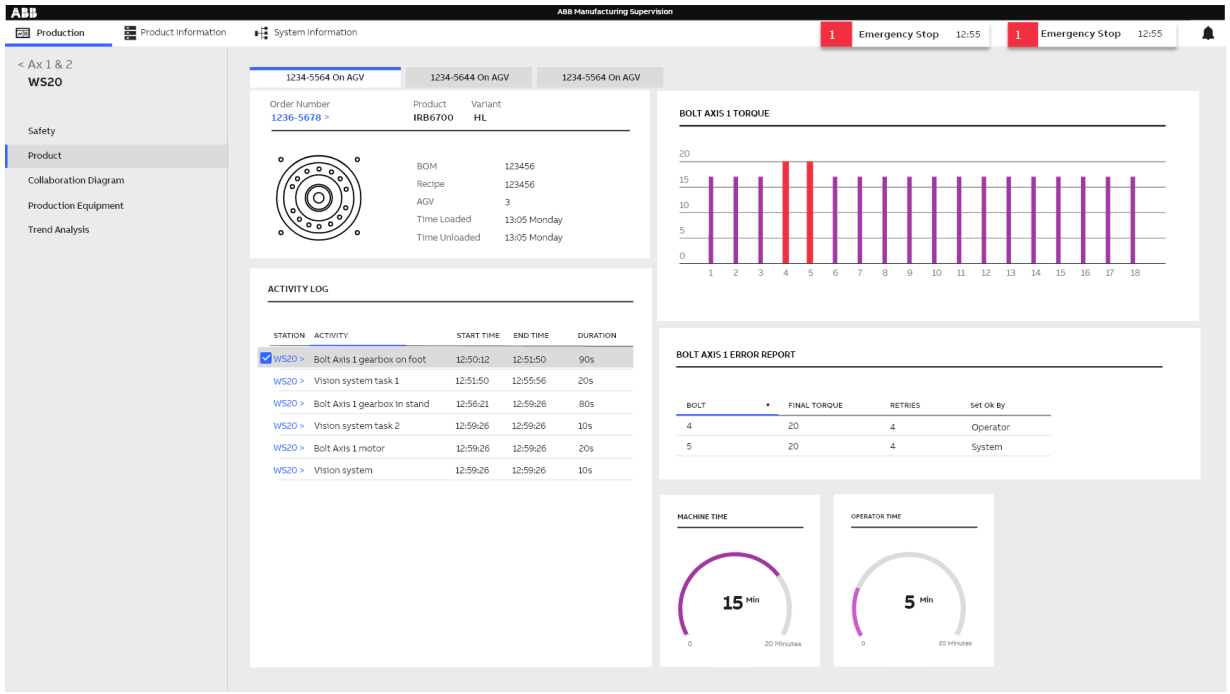
He/she can also see that this occurs almost every time for this certain model.

With this information, Maintenance finds several paths to investigate, to locate the source of error, and prevent it from recurring.

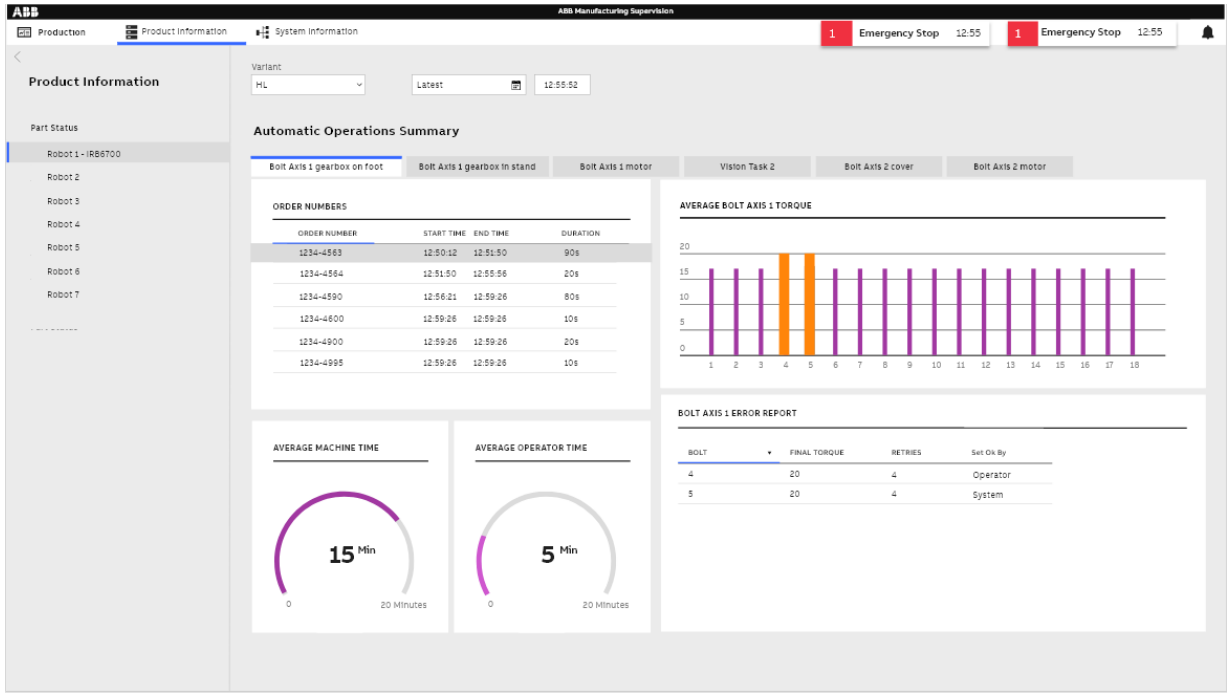
Scenarios for the Mockup

Bolt Breakage Visualization

Picture shows that there was a problem with the torque on WS20



Picture shows that Maintenance can scroll through all the different orders to se if the problem is a common issue.



Scenarios for the Mockup

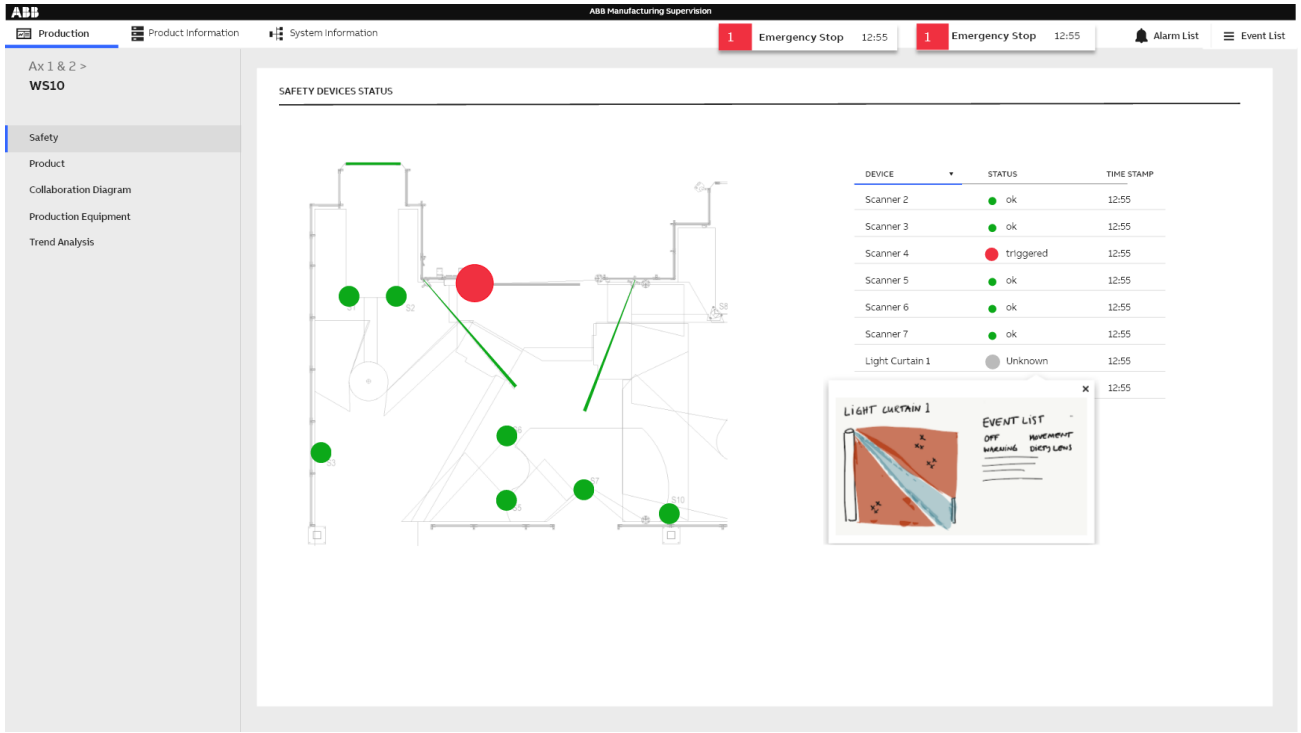
Scenario 3 – Scanner Failure

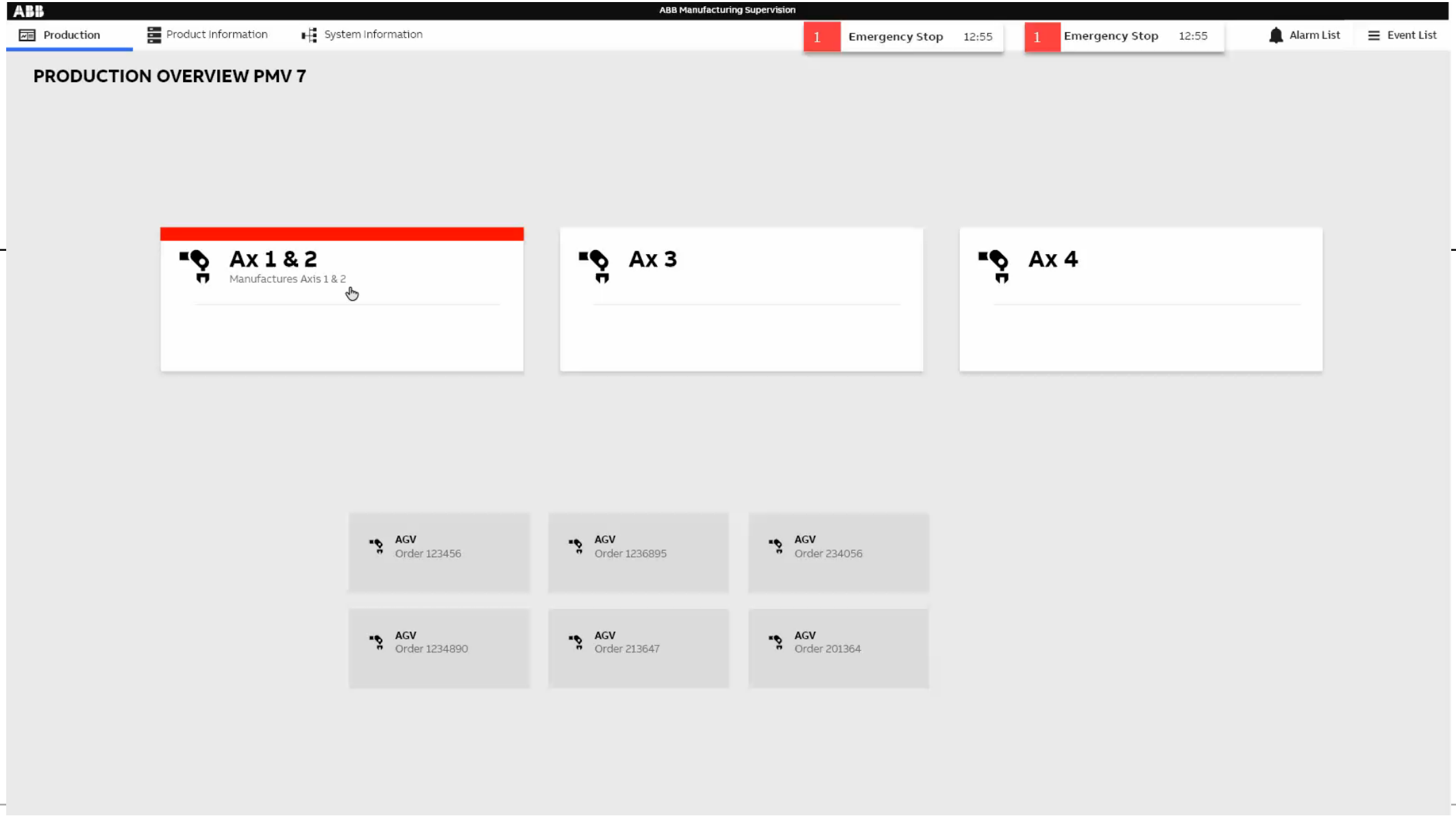
The operator notices that a scanner is triggered without any obvious reason, and calls the Maintenance to get assistance.

The maintenance is in a meeting room when he gets the call, and opens up the applications to get the safety overview.

He/She directly sees which scanner has a problem. He/She views the details and can conclude that operation is safe, and that the

scanner can be restarted and be up and running again.

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AGV
Order 1236895
AGV
Order 234056
AGV
Order 1234890
AGV
Order 213647
AGV
Order 201364

Findings or Future improvements

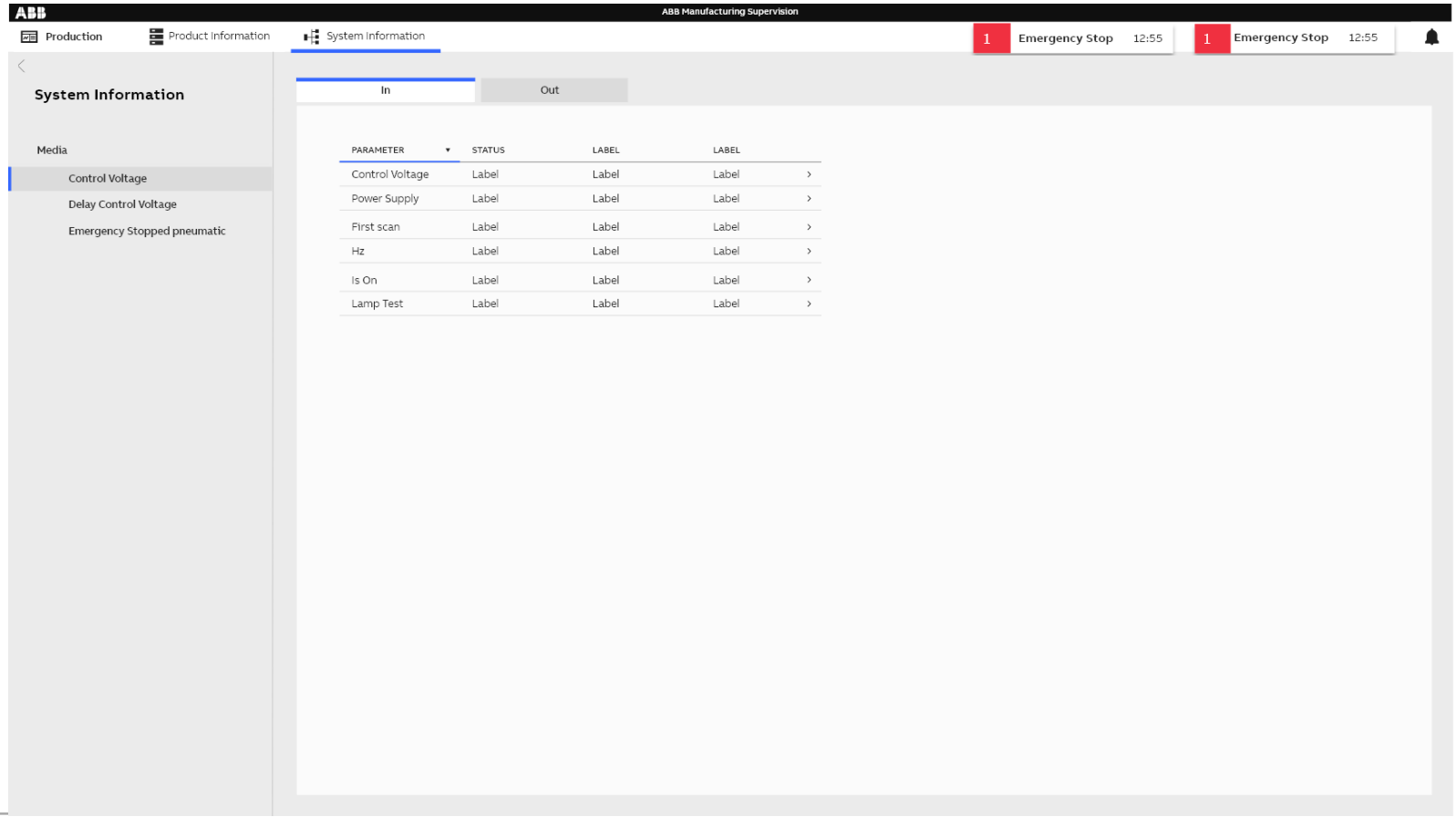
Findings and future improvments discussed

System Overview

This could be a start on a system overview.

This was briefly discussed,

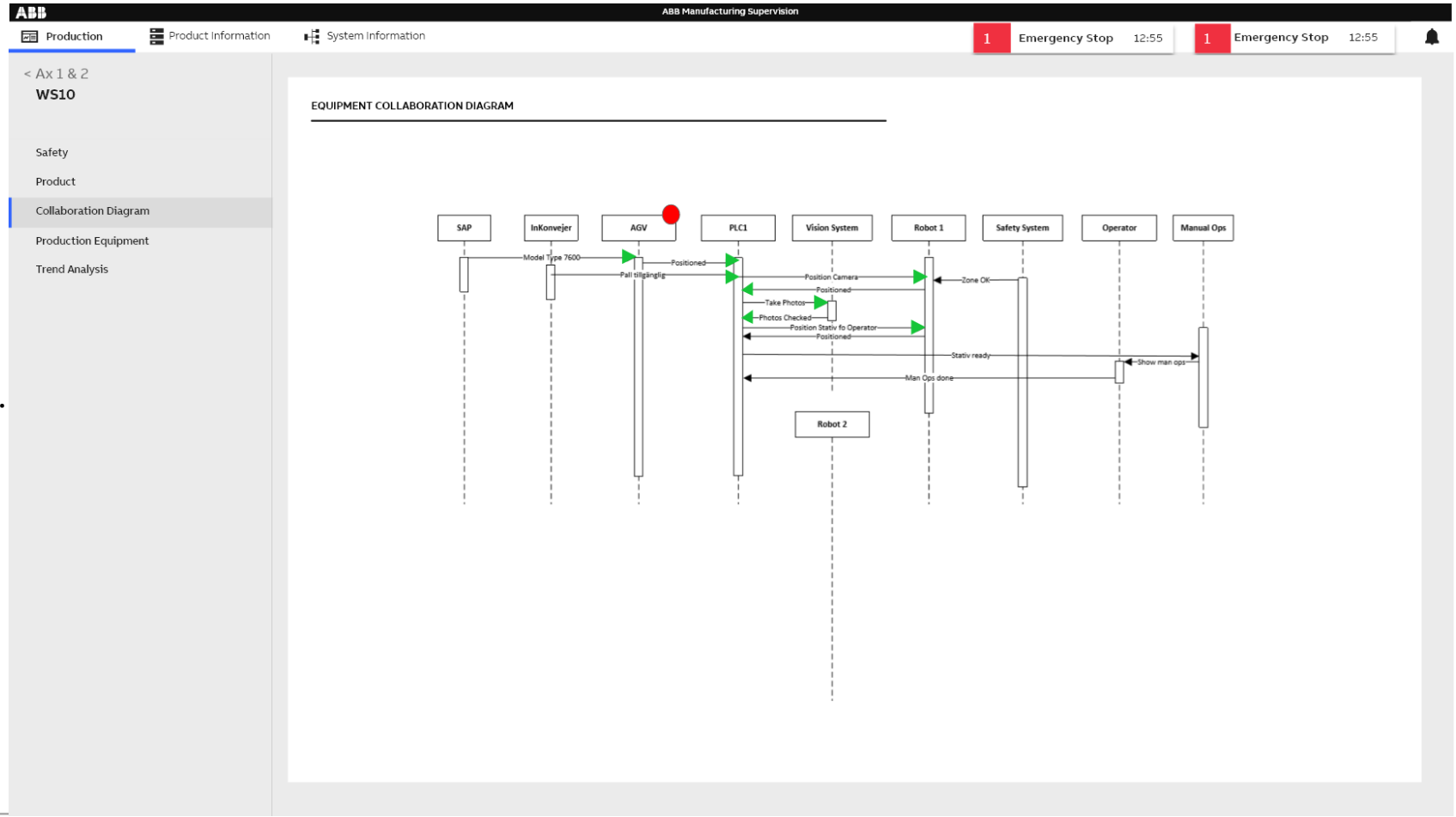
but not investigated further.



Findings and future improvments discussed

Collaboration Diagram

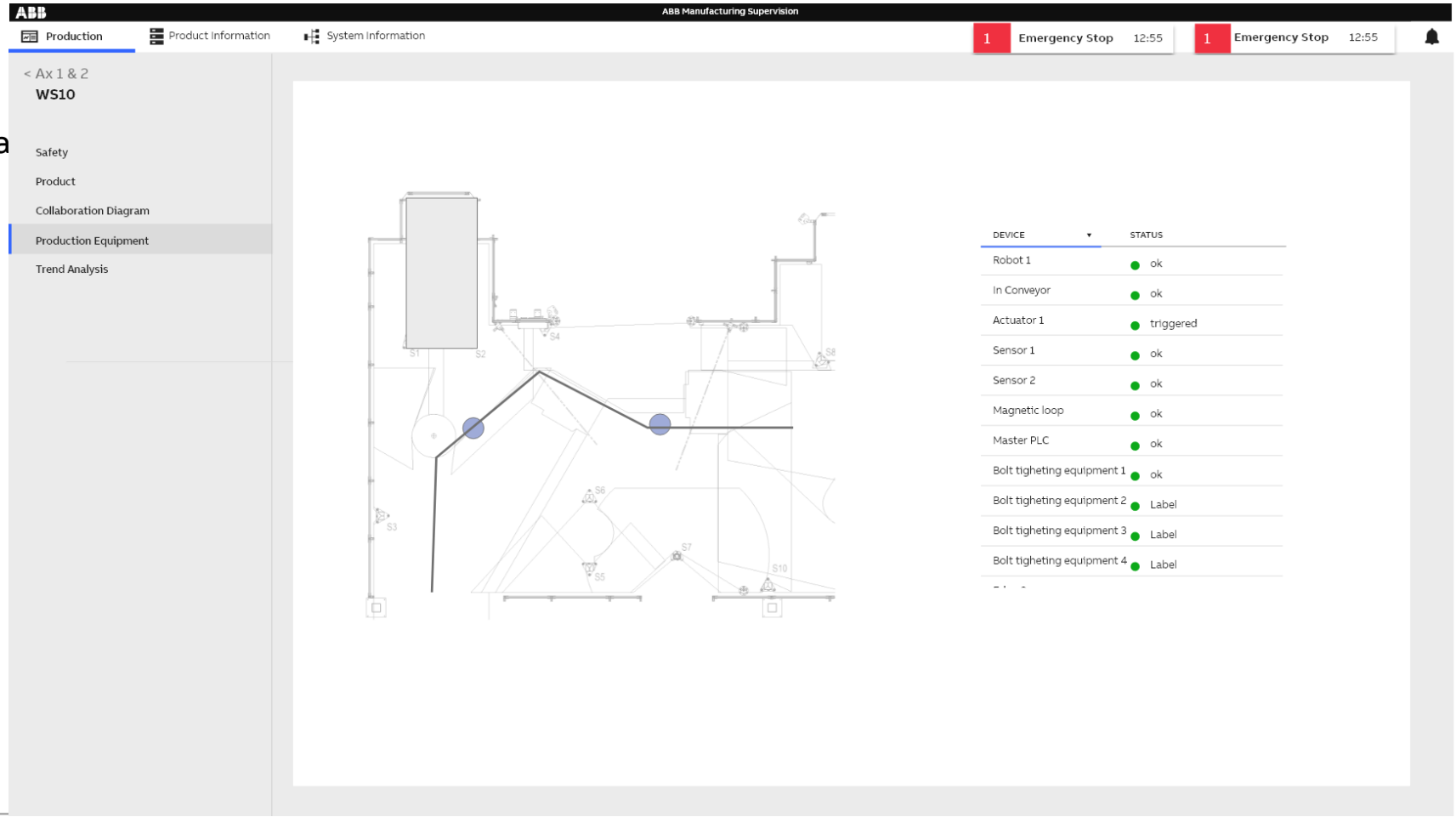
The collaboration diagram provides an overview of the communication.
Here, the maintenance would be able to see if the production stopped due to communication faults. This could be further improved to be very useful, according to target audience discussions.



Findings and future improvements discussed

Production Equipment Overview

A production equipment status overview was requested during discussions with ta Users. In the process industry this is common practice to have similar views for operators, and in this case, it would be intended for maintenance and others.



Findings and future improvements discussed

Possible use case: Optimize production times for a certain product

Duration in context with other workstations

To find out reasons for waiting times.

Main user group would be production Technicians which are responsible for production automation.

Wants to prevent stops or failures and optim manufactured. By logging data and with follow-ups visually, the goal is to see if something is about to break.

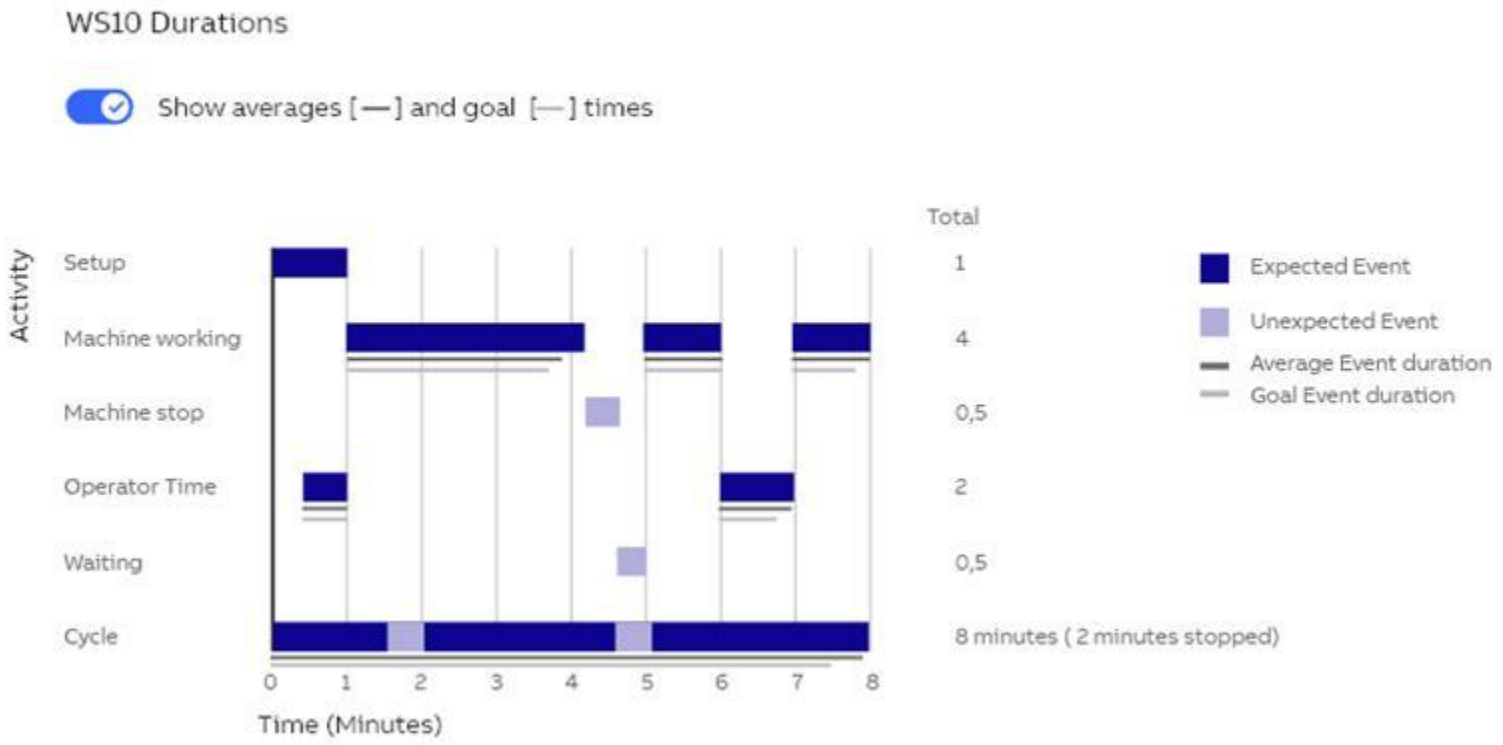
This group is interested in questions like:

Long term analysis

Answer questions such as

– "Why do we have variations"

Find root cause of secondary failures

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