Exercises 2

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1 Assumptions

In order to provide context around the system we make assumptions regarding it. We make assumptions regarding the company size and it's production need. Additionally, we also make some assumptions about the production process in regards to technology and requirements.

We assume the the company is a mid-sized company producing bikes and electric bikes for the commercial market. We have made the assumption that it is a mid sized company because the hardware seems expensive and because most smaller companies have no need for a 24/7 production line. Moreover, it does not appear to be a large company as the production line appears small. The assumption that the company produces bikes or electric bikes was made because the tools in the assembly line seems advanced, however this assumption is mostly arbitrary but serves to give an interesting context for the system.

Based on the assumption that the company produces bikes and electric bikes, we further assume that the production line should be able to manipulate parts from metal and plastics to electronics, in a complex assembly and treatment process. In the process of this we assume that there is a need for many different technologies along the assembly line, which we assume would create a strong need for middleware. We also assume that the production line should concern itself with being able to recover unfinished products that may come from an emergency stop or an unexpected breakdown. In such cases, we assume that it would be reasonable for it to automatically recover or discard the products when resuming operations. Furthermore, it would be important to allow for the addition or variation of modules in the assembly line. This would be important in order to accommodate changing production needs. We assume that system needs to concern itself with security and safety of human actors during production due to compliance. This could cause a need for emergency stops or automatic proximity shutdowns.

2 Use Cases

Table 1: Extensibility and flexibility use case

Name	Introduction of a new bike model
Actors	Assembly technician, production manager, production scheduler
Pre condition	A design of the new bike, specifying the required production
Description	1. The production manager logs into the the production software. 2. The production manager configures a new production step in the software. 3. The production manager asks the assembly technician to add new hardware to the assembly line. 4. The assembly technician installs hardware to the assembly line. 5. The production manager configures a new production run including the new production step in the software. 6. The production manager schedules a test run. 7. The production scheduler confirms the test schedule and starts the production run. 8. The assembly technician and production manager confirm the correctness of the newly established production run.
Post condition	A new bike resembling a test artifact of the newly established production run.

Table 2: Security use case

Name	Emergency shutdown due to malfunctioning test bench
Actors	Test bench, quality assurance worker
Pre condition	QA Worker performs quality assurance of the produced bike at a test bench. The test bench includes the use of robotic arms for easier inspection of the bike.
Description	1. The quality assurance worker starts his inspection of the produced bike. Therefore, he uses a test bench that utilizes robotic arms enabling easier inspection of the bike (i.e. the robotic arms help to lift, rotate, etc. the bike). 2. While standing very close to the bike, the robotic arms begin to move the bike in unpredictable ways. 3. Sensors detect the proximity of the human worker to the malfunctioning machine. 4. The security system interprets it as threat to the human worker. 5. The security system shuts the malfunctioning test bench down and reports the shutdown to the supervisory system.
Post condition	The production machine is shutdown and remaining work is load-balanced to the other machines that are available.

Table 3: Availability use case

Name	Failure of one of the robotic arms.
Actors	Robotic arm, Supervisor system (system) and Production line worker
Pre condition	Production line is running
Description	1. One of the robotic arms suddently starts malfunctioning and not picking up parts. 2. The system notices that the arm that is malfunctioning is not assembling the parts it needs to assemble. 3. The system notifies the operator that the arm is malfunctioning. 4. The system checks if there is another robotic arm that can pickup for the failing robotic arm. 5. The system finds another robotic arm that can pickup the slack. 6. The system reconfigures the production to to use the other arm. 7. The system notifies the operator what it has changed.
Post condition	The system keeps runnng with the other arm doing the job of the malfunctioning.

Table 4: Recoverability use case

Name	Power outage interrupts the production line
Actors	Production line
Pre condition	The production line is running.
Description	1. The area for the production line encounters a loss of power for 5 minutes. 2. The power is back on again. 3. The production line is starting up again. 4. The production line queries the supervisor system for what the current task is and what the last state was. 5. The supervisor system responds with the details. 6. The product line uses the details from the supervisor system to resume activity
Post condition	The product line is running again and continuing as normal.

3 Systems and subsystems

For our bike manufacturing company, we have defined 3 primary systems that will be discussed in this section. These systems should be sufficient to accept an order, manage the supply of all materials, and manage the whole production line.

3.1 Enterprise resource system

First to mention is an enterprise resource system whose first step is to receive orders. After an order is received the system generates an invoice for the customer and tries to predict the time needed to complete the bike. This estimate is based on other subsystems such as the production capacity system or human resource planning system. In case of unhappy customers, this system also handles customer support including accepting the complaint and assigning it to employees.

3.2 Suply chain management system

This system is used to manage the supply chain and logistics. Part of the logistics is ensuring that there is enough material in the warehouses – this is managed by an inventory subsystem. If there are materials missing and need to be ordered that's when the procurement subsystem comes in handy. This subsystem consists of a blockchain of vendors and a tracking system which helps us with planning. Since we consider collecting data from various suppliers there is also a quality history system helping with decision-making when it comes to choosing a supplier.

3.3 Production management system

This is the system where the actual production of a bike takes place. Apart from the production itself, also a scheduling system is a must, in order to achieve maximal efficiency. Another mentionable subsystem is quality control where it is ensured that every bike meets industry standards. It is inevitable that there might occur some errors in the production line and therefore there is also an existence of an error handling system ensuring fault correction and recovery. Integration of some bike components can´t be assembled fully by robots and that is when assembly technicians come in. That creates a need for safety requirements ensuring no human is harmed. That is a responsibility of a security system.

Figure 1: Diagram of our system for a bike assembly line.