# Project plan

## *Mini FLUFFY project*

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**Version**

| Version | Date | Author(s) | Amendments | Status |
|---|---|---|---|---|
| 1.0 | 28/03/2024 | Team | Sprint 1 version | Draft |
| 2.0 | 05/04/2024 | Team | Sprint 2 version | Draft |
| 2.1 | 12/04/2024 | Team | *Requirements transformed into functional and non-functional requirements;<br>*Research questions added.<br>*Communication Updated.<br>*Added a risk | Draft |
| 2.2 | 19/04/2024 | Team | *HMI requirements added.<br>*Research questions answered.<br>*Configuration management updated.<br>*Digital Twin Requirements split up | Draft |
| 3.0 | 03/05/2024 | Team | Sprint 3 version | Draft |
| 3.1 | 17/05/2024 | Team | *Use cases added. | Draft |
| 4.0 | 21/06/2024 | Team | Final Draft | Closed |

## Content

# 1. Project Overview:

The company responsible is the mechatronics department of Fontys University of Applied science. They developed a system called "FLUFFY", which stands for flexible automated future factory. The "FLUFFY" system is a modular industrial automatic conveyor system which is designed to be a self-contained factory where students can practice with.

## 1.1 Goal of the project:

Since the original "FLUFFY" was too big to transport to any other locations, there was a demand for a smaller form version of the "FLUFFY" system. Mechatronic made the smaller system called "Mini FLUFFY". Not only does this solve the transport issue with the system, but it can also be used to showcase the system at different events in case there is a potential buyer. The Mini FLUFFY has already been mechanically and electronically built. The goal of this project is to program the complete system.

## 1.2 The assignment:

Our assignment is to set up the modular software for the Mini FLUFFY that can be used to run the system. The Definition of Done for the "Mini FLUFFY" project is: The pallet needs to go endlessly around the "Mini FLUFFY" system and stop at the designated points (stations) for a chosen amount of time (5 sec).

### 1.2.1 Requirements:

For the "Mini FLUFFY" project we also got a list of functional- and non-functional requirements:

#### 1.2.1.1 Functional requirements:

| ID | Requirements | MoSCoW |
|---|---|---|
| F1 | Stopper is pushed up, stops pallet | Must |
| F2 | Stopper is pushed down, let pallet through | Must |
| F3 | Pusher pushes pallet up | Must |
| F4 | Pusher pushes pallet down | Must |
| F5 | Switch sensor detects pallet | Must |
| F6 | Switch lifts pallet | Must |
| F7 | Switch moves pallet | Must |
| F8 | Switch detects pallet | Must |
| F9 | Switch lowers pallet | Must |
| F10 | The status light is configured | Must |
| F11 | The system tracks the pallet | Should |
| F12 | HMI has system input functionality | Must |
| F13 | HMI displays system status | Must |

#### 1.2.1.2 Non-functional requirements:

| ID | Requirements | MoSCoW |
|---|---|---|
| NF1 | Code should follow general conventions, such as comments and consistent variable names. | Must |
| NF2 | System needs to be modular and reusable | Must |

| | | |
|---|---|---|
| NF3 | System needs to do error handling | Must |
| NF4 | System needs to do logging | Must |
| NF5 | The pallet needs to stop at every station for a predefined amount of time | Must |
| NF6 | An HMI dashboard to show status of the system | Must |
| NF7 | The system needs some type of logic (specify later) | Must |
| NF8 | Working Digital Twin of the system | Could |
| NF9 | An HMI dashboard to control the system | Must |
| NF10 | An HMI dashboard that shows the location of the pallet | Should |
| NF11 | Save data from the machine in a database of some kind | Should |
| NF12 | 3D Mini Fluffy imported into Solidworks. | Could |

## 1.3 Scope

| | **The project includes:** | **The project does not include:** |
|---|---|---|
| 1 | The physical Mini-Fluffy system | Digitial Twin |
| 2 | HMI Dashboard | |
| 3 | Program documentation | |

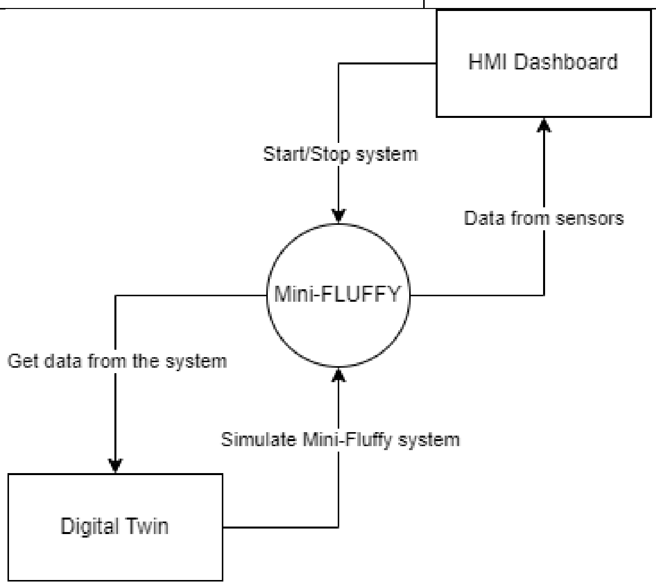



***Figure 1:*** *Context Diagram Mini-FLUFFY*

## 1.4 Conditions:

Upon the Project beginning, we are met with a few conditions that are not negotiable. These are the following:

- Hardware needs to be delivered by the product owner.
- We are not allowed to change any of the electronic systems without discussing it with the product owner.
- License for Siemens PLC we need to receive from Fontys' ICT department.
- 3D design files needed to make a digital twin of the system are provided by the product owner.

## 1.5 Finished products

**Project Documentation:** Regarding the project documentation, it is expected to turn in all the documentation that was made for the project. This will include all the information about the project for example, requirements, risks, approach and planning and project organization. Three subproduct will be delivered, HMI research, Digital Twin research and S-88 research.

**Mini-Fluffy System:** Regarding the project system, it is expected to turn in the full system, tested and functional. The system can run for hours without any problems. Included with this delivery, the documentation and logic behind the program will also be provided to the stakeholder as the subproduct.

**HMI Dashboard:** Regarding the project dashboard, it is expected to turn in the HMI dashboard with the functionality to control the system, show the status of the system and track the pallet location on the system. This includes two subproducts: System control to control the system without being physically near the system. Data visualization to see both the status and the location of the pallet.

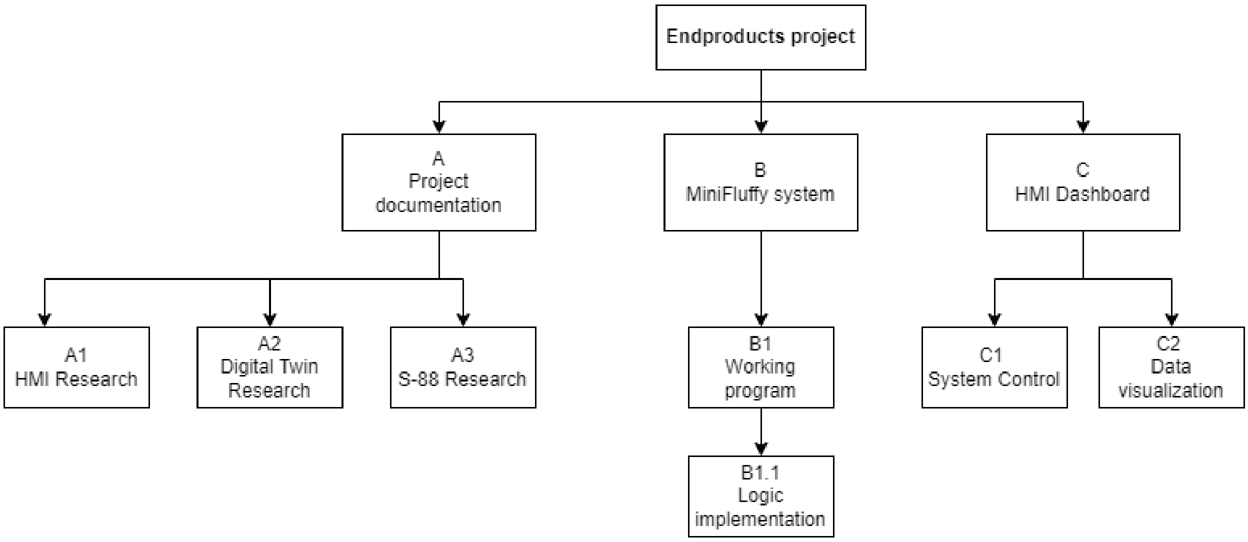



***Figure 2:*** *Finished products diagram*

## 1.6 Research questions:

Some research questions that were thought of from the start are the following (this list is susceptible to change):

**ISA-88**
How to work with Siemens PLC using the ISA-88 standard?
- What is ISA-88?
- What is the use case of ISA-88?

**Digital Twin**

How can we create a digital twin for the system which emulates the hardware?

- What is a digital twin?
- What software is available to make a digital twin?
- How can we emulate hardware in a digital twin?
- How can we program a digital twin?

**HMI**

How can we create an HMI for the Mini-FLUFFY project that uses a Siemens PLC that can monitor and control the system remotely?

- How to create a dashboard for a Siemens PLC?
- How to retrieve the data from the system?
- What do we do with retrieved data?
- How to control the system from the HMI?

**TIA Portal**

- What is the difference between a function and function block?
- What are instances?

# 2. Approach and Planning:

## 2.1 Approach:

For planning during this project, we make use of Trello and planning documents. Additionally, we make use of the scrum method. What is meant by this is that tasks are set up on a board of tasks ready to be used. The team will have standups on every project day to discuss what they have done and what they plan on doing for the day/week/sprint.

## 2.2 Research methods

We plan to implement the Fontys DOT framework for research to be conducted:

- **Library:** To utilize the library aspect, we want to use existing research or work that has already been done using the software and similar projects. This is done for both the PLC software and the HMI software.
- **Lab:** To utilize the lab aspect, we plan on performing multiple experiment son the machine itself to helps us both understand it and improve it. The same can be said for the software of the HMI and the PLC.
- **Showroom:** To utilize the showroom aspect, we plan on showcasing the different working versions of the system to both the Fontys as well as the product stakeholders. This is done in hopes that they can give feedback on what went well, improvements that can be made and what was not as desired as the rest.

## 2.3 Breakdown of the project

**Sprint 1**
Get acquainted with each other and learn more about the project. Set the definition of done and make the corresponding requirement.

**Sprint 2**
Our goal of sprint 2 is: Basic movement. This means that we want to learn the environment of Siemens PLC and make basic parts move like the pushers, stoppers and switchers.
Work on the project plan documentation (improve the requirements and set some risk with this project).
And beginning research on HMI and Siemens PLC programming.
Make progress with getting and learning the Siemens PLC program. Make basic movements and begin implementing simple logic.

**Sprint 3**
Finish research on S-88 programming standard, HMI dashboards, and most documentation. Finish implementing the basic logic of moving the system.
Begin thinking about the advanced logic for the system.
Finish implementing a basic HMI dashboard to handle simple button controls.

**Sprint 4**
Look into the digital twin and define tests.
Finish implementing advanced version of HMI dashboard.
Finish implementing the advanced logic for the system.
Update documentation according to progress.

**Sprint 5**
Ensure the system is modular.
Make sure the system passes all predefined tests.

# 3. Project Organization

## 3.1 Team members

| **Name + Contact details** | **Abbr.** | **Role/tasks** | **Availability** |
|---|---|---|---|
| *Johnson Domacasse* | | *Contact person for group* | *Mon-Fri from 9:00 – 16:00* |
| *Milan Kapitein* | | | *Mon-Fri from 9:00 – 16:00* |
| *Kevin Geurts* | | | *Mon-Fri from 9:00 – 16:00* |
| *Thijs Geus* | | | *Mon-Fri from 9:00 – 16:00* |
| *Mats Daamen* | | | *Mon-Fri from 9:00 – 16:00* |
| *Omar Idoum* | | *Product owner* | *On request* |
| *Ben Schreur* | | *Fontys Stakeholder* | *Fridays from 9:00 – 9:30, on request* |

## 3.2 Communication

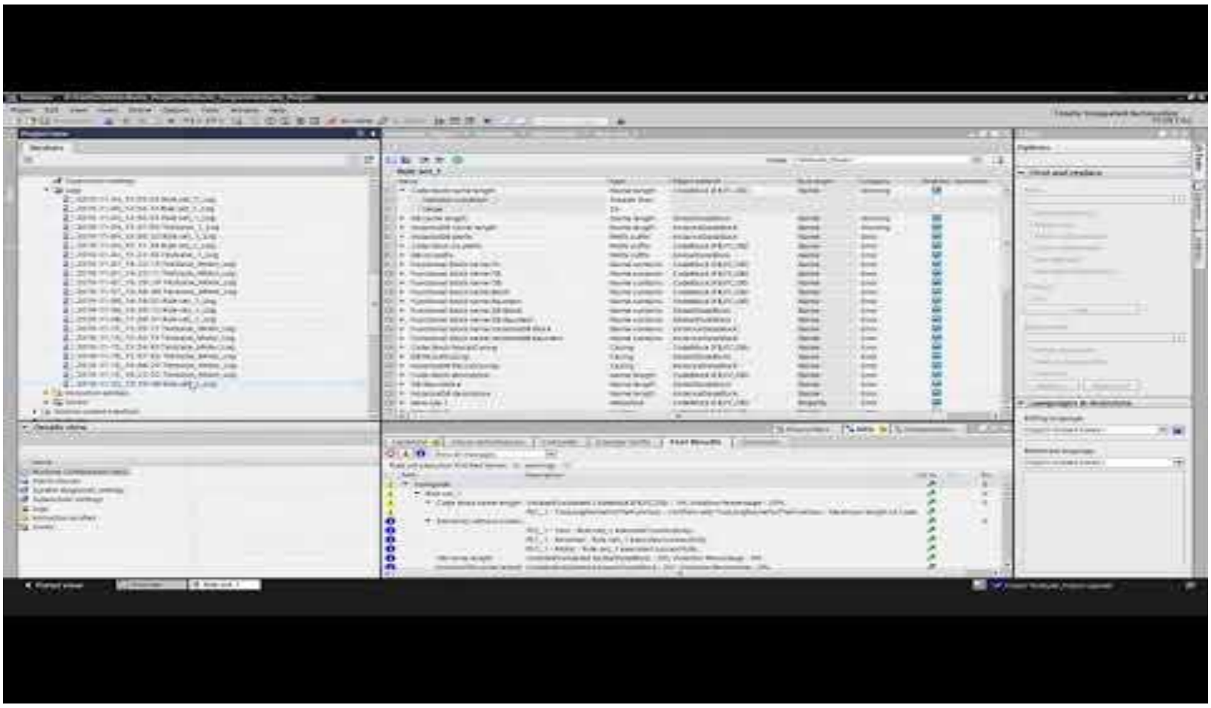
For communication with both our stakeholders, we use Teams and email. The team has a standup meeting on each day the project takes place. The Fontys stakeholder is present on the standups on Friday. Every sprint meeting we will have a meeting with the Product owner, this takes place on Friday every three weeks.

Every Thursday afternoon and Friday morning to afternoon, we will work on the project. The Thursday will be mostly spent in R10 but when needed we will go to mechatronics. For the Friday's we will be from 9:00 till 16:00 at mechatronics to physically work on the Mini-FLUFFY. Every Friday we also have a standup at 9:00 at mechatronics where our Fontys stakeholder is present.

For our team agreement you can read the details described in the “Collaboration Document”. This document can be found in the TEAMS folder with the following path: “Documentation\sprint1\”.

## 3.3 Testing approach and Test environment

The products we are going to test are the Mini-FLUFFY system and HMI dashboard. The products we are going to test by physically testing it using the use cases we set up in chapter 5, documenting each test case with the result. The results will be checked to see if they line up with what is expected. Additionally, we are going to investigate the test suite from TIA portal trying to use this to make some test cases. See the example video below:
https://www.youtube.com/watch?v=3H0Cnyvpcg0



## 3.4 **Configuration management**

The use of a version control environment was implemented to keep track of the state of the project without any difficulty. The way this project is structured is, it is kept into a private GIT repository with the working version of the program. In the end, on a project date, the project will be saved, reviewed and committed to the repository. The next day of the project, the program will be pulled from the GIT on the machine of the programmer for that day. We will work directly from the repository rather than the user's local machine. Additionally, the project will also be saved on a physical drive separately.

# 4. Finance and Risks

Below are the risks this project contains, and what are plans are to prevent these situations.

## 4.1 Risks and fall-back activities

| Risk | Prevention activities included in plan | Fall-back Activities |
|---|---|---|
| 1 Trouble obtaining license Siemens software | Ask around for someone that can give licenses | Ask school to purchase these licenses |
| 2 Hardware breaking | Being careful with the machine | Contacting Omar and/or other mechatronics persons |
| 3 Person with Code not available | Have a USB drive with a backup of the code, that is always located at the system. As well as version control for the project. | Contact the person with the code to get it in another way (OneDrive, WeTransfer); Upload the code on the storage device to a new computer. |
| 4 Shortage of time | Have good planning on which days we will work on the project and which days are free. Also update Trello to know what needs to be done | Plan extra days to work on the project |

# 5. Use cases

Use cases were defined down below which will be used for user testing. The following use cases were defined:

| | |
|---|---|
| **Use Case ID:** UC_01 | **Use Case:** Start system |
| **Description:** | When the operator wants to start the system, he presses the “start/reset” button |
| **Actor:** | Operator |
| **Precondition:** | System needs to be powered<br>“System safe” needs to be OK |
| **Postcondition:** | System is running safely<br>Green LED on |
| **Trigger:** | “start/reset” button is being pressed |
| **Standard Process:** | 1) Connect system to power<br>2) Press “start/reset” button<br>3) Green LED on<br>4) System running safely |

| | |
|---|---|
| **Use Case ID:** UC_02 | **Use Case:** Start system with error |
| **Description:** | The operator starts the system, but system is not safe so goes into the “error” state |
| **Actor:** | Operator |
| **Precondition:** | System needs to be powered |
| **Postcondition:** | System doesn’t start and is in the “error” state |
| **Trigger:** | “start/reset” button is being pressed |
| **Standard Process:** | 1) Connect system to power<br>2) Press “start/reset” button<br>3) System doesn’t start and goes into “error” state<br>4) Red LED on |

| | |
|---|---|
| **Use Case ID:** UC_03 | **Use Case:** Pallet enters station and lifted up |
| **Description:** | A pallet on the conveyor arrives to a station where the pallet is being detained and lifted for predefined amount of time, where after that the pallet is being dropped and let through when next station is free |
| **Actor:** | - |
| **Precondition:** | Pallet has been loaded onto the conveyor |
| **Postcondition:** | Pallet goes to the next station |
| **Trigger:** | Magnetic sensor detects the pallet |
| **Standard Process:** | 1) Magnetic sensor detects the pallet<br>2) Pallet is being lifted up<br>3) Waits for predefined amount of time<br>4) Pallet is being dropped down<br>5) Check of next station is free<br>6) Stopper goes down and let the pallet through |

| | |
|---|---|
| **Use Case ID:** UC_04 | **Use Case:** Pallet enters transfer unit and transferred to another conveyor |
| **Description:** | A pallet on the conveyor arrives to a transfer unit where the pallet is being lifted, transferred across to the conveyor on the other side and lifted down. Then let through when next station is free |
| **Actor:** | - |

| | |
|---|---|
| **Precondition:** | Pallet has been loaded onto the conveyor |
| **Postcondition:** | Pallet has been moved across to the other conveyor |
| **Trigger:** | Magnetic sensor detects the pallet |
| **Standard Process:** | 1) Magnetic sensor detects the pallet<br>2) Transfer unit goes up<br>3) Conveyor moves the pallet to the other side<br>4) Magnetic sensor detects the pallet<br>5) Transfer unit goes down<br>6) Check of next station is free<br>7) Stopper goes down and let the pallet through |

| **Use Case ID:** UC_05 | **Use Case:** Pallet enters station end is not being lifted |
|---|---|
| **Description:** | A pallet on the conveyor arrives to a station where the pallet is being detained and hold until the next station is free. The pallet is not being lifted up. |
| **Actor:** | - |
| **Precondition:** | Pallet has been loaded onto the conveyor |
| **Postcondition:** | Pallet goes to next station |
| **Trigger:** | Magnetic sensor detects the pallet |
| **Standard Process:** | 1) Magnetic sensor detects the pallet<br>2) Check of next station is free<br>3) Stopper goes down and lets the pallet through |

| **Use Case ID:** UC_06 | **Use Case:** Pallet enters transfer unit and transferred to another conveyor. Pallet stops at buffer station |
|---|---|
| **Description:** | A pallet on the conveyor arrives to a transfer unit where the pallet is being lifted, transferred across where the pallet waits for a predefined amount of time, then moves to the end and lifted down, then let through when next station is free |
| **Actor:** | - |
| **Precondition:** | Pallet has been loaded onto the conveyor |
| **Postcondition:** | Pallet has been moved across to the other conveyor |
| **Trigger:** | Magnetic sensor detects the pallet |
| **Standard Process:** | 1) Magnetic sensor detects the pallet<br>2) Tranfer unit goes up<br>3) Conveyor on<br>4) Inductive sensor at buffer station detects the pallet<br>5) Conveyor stops at buffer station and waits for predefined of time<br>6) Conveyor on and moves pallet to the other side<br>7) Magnetic sensor detects the pallet<br>8) Transfer unit goes down<br>9) Check of next station is free<br>10) Stopper goes down and lets the pallet through |

| **Use Case ID:** UC_07 | **Use Case:** Emergency button pressed |
|---|---|
| **Description:** | The emergency button is pressed by the operator. The system goes into the “error” state |
| **Actor:** | Operator |
| **Precondition:** | System needs to be powered |
| **Postcondition:** | System is in the “error” state |

| | |
|---|---|
| | Operations have been stopped |
| **Trigger:** | Emergency button has been pressed |
| **Standard Process:** | 1) Emergency button is being pressed<br>2) System stops it operation<br>3) System goes into the “error” state |

| **Use Case ID: UC_08** | **Use Case:** Magnetic sensors show detected pallet in HMI |
|---|---|
| **Description:** | In The HMI dashboard the status of the magnetic sensors is shown. If the magnetic sensor detects the pallet this is shown in the HMI dashboard |
| **Actor:** | - |
| **Precondition:** | System needs to be running |
| **Postcondition:** | Magnetic sensor shows detected pallet in HMI |
| **Trigger:** | Magnetic sensor detects pallet |
| **Standard Process:** | Magnetic sensor detects pallet<br>HMI dashboards show that pallet is detected at magnetic sensor |

| **Use Case ID: UC_09** | **Use Case:** HMI dashboard shows when transfer is busy |
|---|---|
| **Description:** | In the HMI dashboard the status of the transfer unit is shown. If the transfer unit is busy, it is clearly shown in the HMI dashboard |
| **Actor:** | - |
| **Precondition:** | System needs to be running |
| **Postcondition:** | Transfer unit status is being shown in HMI dashboard |
| **Trigger:** | Pallet is being detected at the transfer station magnetic sensor |
| **Standard Process:** | Magnetic sensor detects the pallet<br>Transfer unit lift pallet<br>Status is being shown in the HMI dashboard |

| **Use Case ID:** UC_010 | **Use Case:** Start the system from the HMI dashboard |
|---|---|
| **Description:** | In the HMI dashboard the operator can start the system by pressing the start button |
| **Actor:** | Operator |
| **Precondition:** | HMI dashboard running |
| **Postcondition:** | System is running<br>Green LED on |
| **Trigger:** | Start button in HMI pressed |
| **Standard Process:** | 1) Start button on HMI dashboard is being pressed by the operator<br>2) System starts and Green LED is turned on |

| **Use Case ID:** UC_08 | **Use Case:** Timer variable change |
| --- | --- |
| **Description:** | In the HMI dashboard the operator can change the time variable for deciding for how long the pallet needs to wait at the stations |
| **Actor:** | Operator |
| **Precondition:** | HMI dashboard running |
| **Postcondition:** | Timer variable changed |
| **Trigger:** | Operator changes timer variable |
| **Standard Process:** | 1) The operator uses a button- or drop-down menu to change the timer variable<br>2) Timer variable changed |

| **Use Case ID:** UC_09 | **Use Case:** Pallet removed from system |
| --- | --- |
| **Description:** | A pallet has been removed from the system. This is registered to the counter and states are reset |
| **Actor:** | - |
| **Precondition:** | System needs to be running |
| **Postcondition:** | Orange light is turned on. Error shown in HMI |
| **Trigger:** | Pallet removed |
| **Standard Process:** | 1) Pallet is removed<br>2) Error is shown in HMI |