

2119240

by Bryn Janes

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Assignment: 1. Instrumentation for Automation Systems
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1. Work Plan for Lifelong Learning and Risk Assessment

The assignment will be approached by reading the brief and understanding the tasks to be done and follow the correct procedures to get the tasks done correctly, then the risk assessment will be carried out. Use the resources given such as diagrams to help complete the tasks. Begin by investigating each control loop and instrumentation used on the two systems, provide technical data for the sensors to confirm they are suited for the task. You then carry out calibration procedure for the pressure sensor recording the results in tables and relevant graphs to demonstrate its static performance.

The next step would be to carry out the same calibration procedure appropriately for the temperature sensor, level sensor and position sensor. After completing the calibration procedures and recording results the next step is to research newer standards and devices to meet the demands of modern manufacturing. Next discuss the effects the subsystems have on environment and society and discuss maintenance and reliability of the system. Then write suitable conclusions and recommendations for improvements that could be made on the subsystems. To conclude, write how working as a team has produced a good outcome and explain your inclusive approach to engineering practice and responsibilities, benefits and importance of supporting equality, diversity and inclusion when working in a team. Figure1 shows how the Risk assessment table will work.

		Severity/Consequence		
		Slightly harmful (1)	Harmful (2)	Extremely harmful (3)
Likelihood	Highly unlikely (1)	Trivial risk (Score 1)	Tolerable risk (Score 2)	Moderate risk (Score 3)
	Unlikely (2)	Tolerable risk (Score 2)	Moderate risk (Score 4)	Substantial risk (Score 6)
	Likely (3)	Moderate risk (Score 3)	Substantial risk (Score 6)	Intolerable risk (Score 9)

A very good plan. Remember to write in the third person.

Figure1

The Risk assessment table can be found in the Appendix as Figure A6.

2. System Investigation

Process Station

The Process Station has hand valves for manually stopping and allowing water to pass through or for draining water. There's also automated valves for automatic control of flow to keep tanks at the correct level. There are pumps to fill tanks and push water through the system, and Level Sensors to give feedback on tank level and to control pumps and flow. There're also temperature transmitters to control temperature of the heater in B1 and Flow Transmitters to control valves.

Water recirculation sub-system

Level transmitters to give tank level feedback, hand valves and automated valves to control tank outlet.

Flow control loop

This loop controls the flow, as FC535 produces a control variable which feeds into the pump amplifier (LY541). It then gets its process value from FT535, which is the raw flow going into B1. To ensure the water is allowed to be safely pumped to the tank B1, it needs an interlock either from V516 or V515.

Temperature control loop

For this control loop, a temperature controller TC511 controls the heating of B1 which produces the control variable which is fed into the SSR using Pulse Width Modulation, which controls the heater. It then gets its PV from TT511 which is the temperature transmitter on B1, there is then an interlock from LS542 which reads the level of B1, so if it is below a certain level then this control loop will be off. There is then another part for this loop for cooling B1 by the cooling fan and solenoids V516 and V515. Once valves are open, they send cooled water to the B1 and pump amplifier LY541, which pumps the water to the tank when requested.

Level control loop

This loop is for controlling the level in tank B1 which is controlled by LC541. The level is measured by transmitter LT541 and there is a drain solenoid V500 which is able to drain the tank into B0 when requested. The LY541 is the pump amplifier that controls the water flow according to the level, it then has an interlock with the low water limit switch, LS541, which deactivates the control loop once the level is below a certain value.

Water input flow control loop

This loop controls the flow going into tanks B2, B4 and B6. This is done by FT531 sensing the flow. It has a pressure behind the water which is built up by the recirculating water system where the flow is controlled by the proportional valve, VF531, from controller FC 531. The water then enters each tank through solenoids VF510, VF511 and VF512 when requested.

3. Calibration of Pressure Sensor

To calibrate the pressure sensor, a voltmeter is used to measure the voltage as we increase the pressure by increments of 0.5bar from 0-5bar and plotting the data of rising voltage and falling voltage as we increase the pressure then decrease the pressure back to 0bar.

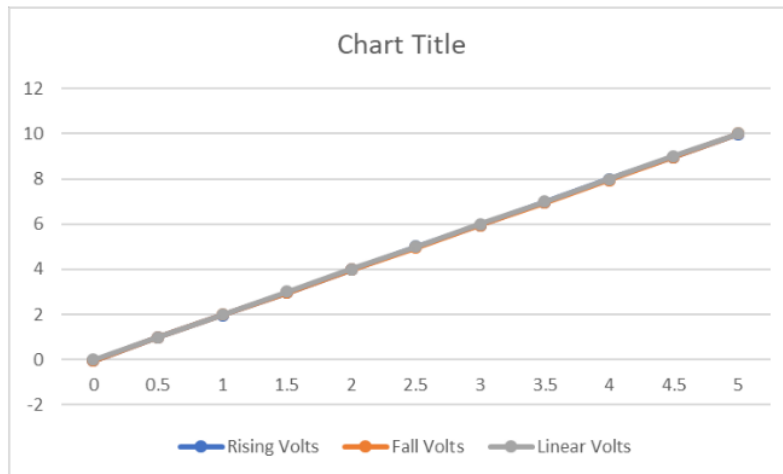


Figure2

You can find the data sheet for the test results In appendix FigureA1.

Analysis

Write in the third person *an be seen*

After carrying out the calibration procedure as a group, from the data, I can see that the sensor is working correctly with minor errors as can be seen in the table in the appendix with the biggest rising error being 0.05 which at 10bar would be 0.5%, the biggest falling error being 0.06 witch at 10bar would be 0.6%, and the biggest hysteresis error being 0.04, which at 10bar would be 0.4%FSD. These errors are very minor a *Write in the third person an be seen* significant problems in the system. Static sensitivity is $V/P = 10/5 = 2v/bar$. As you can see from the graph in figure2, each line is going over the top of each other showing there is very minimal error.

According to the manufactures data sheet, the linear voltage should be $\pm 0.25\%$. This means that our pressure sensor is not within the allowed error from the manufacturer with the worst case linearity being 0.6%, although this is most likely down to human error as we try to stop the long-term stability of the sensor which, *X the range is 5bar* from the data found on the GE PDF, is $\pm 0.3\%$. It also has a maximum of 20bar in line pressure.

(GE, 2006) *Correctly cited*

4. Calibration of Temperature Sensor

To calibrate the 4-20mA Temperature sensor, you increase the temperature in increments of ten until you reach 100°C. *The HMI showed* the current of mA increases when the temperature increases, with it meeting its max 20mA at 100°C.

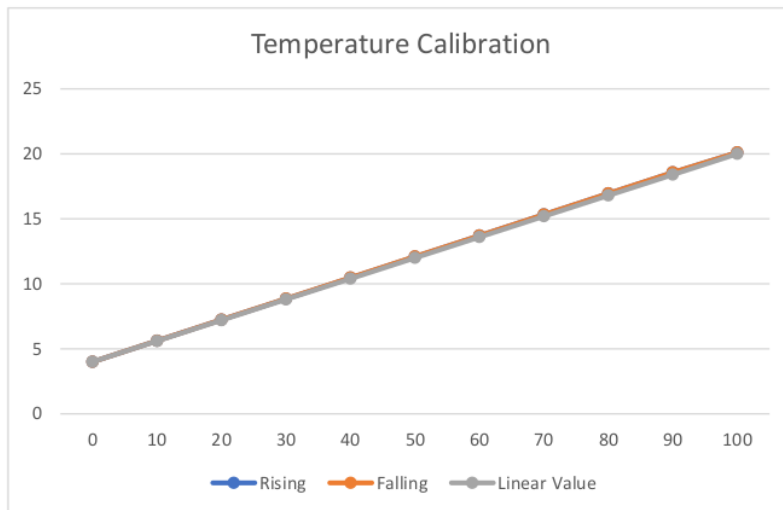


Figure3

You can find the data sheet for the test results in the appendix FigureA2.

Don't include data sheets. Quote from them and cited their source (yet not even included)

Analysis

Write in the third person

After carrying out the calibration procedure for this device with the group, I can now analyse the data and see that the temperature sensor is working with high precision and very little error with the only hysteresis error being -0.01°C on the three readings 30°C, 40°C and 50°C, which could suggest those three readings are the weakest area of precision as that's the only data with hysteresis error. Figure3 shows the graph of the result, where each line is over the top of each other meaning there is very minimal error.

The temperature sensor calibrated in this task is a RTD PT100 PPL3-P with a 4-20mA output signal. It has an IP rating of 68 and can sense temperatures from -75°C to +250°C. It has an accuracy of +/-0.3°C. (Parameters, 2023)

5. Calibration of Level Sensor

To calibrate the 4-20mA Level sensor, the level of the tank was increased from 7cm to 23cm using the HMI screen. As the level increased, we took readings of the current output of the device with was increasing up to a maximum of 12.5mA while at 23cm so not the full capacity of the 4-20mA.

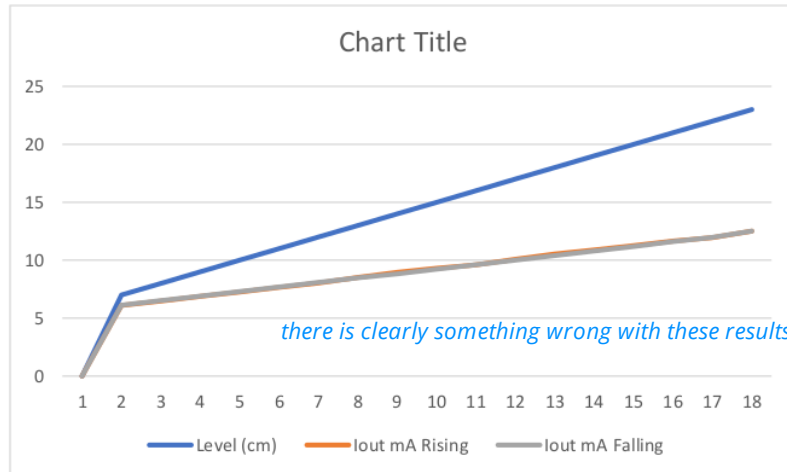


Figure4

You can find the data sheet for the test results In the Appendix Figure A3.

I calculated the offset, divisor, multiplier and scaled value as seen below:

$$\text{Multiplier} = 12.51 - 6.11 = 6.4$$

$$\text{Divisor} = 23 - 7 = 16\text{cm}$$

$$\text{Offset} = 12.51 - \frac{6.4}{16} * 23 = 3.31$$

$$\text{Scaled value} = \frac{6.4}{16} * 7 + 3.31 = 6.11$$

Analysis

As seen from the graph and the results, there was very little error when using the sensor. In Figure4, the rising and falling lines on the graph are over the top of each other, meaning that there is very minimal error. The worst-case hysteresis error was 0.08mA. Percentage of hysteresis is 0.64%.

The Data sheet for the Level sensor, Liquiphant FTL41, which was used had a maximum error of $\pm 1\text{mm}$, which can be found in the website on page 11. It can withstand temperatures of -40°C to 150°C , and pressures up to 40bar and viscosities up to 10000mPas.

(Endress+Hauser, 2019)

Correctly cited

6. Calibration of Position Sensors

IFM-01D100-01 DLF3KG-Photoelectric distance sensor. This is the one ^{that was calibrated} we have calibrated and this sensor has an accuracy of up to +/-26.5mm at the distances we are ^{measured} measuring, but better accuracy of +/-16.5mm when measuring the lower values. This sensor works with IO-Link. (ifm, 2023)

To calibrate the level sensor, we started off by using the HMI screen to read the start off values of the encoder and the laser then using the HMI, beginning with moving the arm the right roughly in increments of 100mm and recording our data each time. We then repeated this until we reached all the way to the right which had the encoder at 1315.2mm and the laser at 1528mm. We then did the same but with the arm coming back to the left until it is all the way back to the left with the encoder at -1mm and the laser at 202mm.

Analysis

You can find the data sheet for the test results In Appendix Figure A4 and A5. ^{Not required}

These findings show that the worst measurement error between the laser and the encoder when moving to the right was 14.87mm. When moving to the left, it was 14.09mm which is within the manufacturers limits. ^{Citation Needed}

7. Research

Industry 4.0 wants intelligent industrial products, processes and services that communicate with each other and people over a global network. (Intergrators, 2022) Correctly cited

^a The goal of industry 4.0 is to increase reliability, predictability, inter-compatibility consistency, And efficiency which would improve overall how well devices work in the industry and how well everything works together. These industry standards also ensure that different products are compatible with each other and that customers can mix and match products from different suppliers. Industry 4.0 also ensures costs are reduced and enable cost-effective and better solutions. (Flowcate, 2022) Correctly cited

Write in the third person

we can swap out our 4-20mA level sensor using PLC Card for an IO-Link level sensor to connect to an IO-Link master to improve its reliability and meet industry 4.0 standards. A good replacement would be the LK8123, which is an electronic level sensor and would be better as it meets more industry 4.0 standards so it's more reliable, compatibility and is more consistent. (IFM, 2022) Correctly cited

If you were to change the flow meter to comply with industry 4.0, you could use a SM6601 which is a magnetic-inductive IO-link flow meter and is more reliable than the current flow meter. (IFM, 2022)

Write in the third person

If you were to change the temperature sensor to comply with industry 4.0, you could use a TD2913 which is IO-link and is more reliable and also has a display for setting up and calibrating and displays the current temperature. (IFM, 2022)

Write in the third person

If you were to change the distance sensor to comply with industry 4.0, you could use a OGD580 which is a photoelectric IO-link distance sensor and is more reliable than the current distance sensor and has all the benefits of IO-link. (IFM, 2022)

8. Environmental, Maintenance and Reliability

Write in the third person

Looking at the Health and safety of each subsystem, problems have been found. For example, chambers B0 and B1 heat up due to the heater and can burn skin if you touch it. This is an environmental and society problem due to it affecting anyone that works on them as they could be unaware of the hazard and you may be slower carrying out the task knowing to be cautious of this hazard. In B3 there is sulfuric acid which is very hazardous to skin and eyes so you must be careful when working around this chamber. It also corrodes metals so we must make sure it does not touch any instrumentation as it will damage it and we will get false readings. The two environment and society problems can be minimised by being careful around the chemicals and covering the heated chambers with insulation so you are unable to touch the tank.

9. Conclusions and Recommendations

Write in the third person

The two subsystems have some IO-Link devices, but I recommend changing out all the 4-20mA devices for IO-Link as there's less wiring and easier to set up and calibrate as they would then be smart devices which then can comply with industry 4.0. Carrying out these tasks has helped me to understand these sort of devices, which is also helpful for any jobs to do with these sorts of devices in my workplace.

Write in the third person

Conclusion for pressure sensor calibration

Upon completion of the calibration tasks, this sensor has been calibrated successfully as most of the error is down to human error and not the device so this can be put down as a successful calibration.

Conclusion for temperature sensor calibration

It is obvious that this sensor is the most accurate out of all the sensors as there was only one very minor error so it undoubtedly had a successful calibration. Although, due to this being a 4-20mA device, you could swap this out with an IO-Link device such as the TR7439 from IFM to comply with industry 4.0 as it would then be a smart device.

Conclusion for level sensor calibration

The errors for this sensor were within the error allowance which means it has been calibrated successfully. Although, due to this being a 4-20mA device, you could swap this out with an IO-Link device such as the LR2050 from IFM to comply with industry 4.0 as it would then be a smart device.

Conclusion for distance sensor calibration

To conclude, the distance sensor has an error within the error allowance which means the calibration was successful.

Although the sensor uses IO-Link, we could find a better sensor with much less of an error allowance as there are sensors capable of much better accuracy which also works at the standard of industry 4.0.

10. Team Working

Write in the third person

During the calibration of each device, we would be in our team of three as more than one person is needed and it allows you to carry out the task more efficiently as one person was changing the device's value using the HMI screens. Another person was reading and relaying those values, such as for the pressure sensor looking at the pressure value and the value on the multi-meter, then relaying those values to the person on the computer who would then put those values into the data table for us all to use after the calibration which saves us all time.

It is important that all of us concentrate and follow our roles correctly, otherwise we could get false information which could make our data unreliable. Nothing happened during the calibration process that could cause this to happen as we dealt with our responsibilities responsibly. We would make sure each team member would have a different role for each calibration task so that everyone was included in the different parts of the tasks. This allows equality, diversity and inclusion in the group when working as a team. Changing your role in each task also benefits the groups so we all understand each role. Once the calibrations were completed we then separated to carry out the calculations and work separately.

11. Citation List

Good range of sources

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12. Appendix

FigureA1

	Rising	Fall	Linear	Rising	Falling	Hysteresis
Pressure	Volts	Volts	Volts	Error	Error	Error
0	-0.05	-0.04	0	-0.05	-0.04	-0.01
0.5	1	1	1	0	0	0
1	1.96	1.98	2	0.04	0.02	0.02
1.5	2.95	2.96	3	0.05	0.04	0.01
2	3.97	3.98	4	0.03	0.02	0.01
2.5	4.99	4.96	5	0.01	0.04	0.03
3	5.95	5.95	6	0.05	0.05	0
3.5	6.97	6.94	7	0.03	0.06	0.03
4	7.98	7.94	8	0.02	0.06	0.04
4.5	8.96	8.97	9	0.04	0.03	0.1
5	9.99	10	10	0.01	0	0.01

FigureA2

	Temperature	Temperature	Linear	Rising	Falling	Hysteresis
Temperature	Rising (mA)	Falling (mA)	Value	Error	Error	Error
0	4	4	4	0	0	0
10	5.62	5.62	5.6	0.02	0.02	0
20	7.24	7.24	7.2	0.04	0.04	0
30	8.85	8.86	8.8	0.05	0.06	-0.01
40	10.47	10.48	10.4	0.07	0.08	-0.01
50	12.09	12.1	12	0.09	0.1	-0.01
60	13.71	13.71	13.6	0.11	0.11	0
70	15.33	15.33	15.2	0.13	0.13	0
80	16.95	16.95	16.8	0.15	0.15	0
90	18.57	18.57	18.4	0.17	0.17	0
100	20.1	20.1	20	0.1	0.1	0

FigureA3

Level (cm)	Iout mA Rising	Iout mA Falling	Linear Value	Error Rising	Error Falling	Hysteresis Error
0	4.01	4.01	3.295			
7	6.1	6.12	6.1	0	0.02	0.02
8	6.47	6.51	6.5	0.03	0.01	0.02
9	6.88	6.9	6.9	0.02	0	0.02
10	7.25	7.29	7.3	0.05	0.01	0.04
11	7.66	7.69	7.7	0.04	0.01	0.03
12	8.03	8.08	8.1	0.07	0.02	0.05
13	8.51	8.48	8.5	0.01	0.02	0.01
14	8.95	8.82	8.9	0.05	0.08	0.03
15	9.3	9.23	9.3	0	0.07	0.07
16	9.6	9.61	9.7	0.1	0.09	0.01
17	10.08	10	10.1	0.02	0.1	0.08
18	10.54	10.4	10.5	0.04	0.1	0.06
19	10.88	10.8	10.9	0.02	0.1	0.08
20	11.26	11.18	11.3	0.04	0.12	0.08
21	11.65	11.61	11.7	0.05	0.09	0.04
22	11.95	11.97	12.1	0.15	0.13	0.02
23	12.51	12.51	12.5	0.01	0.01	0

FigureA4

Encoder (mm)	Laser Right	Encoder minus off	Laser Minus off	Error
4.7	205.13	0	0	0
85.1	278.7	80.4	73.57	6.83
209.2	406.63	204.5	201.5	3
299.8	502.27	295.1	297.14	-2.04
407.4	610.43	402.7	405.3	-2.6
501	709.7	496.3	504.57	-8.27
601.1	813.83	596.4	608.7	-12.3
700.5	915.7	695.8	710.57	-14.77
810	1025.3	805.3	820.17	-14.87
900.3	1114.81	895.6	909.68	-14.08
1002.5	1216.46	997.8	1011.33	-13.53
1100.9	1314.48	1096.2	1109.35	-13.15
1200.4	1411.28	1195.7	1206.15	-10.45
1315.2	1528.01	1310.5	1322.88	-12.38

FigureA5

Encoder (mm)	Laser left	Encoder minus off	Laser Minus off	Error
-1	202.01	1299.3	1309.78	-10.48
99.8	296.89	1198.5	1214.9	-16.4
202.1	403.9	1096.2	1107.89	-11.69
301.8	503.13	996.5	1008.66	-12.16
401.1	600.5	897.2	911.29	-14.09
500	706.4	798.3	805.39	-7.09
601.8	812.4	696.5	699.39	-2.89
699	911.3	599.3	600.49	-1.19
800.1	1012.7	498.2	499.09	-0.89
900.1	1111	398.2	400.79	-2.59
999.3	1212.03	299	299.76	-0.76
1100	1314.9	198.3	196.89	1.41
1198.7	1410.2	99.6	101.59	-1.99
1298.3	1511.79	0	0	0

FigureA6

Risk	Hazard	Likelihood 1-3	Consequence1-3	Overall Risk 1-9	Risk Level
No guard	moving arm could hit you or trap limbs	1	2	3	Tolerable Risk
No isolation procedure	Live electrical equipment could electricute someone	1	3	4	Moderate Risk
Chemicals	Could splash onto skin or eyes	1	2	3	Tolerable Risk
Heating tank	Burn your skin	1	1	2	Trivial Risk
High pressure air supply	Disconnect and knock/hit you	1	1	2	Trivial Risk
Cables running on floor	Could trip on cable and fall	2	2	4	Moderate Risk

FINAL GRADE

GENERAL COMMENTS

Instructor

58/100

PAGE 1

PAGE 2

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PAGE 3

QM

Write in the third person

Don't refer to your self as I, me, my or others as you etc. Avoid personal references. If absolutely necessary, refer to self as "the author".

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Correctly cited

Citation method conforms to Harvard standard, well done.

PAGE 7

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PAGE 8

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Text Comment. the graphs you have provided are very different !!!!!

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Correctly cited

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PAGE 9

QM

Use the third Person

You are referring to first or second persons (I, we, you, us etc) whereas you should use the third person thus depersonalising it.

Text Comment. that was calibrated

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Spelling

Spelling error

Text Comment. measured

QM

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Text Comment. Not required

QM

Citation Needed

Cite Source:

Please use the link below to find links to information regarding specific citation styles:
http://www.plagiarism.org/plag_article_citation_styles.html

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PAGE 13

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Don't refer to your self as I, me, my or others as you etc. Avoid personal references. If absolutely necessary, refer to self as "the author".

PAGE 14

QM

Good range of sources

You have demonstrated reading from a good range of sources shown by your list below

QM

Correct method of listing.

You have listed your sources correctly according to the Harvard method.

PAGE 15

GRADING FORM: NEW CSG-RUBRIC

BRYN JANES

58

1. ENGAGEMENT WITH LITERATURE



A good research section with evidence of reading from a wide range of sources cited and listed correctly using the Harvard method. 13/20

13

2. KNOWLEDGE AND UNDERSTANDING



Good knowledge demonstrated in your system investigation, explanation of calibration procedure and environment/maintenance section. 12/20

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3. COGNITIVE AND INTELLECTUAL



Some good analysis of results and conclusions/recommendation presented. 11/20

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4. PRACTICAL APPLICATION



Good use of calibration equipment and recording/graphing of results though there are some errors. (11/20.

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5. TRANSFERABLE SKILLS



A good work plan, risk assessment and explanation of team working. Report is well structured and presented with clear diagrams. Word count not exceeded. However, you must learn to write in the third person. You appear to be either writing a journal or a user manual. 11/20

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