

1809799
by Thomas Grennan

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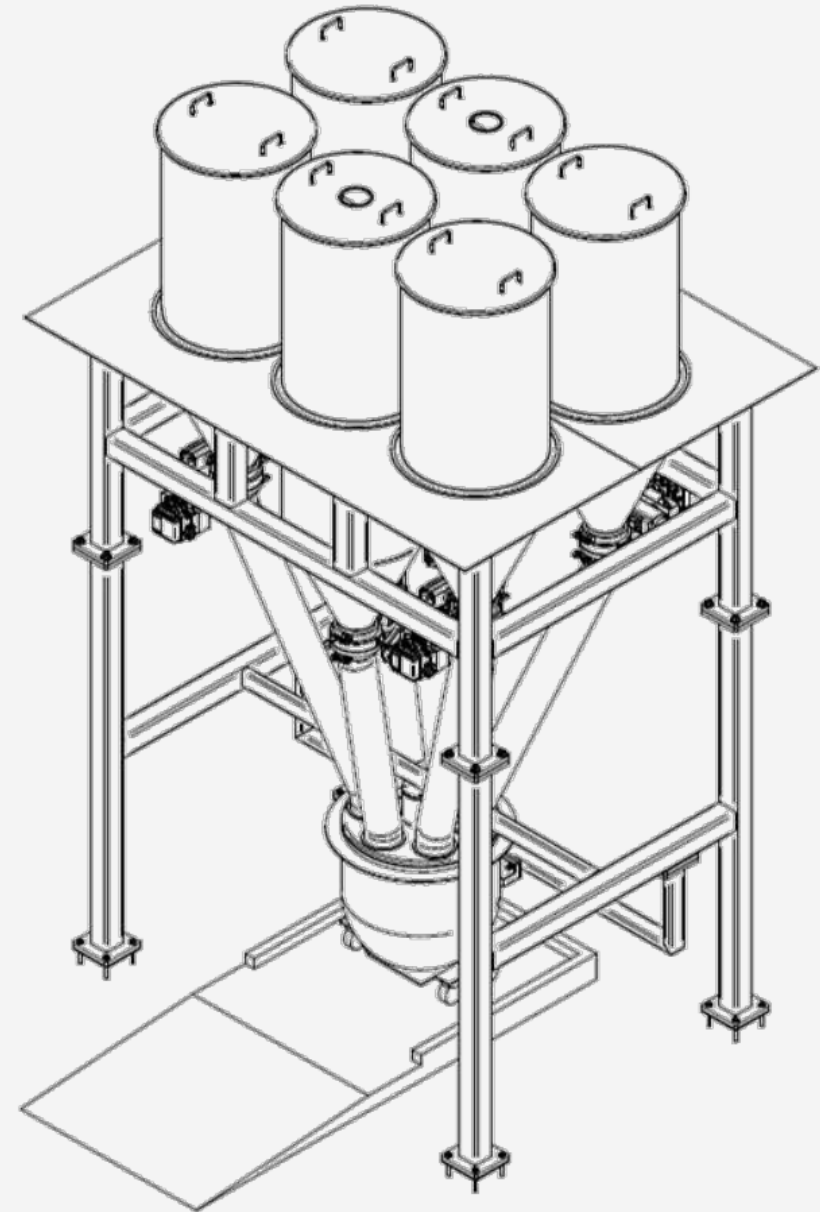
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Prifysgol Cymru
Y Drindod Dewi Sant
University of Wales
Trinity Saint David

Ingredient Dosing System

Thomas Grennan



Introduction

- Based within a special purpose machinery company
- System is for a bakery who produce tray bake cakes
- Aim of proving that productivity and sustainability targets in manufacturing can be achieved through digital manufacturing technologies
- To introduce a fully-automated dosing system with traceability of products
- Remove a time-consuming labour-intensive task



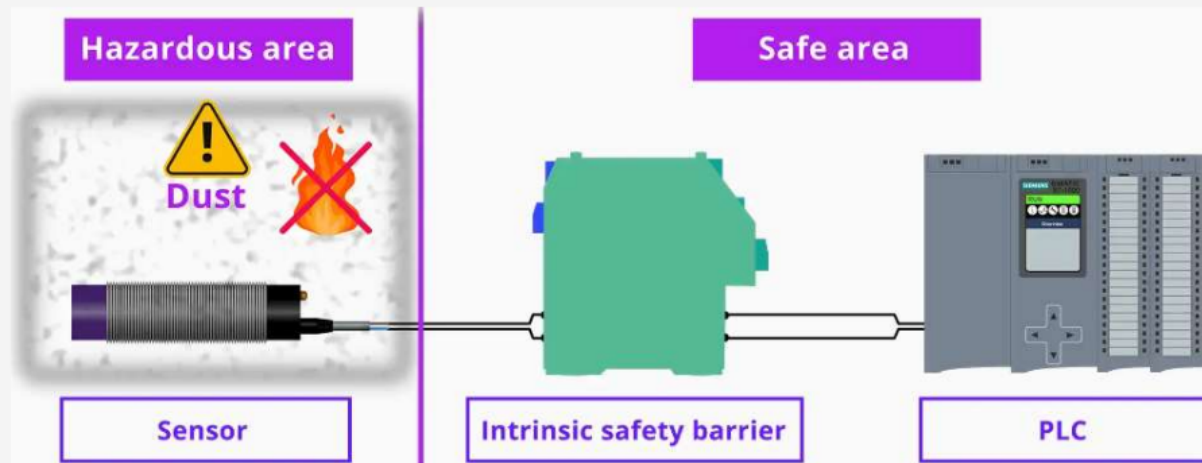
Functional Design Specification (FDS)

- Remained largely accurate to the original FDS
- IFM 24V Fuses no longer deliverable within timing plan (P.11)
- New requirements for Alarm Screen (P.12) & Emergency Stop Pushbutton (S.8)

Functional Design Specification – Original vs. Deliverable		
Ref.	Original Requirement	Current Requirement
P.0	4-off 375 Litre capacity stainless steel hopper for Caster Sugar, Light Brown Sugar, Buttery Scone Mix and Rolled Jumbo Oats	Required
P.1	2-off 500 Litre capacity stainless steel hopper for Plain & Self-Raising Flour	Required
P.2	System must detect if a hopper is empty	Required
P.3	System must allow for 'Recipes' to be added	Required
P.4	System includes function to add external product to mixing bowl	Required
P.5	System includes function to empty each hopper for cleaning	Required
P.6	Weigh Scale must allow for weights up to 300Kg	Required
P.7	Weigh Scale must be accurate to 20g (0.02Kg)	Required
P.11	System must include IFM DF2101 IO-Link fuse modules	No longer deliverable due to the global chip shortages.
P.12	Must Include an Alarms Screen	New Requirement
S.6	The system must be designed following the best EMC practices	Required
S.7	Live parts shall be located inside enclosures that provide protection against contact with live parts, and can only be opened with a proprietary key	Required
S.8	The system must implement an emergency stop button	New Requirement

Design - ATEX

- Intrinsically Safe Design for Equipment in the ATEX Zone
- Intrinsic Barriers limit power levels of devices, preventing ignition of dust clouds
- Designed in accordance with manufacturer recommendations
- Meets the requirements of 'The Equipment and Protective Systems Intended for use in Potentially Explosive Atmospheres Regulations 2016'



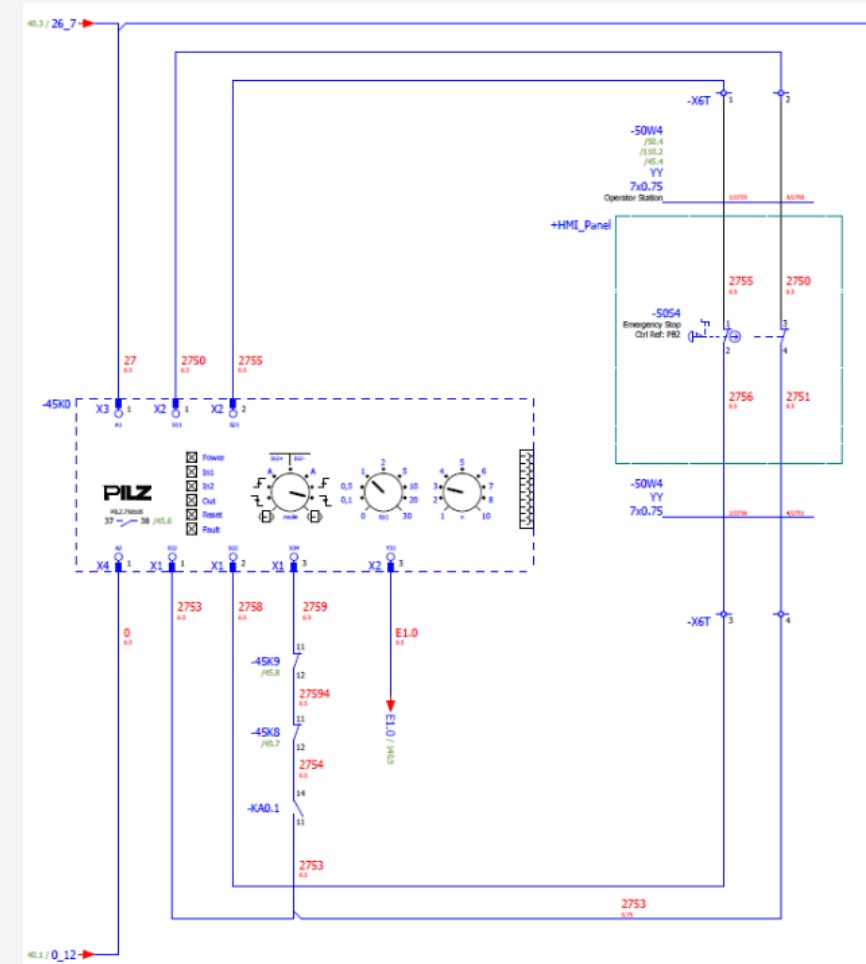
Design – Food Hygiene

- FDA approved materials and components
- Designed following guidance of General Food Law 178/2002
- Full traceability of Primary Ingredients & End Mixed Product
- ‘Run Data’ datablock in PLC maintains the “One Step Forward, One Step Back” Supply-Chain Rule
- Capturing Important Data in case a product re-call is required



Design – Machine Safety

- Emergency Stop Safety Function added to reduce Compressed Air Risks
- Removes the system air & actuator power under Emergency Stop Conditions
- Category 2 Architecture
- Performance Level D
- Verified & Validated through SISTEMA
- Meeting the requirements of EN ISO 13849-1, 13849-2 & 13850



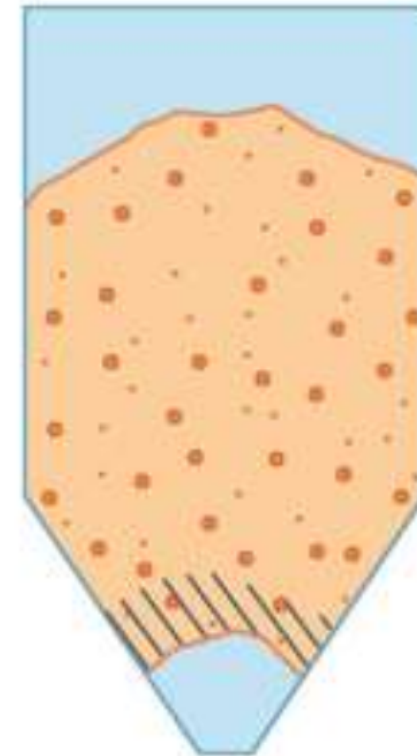
Construction

- Electrical Panel
- Field Wiring
- Mechanical & Pneumatic Install
- Software & Electrical Commissioning



Issues

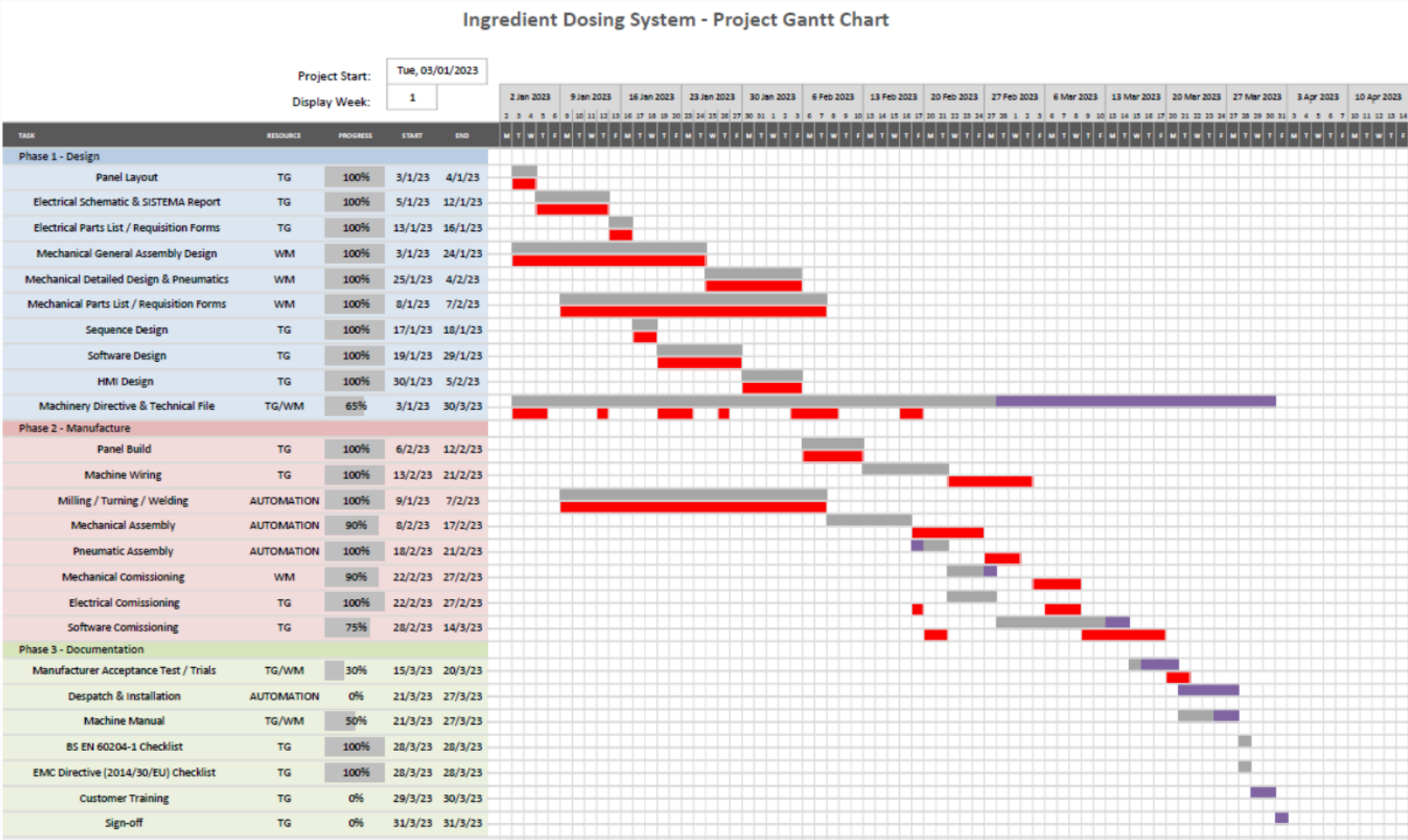
- Supply-Chain Issues have directly prevented the implementation of 2 FDS requirements, and indirectly prevented the implementation of 4 FDS requirements
- Cohesive Bridging has prevented the system being fully tested



Testing & Analysis

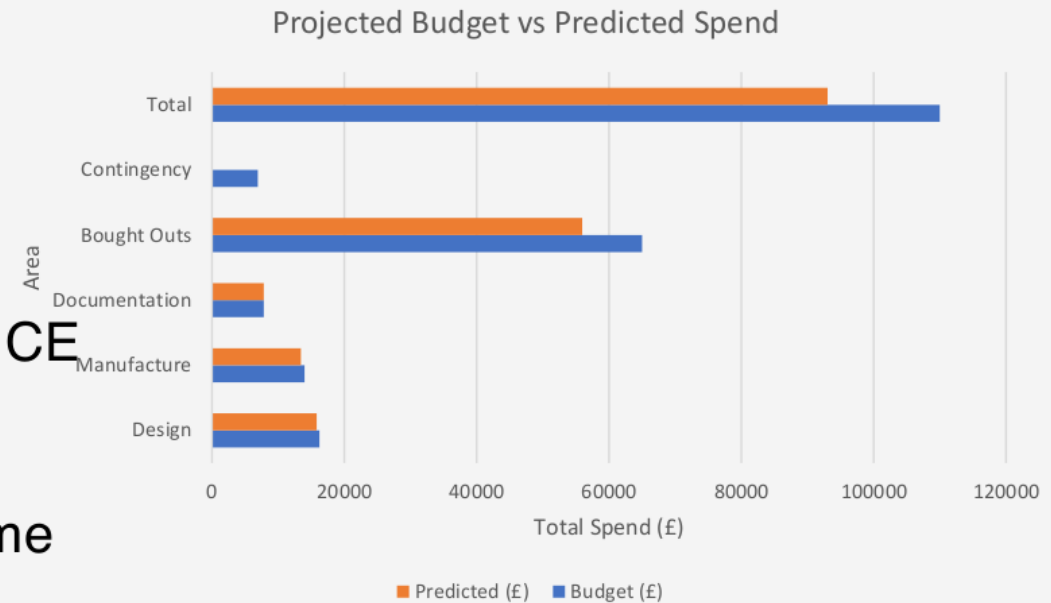
Conformity Tests					
Ref.	Test Description	Expected Outcome	Actual Outcome	Pass or Fail?	Evidence
P.0	Check the Hopper Capacity for Caster Sugar, Light Brown Sugar, Buttery Scone Mix and Rolled Jumbo Oats Hoppers	4-off 375 Litre capacity stainless steel hoppers are fitted for Caster Sugar, Light Brown Sugar, Buttery Scone Mix and Rolled Jumbo Oats	4-off 375 Litre capacity stainless steel hoppers are fitted for Caster Sugar, Light Brown Sugar, Buttery Scone Mix and Rolled Jumbo Oats	Pass	Figure 96
P.1	Check the Hopper Capacity for Plain & Self-Raising Flour	2-off 500 Litre capacity stainless steel hoppers fitted for Plain & Self-Raising Flour	2-off 500 Litre capacity stainless steel hoppers fitted for Plain & Self-Raising Flour	Pass	Figure 97
P.8	Check the screen size of the GUI	GUI has a 12" Screen	Siemens MTP1200 12" Unified Comfort Panel Installed	Pass	Figures 98-99
P.10	Check PLC network	System is connected to a Siemens IOT2050 Gateway	Siemens IOT2050 Gateway wired in control panel	Pass	Figure 100
P.11	Check 24V Circuit Protection	IFM DF2101 IO-Link Module Wired	Supply chain issues, the DF2101 is on an extended lead time. Temporarily replaced by MCBs & Auxiliaries.	Fail	Figure 101
S.0	Compare the PL rating to the PLr rating	SISTEMA report confirms that the PL is greater than or equal to the PLr (PLr B)	Sistema Report confirms that the system has achieved Performance Level D.	Pass	Figure 102
S.1	Inspect all protective conductor bonding points	All protective conductor bonding points are labelled in accordance with IEC 60417-5019:2006-08	All protective conductor bonding points are labelled in accordance with IEC 60417-5019:2006-08	Pass	Figure 103
S.2	Check the ATEX rating of electrical components in the ATEX zone	All equipment within the ATEX zone is rated suitably to the risk assessment.	All electrical components in the ATEX zone are suitably rated.	Pass	Figures 104-107
T.0	Check that the technical file is compiled	Technical File is compiled and saved in the project folder	Technical File has not been completed as the system is not complete	Fail	Fail
F.0	Check that the project budget has not been exceeded	Project budget has not been exceeded	Project is incomplete, it is currently within budget and is predicted to be delivered in budget	Fail	Fail

Management Techniques & Planning



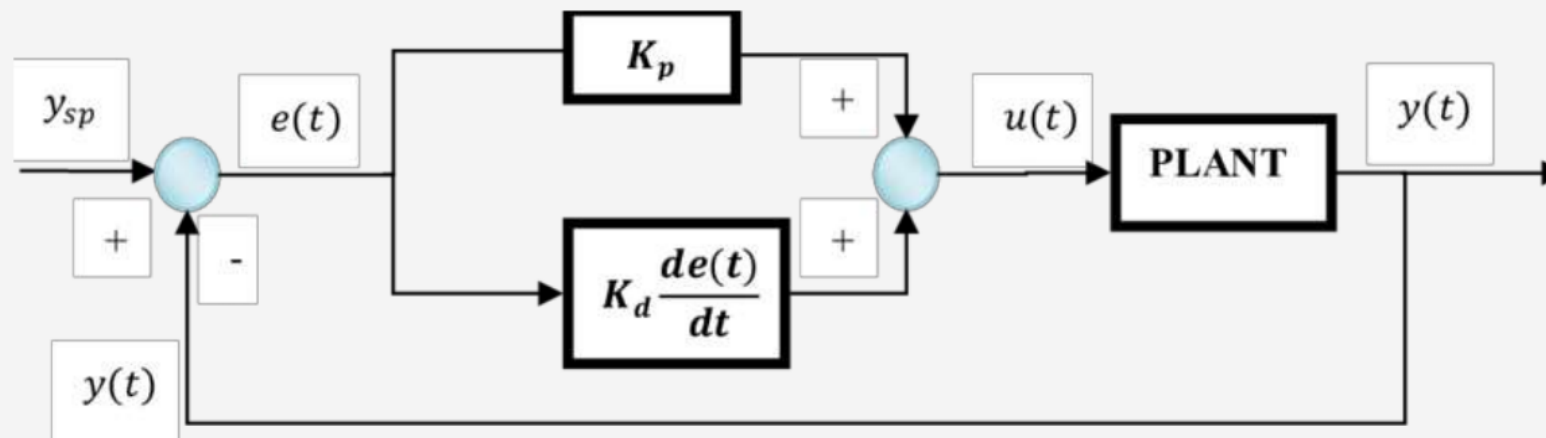
Conclusions

- Currently 83% complete with 77.8% budget remaining
- Predicted to be delivered £18,930 under budget
- All Machine Safety constraints addressed
- Compliant with Machinery Directive for UKCA & CE conformity
- Profinet Devices vastly reduced development time
- Compliant with requirements of 178/2002
- Customer annual savings of £19,719



Recommendations

- Proportional-Derivative Control for Proportional Valve
- Saving £2,436.16 & Reducing Hardware Requirements
- Utilise the abilities of the IOT2050 to benefit the machine



Thank you,
Any questions?

FINAL GRADE

GENERAL COMMENTS

Instructor

75/100

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PAGE 3

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PAGE 5

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GRADING FORM: NEW CSG-RUBRIC

THOMAS GRENNAN

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1. ENGAGEMENT WITH LITERATURE

 N/A

2. KNOWLEDGE AND UNDERSTANDING



Project design

FDS was reviewed and changes with reasons explained and the final solution explained in great detail referring to standards. However, nothing shown about the program. (7/10)

Project implementation

Excellent build with references to supply chain problems and unforeseen production issues such as bridging. No explanation of the program. (7/10)

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Response to questions
Excellent (8/10)

3. COGNITIVE AND INTELLECTUAL

- 
- Testing and analysis of results
 - Good analysis with but little evidence of testing the system from results. (6/10)
 - Critical evaluation of the project outcomes relating to FDS and constraints
 - Excellent and full evaluation (7/10)
 - Conclusions and recommendations
 - Good conclusions and recommendations including vibration method to avoid bridging (7/10)

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4. PRACTICAL APPLICATION

- 
- Deployment method, use of material, tools, equipment and techniques in the construction of the project.
 - Excellent methods used. (8/10)
 - Quality of the final product or system.
 - High quality panel build but nothing shown of the program (7/10)
 - Management of the design process including use of plans, costing spreadsheet.
 - Excellent use of management methods with recovery due to supply chain issues (7/10)

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5. TRANSFERABLE SKILLS



Quality of the presentation slides

Very good (6/10)

Quality of the delivery style

Good, but most was read out in a monotone voice (5/10)