

Jadcup Digital Twin: Factory Automation

STATUS REPORT V1

MYLES HOSKEN

TEAM MEMBERS AND ROLES:

YERAN EDMONDS: DEVELOPER

HARSHIL PATEL: DEVELOPER

JANE JUNG: DEVELOPER

JOSHUA LADOWSKY: SERVICE REQUEST MANAGER/DEVELOPER

MYLES HOSKEN: SERVICE DELIVERY MANAGER/DEVELOPER

CLIENT: DANIEL LI

MENTOR: MATTHEW KUO

Executive Summary

The Jadcup Digital Twin project aims to develop a prototype for a remote monitoring system to interact with programmable logical controllers (PLCs) on a factory floor. The project includes a digital twin of Jadcup's factory simulated in Factory IO. The project utilizes the FERN application stack. The project is organized adhering to Kanban methodology, focussing on milestones, iterations, and feedback.

The team has met milestones such as hosting the server, website, designing the user interface and developing a Factory IO prototype. Noteworthy issues include a lack of linear workflow, scheduling difficulties, communication with the client and licensing issues with Factory IO. To manage these risks and issues the team has implemented updated strategies such as stakeholder demonstrations, continuous communication with the mentor, and an entire rework of the change management strategy.

The project is currently on track, with the team progressing through the third iteration focusing on the status report. Iteration 4 will involve preparing a stakeholder demo, ensuring the API connects and communicates to the real-time database, aiming to complete by 17th of June. To improve the team's performance going forward, the team has identified key areas for improvement including the need for well-defined team-based iteration reviews and a comprehensive testing phase for features. Acceptance tests are to be included in user stories to better define when features meet the definition of done.

Each team member has contributed to the project and gained experience in new skill areas such as Factory IO, Node.js, Firebase, React, JavaScript and Kanban Methodology.

Project Description

The Digital Twin project aims to transition the existing Jadcup production process from Industry 3.0 to Industry 4.0. With the recognition of an opportunity to upgrade the manufacturing process our team has engaged and committed to bring a technological upgrade to their system. The main objective of this project is to produce a remote monitoring system that offers real-time monitoring and analytics, reducing the need for manual intervention and increasing efficiency.

The project and successful transition to Industry 4.0 relies on the integration of key technologies: The internet of things (IoT), Cloud Computing and a Digital Twin. IoT will establish connections between machines in their respective communication protocols. Cloud computing will facilitate the storage and processing of data which will drive the remote monitoring system and control machine parameters. The digital twin will replicate the Jadcup factory floor and allow for simulations to test and apply potential improvements without engaging with the physical production. It is important to note that the project does not intend to replace the existing machinery and production process, instead it will focus on enhancing the current systems through the remote monitoring system and the digital twin.

See Appendix 1.1 for component diagram.

Project Overview

Scope

The Jadcup monitoring application is a limited, functional prototype to read and control PLC data through a user-friendly application. The monitoring application is a FERN stack application, and the project will include a factory IO prototype to represent a digital twin of Jadcup's factory floor.

The project involves the development of a remote monitoring system in conjunction with a digital twin of Jadcup's factory floor. The system is designed to provide easy-to-use access to the machines data, offering both reading and control capabilities. The project is built on a FERN technology stack. (Firebase, Express, React, Node.js) for performance and versatility.

Requirements

Functional Requirements:

- The application must allow users to connect & control PLCs.
- The application must show data managed by PLCs.
- The application must be modular enough to support multiple, different PLCs.
- The application must provide secure user authentication and authorization.

Non-Functional Requirements:

- The application must be responsive and have a fast load time.
- The application must be functional and user-friendly when run on a PC.

Meeting evidence

All dates are based on the end of week 11.

- Scheduled Team meetings: 12
 - 11 Saturday Meetings
 - 1 team kick-off meeting
- Scheduled Mentor Meetings: 13
- Team Meetings Had: 16
- Mentor Meetings Had: 12

Starting in week 3 we began scheduling meetings online every Saturday. This was to remedy our lack of availability over the week. We went over our expected scheduled meetings due to extra meetings that were held in preparation for the proposal assignment.

We had less Mentors than where scheduled because the 25th of April was ANZAC day, due to this, Matthew was unavailable to meet during our regular time. Due to our conflicting schedules there was not another time we could meet.

See Appendix 1.2 Meeting Documentation

Approach

This project is using Kanban to organize workflow and tasks. Our approach places key emphasis on milestones, iterations, and feedback from our client as well as our mentor acting as a pseudo-client specialized in technical requirements. Our team also has team leads to delegate responsibility but focuses on mob programming to make sure team knowledge is shared during bi-weekly stand-ups.

Major milestones

Our biggest milestone is our server hosted live and our website available to view. Further details about our milestones reached will be discussed as part of our project status section.

Milestone:

- Project Proposal Deadline - 31/03/2023 – Completed ✓
- Proposal Presentation - 07/04/2023 – Completed ✓
- Upskilling completed - 23/04/2023 – Completed ✓
- Server Host Online - 06/05/2023 – Completed ✓
- Website hosted – 06/05/2023 – Completed ✓
- UI Design mock-up is designed and approved - 20/05/2023 – Completed ✓
- Factory IO prototype working – 20/05/2023 – Completed ✓
- Mid-term Review - 02/06/2023 - Active/Currently working on
- Web API connects to database – 17/06/2023 – Incomplete
- UI Design implemented onto web host 01/07/2023 – Incomplete

Addressing Proposal Feedback

Development & Monitoring

Section 6, Page 13

We received feedback that our Kanban board example on the project proposal was not clear. We've added a screenshot that shows our actual Kanban board to show how our workflows will work.

Milestone Report

Appendix 8.1 Page 37

Our mediator informed us that while Kanban was good for discovering requirements as we go, this was still a university project that needed key deliverables and evidence of progress. We did not have milestones. As part of our proposal adjustments, we made a milestone report that included key deliverables reaching up to the end of the project.

Our iterations are now based around these milestones so that we know clearly what we need to work on for each iteration. These milestones also form the backbone of our project schedule and give us a clear path of work going forward. Additionally, we have included stakeholder demos as part of our milestones.

Project Schedule

Section 8, Pages 16. Appendix 8.1, 39-41

Our mediator informed us that our project schedule was not particularly clear nor had specific iterations or work for those iterations. As mentioned above, our milestones now form the key backbone for our schedule and includes deliverables required for our project. We also specify stakeholder demos as well as key deliverables as required by the university for this project.

Quality Standards

Appendix 9.3, Page 56

It was noted that our Quality Assurance plan lacked definitions of Quality such as the Definition of Ready and Definition of Done. As this was the case, both have been added to our Quality Assurance Plan to ensure that when work is being done, that work is to a standard that does not create further issues. The Definition of ready outlines what requirements are in place for one of our cards to be started, while the Definition of Done outlines what a finished piece of work is, in the various stages of work (Development, Testing, Review)

Team Contract

Appendix 7.1 Pages 35-56

We were told our team contract did not include our exact meeting times mentioned outside of the R&D time. This was added to the contract in the project proposal.

Issue Log

Appendix 9.2, Pages 49-51

We had a new issue discovered concerning incorrect Factory IO licenses. We logged and resolved this with Matthew's help with AUT providing a license.

Risk Management

Appendix 9.1, Pages 45-49

A key risk we didn't include in our proposal was a lack of communication with our client. This is due to the client's busy hours and them being un beholden to this project. The issue that would result from this risk is that our project does not meet our client's expectations due to unclear requirements. To mitigate this, we are sending them stakeholder demos so they can see what we have in their own time. Additionally, we are using our mentor Matthew Kuo as a pseudo-client to provide feedback where necessary. We recognize this doesn't completely mitigate the risk of reduced client communication, but with our mentor's guidance and our listed milestones, we hope to provide as much value as we can.

Change Management

Section 9, pages 17-18

Our change management plan was highlighted as a risk due the nature of form-based approvals failing to take advantage of the dynamic change management in an agile lifecycle. Due to this we have since reviewed and overhauled the change management strategy directly into the workflow and project lifecycle.

Variations from Proposal

Factory IO Limitations:

As part of our deliverable for this project, we intended to provide a digital twin that maps to Jadcup's factory floor, to best show how our remote monitoring system will work with their business. Unfortunately, Factory IO does not provide key information that needs to be represented on Jadcup's factory. For example, there are no machines that represent Jadcup's cup-making machines, nor are there tools to represent key values used by their factory, such as machine temperature.

Because of this, we must try and represent their factory as close as possible in our Factory IO simulation and fill any holes in represented functionality through custom scripts.

Change management reworked:

Part of our original proposal we had included a change management form. After the review it was noted that as we are using Kanban, a change management form would be very inefficient to use and contradicted the chosen methodology. It was highlighted if we chose to keep the change form, we would only be impeding a continuous flow, inhibiting flexibility, and decreasing team autonomy by switching context each time a form needed to be filled out. We have since reworked our change management strategy directly into the workflow of the project. Changes can now be evaluated depending on their impact to the workflow and can be managed dynamically during iteration planning. Section 9: Change Management in the updated Project Proposal.

Project Status

Work done for project so far/ work unfinished:

The table below represents the accomplishments (milestones) we've encountered so far, and their status in relation to our project schedule.

Accomplished achievements	Delays / Issues
<ul style="list-style-type: none">• Server hosted• Website hosted• Factory IO prototype• UI Design.	<ul style="list-style-type: none">• UI design- Approval for the UI design was delayed due to external workload factors amongst the team. Approved as of 23/05/2023

See Appendix 1.2 through 1.5 for achievement images.

Issues/Risks experienced so far:

Poor communication with the client

One issue and risk identified is the lack of communication from the client. This is due to the client's busy hours and them being unbehind to this project. We have requested a range of material that would prove useful throughout the duration of the project such as, model numbers of the programmable logic controllers (PLCs), expansion module confirmation, source code for the PLCs and the software program Jadcup originally used to configure their machinery. Although some of the requested information may not be accessible or feasible, we remain with no response.

Mitigation:

To mitigate the lack of communication from the client, we are committing to keeping them updated according to our stakeholder demos. Furthermore, we are utilizing not only Matthew, but Weihua Li who has contact with Daniel as a pseudo-client which can confirm and provide feedback on the project as it progresses.

Scheduling issues / insufficient meetings

From the onset and throughout the project, the team's timetable and external commitments have proved to clash preventing the team from meeting outside the allocated R&D slot on Tuesdays. To accommodate everyone's time constraints and obligations, we agreed and updated the team contract to introduce an additional team meeting on Saturday mornings from 9:30am – 12pm. These Saturday meetings were intended to serve as a form of catch-up from the week that was, and a platform to collaborate as a team. However, the reality of personal obligations continued to intervene in the form of the meeting being cut short, or members not attending. This would affect the workflow; however, the team still tried within their own personal working hours to complete their delegated tasks.

Mitigation: Moving forward it is critical for us to adapt to this issue more effectively. The team has comprised a further action plan for this. In the case that external factors continue to disrupt the Saturday meeting time slot, the team has agreed to meet for another additional meeting during the week. As the team is currently waiting on semester 2 timetables, this additional meeting will take place during the week for 2 hours on Fridays 12pm-2pm. Additionally, the teams' roles and responsibilities need to be better defined and adhered to. By committing to better defined roles, we can optimize the time spent during our meetings by focusing on the tasks that truly require collaboration, while individual tasks can be managed outside of these sessions with the utilization of digital platforms.

Factory IO Licensing Issues

Throughout the project it became apparent the original license for Factory IO that was provided did not have the supported libraries we needed to establish a connection between Factory IO and our middleware application. To work around this, we tried to create new trial accounts to maintain access to the supported libraries. However, this did not prove to be a successful mitigation strategy as Factory IO maintained a persistent record of an installation and previous account, preventing any type of work around.

Mitigation: Once this issue was identified, we spoke to Matthew who applied for the 'Ultimate Edition' license. This license would provide us with the libraries and functionality we needed, subsidized by AUT. The team is now using the new license with no issues.

Work Summary:

Member: Yeran	Hours done: 112
Work contribution: <ul style="list-style-type: none">• Project proposal• Status report• Factory IO/PLC middleware	Skills gained: <ul style="list-style-type: none">• Factory IO• Node js• Modbus• NoSQL databases• Task prioritization• Team communication• Scope & Requirements analysis
Member: Myles	Hours done: 120
Work contribution: <ul style="list-style-type: none">• Project proposal• Status report• Server Hosted• Website Hosted	Skills gained: <ul style="list-style-type: none">• Firebase• React• Node.js• Communication skills• Planning skills• Teamwork
Member: Josh	Hours done: 125.25
Work contribution: <ul style="list-style-type: none">• UI Draft• Status Report• Project proposal• Factory IO Blackbox	Skills gained: <ul style="list-style-type: none">• InDesign• SQL• Node.js• JS• React• QA methodology

	<ul style="list-style-type: none"> • Factory IO • Communication
Member: Harshil	Hours done: 119
Work contribution: <ul style="list-style-type: none"> • Project proposal • Status report • UI Draft 	Skills gained: <ul style="list-style-type: none"> • React • Node.js • JavaScript • React • Communication skill • Teamwork
Member: Jane	Hours done: 119
Work contribution: <ul style="list-style-type: none"> • Project proposal • Status report • UI Draft 	Skills gained: <ul style="list-style-type: none"> • UX/UI design • SQL • Agile Methodology • React • Node.js • JavaScript • Communication • Cooperation

See Appendix 1.6 for updated skills matrix and weekly work breakdown.

Overall status: On track

Work planned for the future

We are currently on iteration 3 which is focused on this status report. Our project schedule on our proposal best represents our future work, however in Iteration 4 we are due to work on a stakeholder demo and web API. We intend to have these completed by the 17th of June.

Project Recommendations

We've noticed over the weeks that our work done during the iterations aren't as steady as we would have liked, instead we have spikes of concentrated work during certain periods. We've recognized that we were struggling to implement the idea of continuous workflow of Kanban, and are currently trying to improve our work strategies, such as putting more importance in our iteration reviews.

Our team-based iteration reviews were brief and unstructured. We had iteration reviews and documented them in our portfolio but our process for how to review our iteration workflow and processes were sparse. Additionally, while we had clear milestones that kept us on track, we didn't have iteration planning. This combined with our unguided iteration reviews made process review hard to perform. Fortunately, our work performed was on track for each milestone despite this. Our plan is to have clear driving on meetings at or near our iteration ends where everyone can review our milestones and showcase them as needed.

See Appendix 1.7 for current iteration reviews.

The testing phase for our features performed, but unfocused. We had an idea of what needed to be tested but weren't clear on our testing processes. Because of this, we only tested surface-level requirements for our features. This is in part because we had neglected to include acceptance tests on our user stories to define when features will be done. We intend to define clear acceptance criteria and definition of done more thoroughly in the future, during the planning phase of our future iterations.

As individual members we also have outside commitments that take up our time and cause timetable clashes. This means we don't meet up outside of our RnD times or our Saturday morning meetings. This is one of our greatest risks and has directly affected our workflow. Our current mitigation strategy of two team meetings a week keeps us on track but does not plan additional work to be done outside of the meetings. Because of this, we keep on-track with shared team knowledge about our features but fail to perform additional work outside of the planned meeting times.

Appendix

1.1 Component Diagram

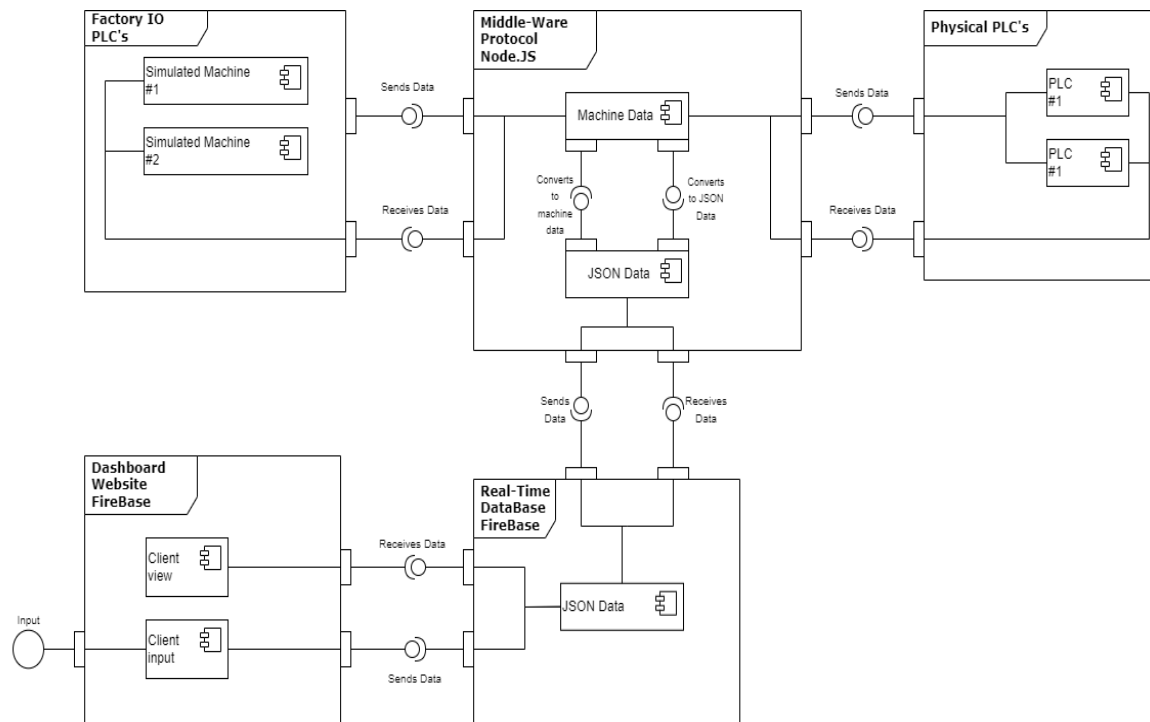


Figure 1 Component Diagram

1.2 Meeting Documentation

Meeting date/time	Meeting type (client/team/mentor)	Meeting topics
06/03/2023 6pm-8pm	Kick-off Meeting (Team)	<ul style="list-style-type: none"> Deciding meeting times
07/03/2023 11am-12pm	Kick-off Meeting (Mentor)	<ul style="list-style-type: none"> Technical requirements Client meeting preparation
14/03/2023 10am-11am	Mentor meeting	<ul style="list-style-type: none"> Project proposal outline Starting proposal plans
14/03/2023 9-12:30pm	Team Meeting	<ul style="list-style-type: none"> Trello Proposal
16/03/2023 1pm-2pm	Client Meeting	<ul style="list-style-type: none"> Factory Tour/ Client introductions Client requirements
18/03/2023 9am-11am	Team Meeting	<ul style="list-style-type: none"> Establishing team roles Designating plans

21/03/2023 9:30am-10am	Mentor Meeting	<ul style="list-style-type: none"> • Proposal checkup
24/03/2023 9am-12pm	Team Meeting	<ul style="list-style-type: none"> • Delegating proposal sections
25/03/2023 9am-12pm	Team Meeting	<ul style="list-style-type: none"> • Proposal checkup and update
28/03/2023 10am-11am	Mentor Meeting	<ul style="list-style-type: none"> • Proposal review
30/03/2023 3:30pm-5pm	Team Meeting	<ul style="list-style-type: none"> • Proposal submission
01/04/2023 9am-11am	Team Meeting	<ul style="list-style-type: none"> • Making the proposal presentation
04/04/2023 10am-11pm	Mentor Meeting	<ul style="list-style-type: none"> • Reviewing the proposal presentation • Q&A for proposal presentation
08/04/2023 9:30am-12pm	Team Meeting	<ul style="list-style-type: none"> • Proposal Feedback Review & Upskilling standup
11/04/2023 2pm-4pm	Team Meeting	<ul style="list-style-type: none"> • Upskilling standup
14/04/2023 3:30pm-4pm	Mentor Meeting	<ul style="list-style-type: none"> • Showcasing our upskilling for week 1
21/04/2023 3:30pm-4pm	Mentor Meeting	<ul style="list-style-type: none"> • Showcasing our upskilling for week 2
22/04/2023 9:30am-11:30am	Team Meeting	<ul style="list-style-type: none"> • Upskilling standup
29/04/2023 9:30am-12:30pm	Team Meeting	<ul style="list-style-type: none"> • Finish proposal based on Tony's recommendations. • Factory IO • Server/database
02/05/2023 10:30am-11am	Mentor Meeting	<ul style="list-style-type: none"> • Factory IO • Server/database • Reviewing the proposal with Tony recommendations with mentor.
06/05/2023 9:30am-11am	Team Meeting	<ul style="list-style-type: none"> • Database • Status Report
09/05/2023 9:30am-10am	Team Meeting prep	<ul style="list-style-type: none"> • Mentor meeting agenda
09/05/2023 10am-11am	Mentor Meeting	<ul style="list-style-type: none"> • Yeran little issue • Firebase (without the factory io) • Addressing the Saturday meeting

		<ul style="list-style-type: none"> UI draft design
13/05/2023 9:30am-12pm	Team Meeting	<ul style="list-style-type: none"> Logbook comparison
16/05/2023 10am-11am	Mentor Meeting	<ul style="list-style-type: none"> Firestore with the factory io Showing the factory io working with firebase Q&A with mentor on Status report
20/05/2023 9:30am-12pm	Team Meeting	<ul style="list-style-type: none"> Mid-term review preparation (status report)
23/05/2023 9:30am-12:30pm	Team Meeting	<ul style="list-style-type: none"> Reviewing and updating Trello Working on Status Report Mentor meeting agenda
23/05/2023 2:00pm-2:30pm	Mentor Meeting	<ul style="list-style-type: none"> Q&A about status report, proposal, and Trello Mid-semester review booking

1.2 UI Design

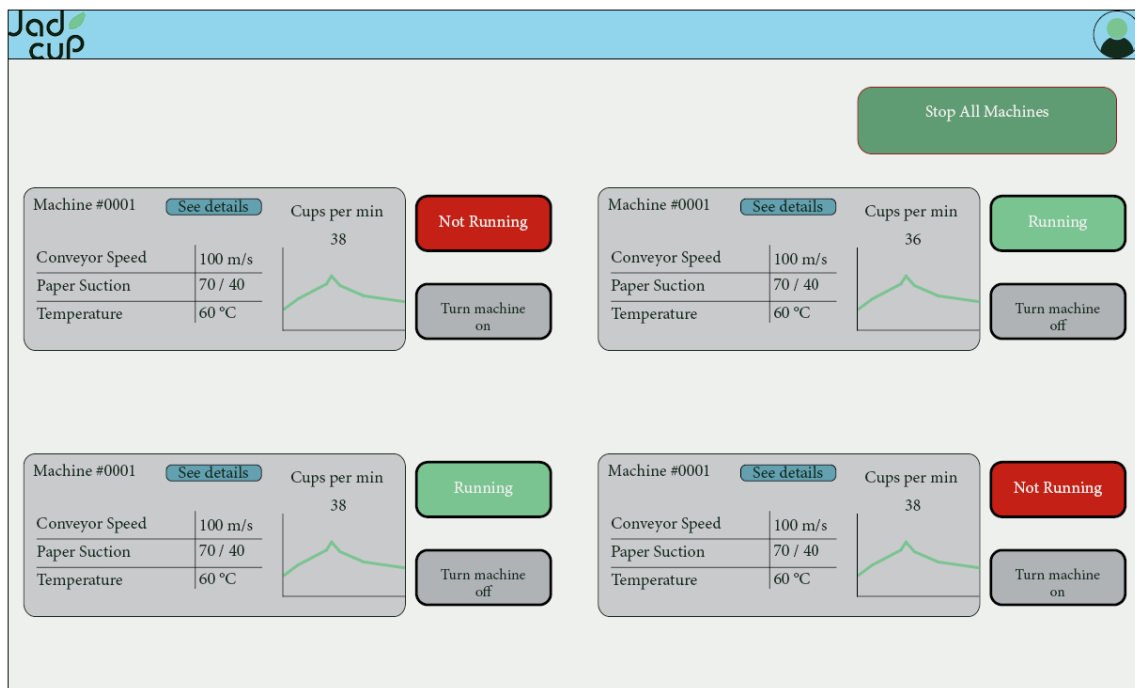
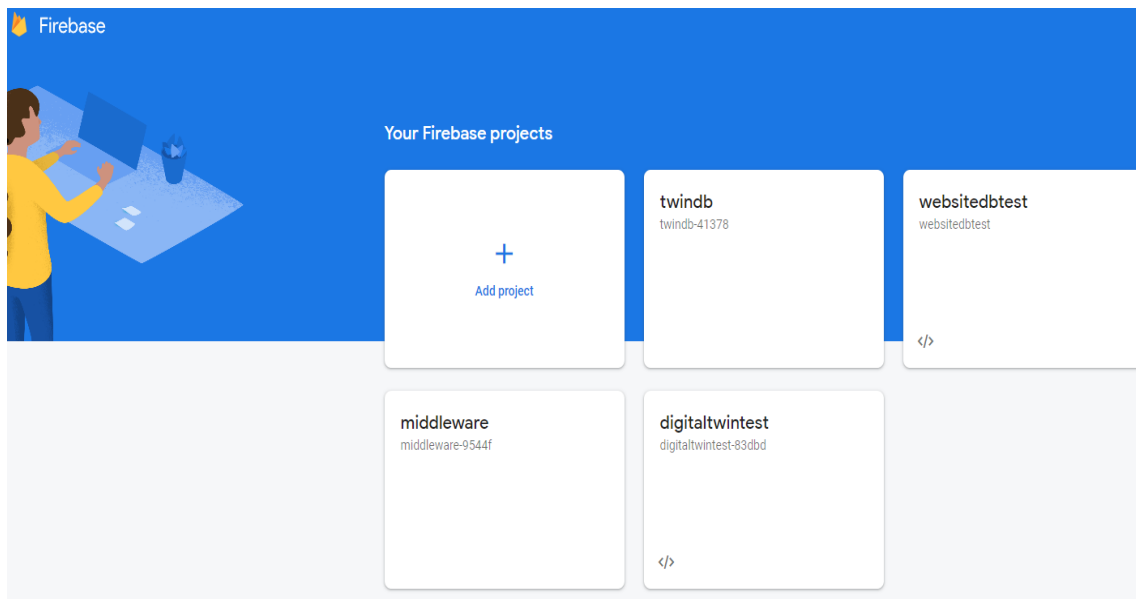


Figure 2 Approved Design for main menu



Figure 3 Approved design for running menu

1.3 Server Hosted



1.4 Website Hosted



Machine Data



elevatorAdvanced

Conveyor0 : 1

Conveyor1 : 1

Conveyor2 : 1

Conveyor3 : 0

1.5 Factory IO Prototype





1.6 Updated Skills Matrix and weekly work breakdown

Skill	Harshil ISTP-A					Jane-ESTP-A					Josh - INTP-T					Myles - ISFJ-T					Yeran - ISFJ-A					Total
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	
Online Servers		2						3					3				2						3			13
Server Administration	1						2					2					2						3			10
PLC		2				1						2				1					1					7
Factory I/O		2				1							4					3					3			13
NoSQL			3				2					2					2						4			13
SQL				4						5			3				2						3			17
Firebase		2							4			2							4				3			15
C#				4						5					5			3					3			20
Git			3						4				4						4				3			18
HTML/CSS				4						5			3						4				3			19
IDEs				4					4				3						4					4		19
Java			3							5		2							4				3			17
NodeRed/SCADA	1						2				1					1					1					6
Visual Studio					5					5				4					4				3			21
Vs Code				4						5					5				4				3			21
Adobe Illustrator		2						3					3			1					1					10
UI Design			3							5			3				2					2				15
UX Design			3							5			3				2				1					14
Agile Methodology Knowledge			3							5			3					3					3			17
Client Management		2						3				2							4				3			14
Github					5					5			3						4					4		21
Teams					5					5			3					3				2				18
Trello					5					5				4					4				3			21
QA Tools	1							3						4			2						3			13
JavaScript			3						4				3						4						5	19
Node.js			3						4				3						4					4		18
PHP		2							4				3						4		1					14
React			3					3				2							4				3			15
Web APIs		2							4			2				1								4		13

Week	Harshil	Jane	Josh	Myles	Yeran	Total
1	8	4	2	6	8	28
2	8.5	8.5	8.66	7	11	43.66
3	12.5	13.5	12.5	13.5	12.5	64.5
4	11.5	19.5	15.75	17.5	11.5	75.75
5	9	15	14.5	5.5	8	52
6	7.5	4	6.5	9	8	35
7	13	13.5	12.5	16.5	8	63.5
8	7	5.5	11	9.5	9	42
9	8.5	9	5	5	5	32.5
10	8	8.5	5	5.5	9.5	36.5
11	6.5	5	6.5	6	4	28
12	8	14	14	5.5	5.5	47
13	11	8.5	16	13.5	12	61
Total	119	128.5	129.91	120	112	585.41

1.7 Iteration reviews

Iteration one review

Planning: 24/04/2023 – 29/04/2023

Development: 29/04/2023 – 04/05/2023

Review: 05/05/2023 – 06/05/2023

Executive summary:

What went well:

Throughout the iteration the team felt very supported by the mentor, with the mentor consistently planning meetings on a weekly basis. The team effectively prioritized their technical tasks and completed them on time. The team communicated issues effectively and acted on feedback given from the mentor. The team successfully completed the milestones within the iteration.

Issues and challenges:

Throughout the iteration the team did not utilize the Kanban board and cards well enough. Improper card management included a lack of detailed descriptions for each card. Client requirements are still unclear in some respects, due to a lack of communication from the client.

The additional team meetings were sometimes cut short and were noted.

Setting up the Firebase project required a member to update the purchase plan of the Firebase Project. The reason for this is Google has since changed their policy on using free command line functions to deploy directly to Firebase. However, it was noted that the functions and amount of traffic in our project would remain free. Although this would be something to look out for as development increases.

The GitHub repo was initially not ours, in which case 3rd party git tools such as Fork would not allow cloning and branching, this was identified and agreed we would stick to git bash and GitHub Desktop.

Milestone Reports:

- Git Repo Initialized:

During the iteration we gained access to emsoft/2023-RnD-Digital-Twin repository. Each member was given admin privileges to ensure we can pull and push accordingly. Throughout the iteration we decided we would compile the repository into respective folders. One for the front-end and one for the back end/middleware. We've also decided our branching strategy is to have a separate branch for each feature.

- Server Host Online:

Throughout the iteration a Firebase project was initialized. The goal of the server host is to ensure that we can communicate data and information between the website and the Factory IO simulation.

- Website Hosted:

In conjunction with the project being hosted online, a further sub project was initialized on Firebase. This would be the domain for the website and the URL for the client to interact with the simulation. <https://digitaltwintest-83dbd.web.app/>

Iteration two review

Planning: 08/05/2023 – 11/05/2023

Development: 12/04/2023 – 19/05/2023

Review: 20/05/2023 – 21/05/2023

What went well:

This iteration was characterized good communication between and the mentor between Factory IO issues and expected deliverables. Our team came together for UI Design and our Factory IO Prototype and Middleware server came together well. The team came together to decide on an agreed branching strategy for Git going forward, being a 'staging main' branch. This was to ensure master's Firebase configuration would remain secure.

Issues and challenges:

The original license for Factory IO did not provide communication protocols required. This was identified and Matthew applied for the Ultimate edition license provided by AUT. To mitigate this, we decided to create further trial accounts which would let us use the Ultimate Edition for 30 days a time, however this did not work entirely as each Factory IO instance was stored on the machine and could not be worked around by simply creating a new account. Even with this delay the Factory IO simulation was still completed on time.

The UI Design mock up approval was slightly delayed due external workload factors experienced by the team. However, with our new change management plan in place, this will be worked into the planning phase of the next iteration.

Milestone Reports:

- **Develop Factory IO prototype:**

A Factory IO simulation was created to represent the clients Factory as close as possible. Development was limited due to Factory IO not allowing for a range of customization options as it became apparent it was more of a learning tool. The simulation designed was created to prototype a similar production process from moving boxes along a conveyor whilst gathering data on each machine.

- **Develop backend server (Middle ware)**

Develop backend server: Throughout the iteration, a middleware application was created to provide a middle point between factory IO and the web dashboard. This was necessary as we do not want to expose our dashboard to PLC communication directly. This is also because not every browser may support the API.

- **UI Design Mock-up is designed and approved.**

UI Design Mock-up is designed and approved: A UI Design was created which reflected the interface seen at Jadcup's factory as close as possible. The design houses a home page which shows each machine, with the option to click further into a machine to see more properties and data for the respective machine.