



Development of Control & Instrumentation System for Final Year Design Project: Checklist P&ID

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ABSTRACT

BACKGROUND & CONTEXT

Final Year Design Project (FYDP) is a compulsory course in the Department of Chemical and Process Engineering (JKKP), accumulating six integrated projects introduced from Year 1, and requiring students to design process plants by integrating theories learned throughout the programme. Each group of five or six students is supervised by two JKKP lecturers and an industry mentor, with the final presentation evaluated against eleven Program Outcomes (PO) reviewed by the Engineering Accreditation Council (EAC) since 2017/2018. A recurring weakness in project reports and presentations has been students' difficulty in producing accurate Process Flow Diagrams (PFD) and Piping and Instrumentation Diagrams (P&ID), skills built upon the Process Control course taught in Semester 2, Year 3.

PURPOSE OR GOAL

This study aims to address the persistent weakness in PFD and P&ID development among FYDP students. A checklist was developed as a structured reference to guide students in applying process control concepts correctly when designing these diagrams, with the goal of improving report and presentation quality.

APPROACH OR METHODOLOGY

The checklist was developed by identifying common errors in P&ID development, particularly inappropriate pump and valve usage, incorrect control configuration selection, and flawed separation concepts. It was structured around key control objectives, including safe operation, production efficiency, product quality, and steady operation with minimal intervention. The checklist was adopted by final year students from the 2020/2021 session onward as a term of reference during PFD and P&ID development.

OUTCOMES

Following implementation of the checklist, a marked improvement in student performance in producing PFD and P&ID was observed. Total scoring for written reports and FYDP presentations increased by more than 50% compared to prior sessions. This indicates that structured referencing tools can meaningfully strengthen students' technical diagramming skills within capstone design projects.

CONCLUSIONS

The checklist proved effective in addressing a long-standing weakness in FYDP diagram development, demonstrating that targeted, practice-based reference tools can substantially improve student outcomes in technical design tasks. These findings support the value of embedding structured checklists within process control and capstone curricula to reinforce theoretical learning through practical application.

KEYWORDS

Final Year Design Project, Process Flow Diagram, Piping and Instrumentation Diagram.

Introduction

Final Year Design Project or simply FYDP is one of the courses that must be taken at the Department of Chemical and Process Engineering, JKPP. The FYDP in chemical engineering program is the culmination of six integrated projects that have been introduced starting from SEM 1 Year 1. FYDP is held for two semesters and involves a series of presentations. The final presentation involved a panel of lecturers and from industry parties related to the FYDP project title. The main objective of FYDP is the ability to design process plants to produce specific products by integrating all theories and knowledge accumulated from their first year of study to the final year and implemented in batches. Each group consists of five or six students and is mentored by two JKPP lecturers and an industry mentor (Masdar et al. 2018). Process control is one of the compulsory courses in chemical engineering programs. The main objective of process control is to ensure that an operating unit or plant is safe (Norliza et al., 2019, Anuar Ahmad and Mohamed Zulkifli Abdul Aziz, 1991). Process control courses are directly involved in FYDP especially to produce process flow diagrams (Process Flow Diagram, PFD and Piping & Instrumentation Diagram, P&ID).

A significant problem in project reports and FYDP presentations is the weakness in producing process flow diagrams (Process Flow Diagram, PFD and Piping & Instrumentation Diagram, P&ID). To address this issue, a checklist has been developed in order making it easier for students to make referrals to PFD and P&ID. The checklist is a continuation of the process control course conducted in Sem 2, Year 3 (Norliza et al, 2022).

Methodology

Figure 1 indicate the steps or procedure involved before the PFD and P&ID can be design. The development of process control and instrumentation starting after the unit operations involved has been finalized as in the PFD. Objectives of control analysis for each unit operation as follow: (Smith, C. A. Corripio, A. B. (2006); Stepanoupoulus, G. 1984)

1. Safe plant operation.
2. Ensure smooth production.
3. To achieve the designed production rate.
4. To maintain the product quality at specified standards.
5. To operate at efficient low cost and risk.
6. To maintain the steady operation with minimal operator intervention.

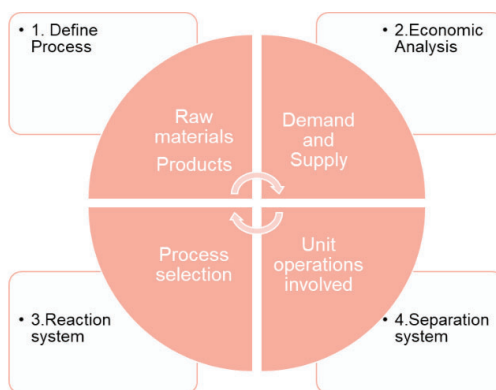


Figure 1. Steps involved in developing PFD and P&ID

Development of P&ID Checklist

Starting from the process control course in Semester 2 Year 3, the problems faced in integrated projects for P&ID are the use of inappropriate pumps and valves, improper selection of control configurations for operating units and basic concepts in incorrect separation.

Various methods have been implemented in an effort to improve the effectiveness of P&ID for process control. The development of this checklist began by identifying the operating units used and followed by the selection of the type of control, sensor and type of valve to be used. The use of pumps and valves corresponding to the type and phase of the fluid was taken into account in the development of this list of shrubs. Table 1 is a checklist has been adopted by final year students from the 20202021 session (Norliza et al.,2022).

Table 1. Checklist for P&ID

Bil	Item	Tick (/)
1	Title: Piping and Instrumentation Diagram (PNID) - industry	?
2	At every stream with pump (L), compressor (v), blower (v), valve	?
3	pump + valve -- > pump first then only valve – why?	?
4	One stream/ In a line cannot have two valves/ pumps/ compressor	?
5	Mixer/ Filtration, no control – just to mix, already set the rpm etc.	?
6	Loop number/tag number for control loop	?
7	Flow equipment – transmitter- controller- valve (dotted line/ electrical/ pneumatic signal)	?
8	DOF – show complete equation (report)	?
9	Transmitter position depends on CV	?
10	HE/ cooler and utility – stream attached – how they are drawn?	?
11	Reactor – adiabatic (no T control)	?
12	DC – Temp top lower, temp bottom higher	?
13	DC – analyzer (more than 1 DC, control at product)	?
14	Dryer – Temp	?
15	Symbol – mounted, DCS, PLC --> decide your controller placement	?
16	Plantwide – already have a flow control then add a level control (redundant), start from individual loops, combine and remove the redundant control loop	?
17	Control P, valve outlet stream	?
18	Control L, valve outlet (liquid)	?
19	Control T, inlet cooler/ steam	?
20	Control pH, inlet buffer solution	?
21	Control foaming, anti-foaming (inlet, liquid)	?
22	Control composition, depends on equipment such as DC/ reactor	?
23	Hydrogen/gas purge – measure concentration	?
24	Control P (what is the indicator, 5 bar, 10 bar etc?)	?
25	Type of valve → draw according to let say butterfly valve, diaphragm valve.	?
26	No stream table in PNID	?

- 27 PNID actually should be done after HAZOP studies (Safety subject) ?
 - 28 Additional after HAZOP – should have alarm system (ex: LAH, LAL) and bypass stream if necessary, check how to draw the alarm system ?
 - 29 Must understand the purpose of bypass in your process ?
 - 30 Common mistakes made by students usually at: ?
 - a. Many transmitters to a controller
 - b. Heat exchanger: wrong control variable
 - c. Single stream has 2 control loops
 - d. Line mistake
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Conclusion

Final Year Design Project or simply FYDP is one of the courses that must be taken at the Department of Chemical and Process Engineering, JKPP. A significant problem in project reports and FYDP presentations is the weakness in producing process flow diagrams (Process Flow Diagram, PFD and Piping & Instrumentation Diagram, P&ID). To address this issue, a checklist has been developed to make it easier for students to make referrals to PFD and P&ID. As a result of this checklist, student performance is better in PFD and P&ID production based on written report markings and FYDP presentations, which are more than 50%.

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