**Vision and mission statements**

*Starting point*: The company is focused on manufacturing a production line for paper planes

**Vision**: “We want to make the world a happier place by making paper planes more accessible.”

**Mision**: “To make a working production line to manufacture a paper plane.”

**Requirements**

The main objective is to:  
“collaboratively design, implement and optimise a functioning production/assembly line using robotic arms to produce paper planes”

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| **1.** | **Functional requirements** |  |
| 1.1 | The production line must perform seven distinct folding steps to create a conventional paper plane. |  |
| 1.2 | The folding sequence must be fully automated and accurately executed by the robotic arms. | Except for loading raw materials (paper) and collecting finished products. |
| 1.3 | The assembly line is divided into three segments, with each robotic arm responsible for specific folding tasks. |  |
| 1.4 | Smooth transition of paper between segments with minimal or no human intervention. |  |
| 1.5 | The production process must ensure repeatability, with consistent folding quality across multiple production cycles. |  |
| 1.6 | The system must detect and handle common errors (e.g., misaligned folds or paper jams) and either correct them autonomously or alert operators. |  |
| 1.7 | The paper plane produced must adhere to a standardized design with precise and consistent dimensions. |  |
| 1.8 | The system should be capable of producing a certain number of paper planes per hour to meet efficiency requirements. |  |
| 1.9 | Safety protocols must be in place to protect operators and prevent damage to the robotic arms in case of errors or malfunctions. |  |
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| **2.** | **Technical requirements** |  |
| 2.1 | Use Arduino Braccio++ robotic arms or approved alternatives. | Alternative is AR4 robot |
| 2.2 | Each robotic arm must have an 180 degrees of freedom to perform complex folding motions. |  |
| 2.3 | The robotic arms must achieve high precision with a tolerance of ±5 mm to ensure accurate folding. |  |
| 2.4 | The system must be integrated into a centralized control system to coordinate movements between the three robotic arms. |  |
| 2.5 | Communication protocols (e.g., I2C, CAN, or ROS) should be used for seamless synchronization. | !specify the protocol! |
| 2.6 | Feedback mechanisms should adjust the arms’ movements based on sensor data. |  |
| 2.7 | A user-friendly interface must allow operators to monitor the production line and make adjustments if necessary. |  |
| 2.8 | The interface should display real-time system status and error notifications. |  |
| 2.9 | Ensure that the power supply meets the requirements of all robotic arms and any auxiliary components. |  |
| 2.10 | Implement a digital twin for virtual testing and optimization of the production line. | RPTU |
| 2.11 | The system must log production data, including cycle time, errors, and maintenance records, for analysis and continuous improvement. |  |
| 2.12 | The system must be modular, allowing easy replacement or upgrade of individual components without disrupting the entire line. |  |
| 2.13 | The design must adhere to relevant safety and automation standards (e.g., ISO 12100 for machine safety). |  |
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| **3.** | **Scenario-based requirements** |  |
| 3.1 | **Normal operation scenario** | **Context**: The assembly line is running under normal conditions. |
|  | The robotic arms must perform all seven folding steps sequentially, with smooth transitions between each segment of the line. |  |
|  | The system should produce one paper plane every X seconds without errors. |  |
|  | The interface must display the current production status and completed units in real time. |  |
| 3.2 | **Paper misalignment scenario** | **Context**: A paper sheet is slightly misaligned during the transition between segments. |
|  | Optical sensors detect the misalignment and signal the system to pause. |  |
|  | The robotic arm in the respective segment should attempt automatic repositioning. |  |
|  | If repositioning fails after two attempts, the system alerts the operator via the interface. |  |
| 3.3 | **Paper jam scenario** | **Context**: A paper jam occurs during one of the folding steps. |
|  | The system should stop the affected robotic arm immediately to prevent damage. |  |
|  | An error message must be displayed, and visual/auditory alerts should be triggered. |  |
|  | Once the issue is resolved manually, the system should allow resumption from the same step. |  |
| 3.4 | **Power outage scenario** | **Context**: A sudden power outage interrupts the production process. |
|  | The system must enter a safe shutdown mode, with the robotic arms retracting to neutral positions. |  |
|  | Upon power restoration, the system should resume from the last completed folding step without restarting the entire process. |  |
| 3.5 | **Emergency stop scenario** | **Context**: An emergency stop button is pressed due to a safety concern. |
|  | The entire system must halt immediately, with robotic arms retracting to a safe position. |  |
|  | The system should log the incident and require manual confirmation before resuming operations. |  |
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* The assembly line is divided into 3 segments
* 3 robot arms are implemented
* There is minimized human contact
* 7 folding steps are automated in the excecuted assembly line
* Within 2 minutes one plane is produced
* The production process is repeatable