Keit
한국산업기술평가관리원

Developing a smart training system for FEED engineers of advanced plant design based on a tailored systems engineering process

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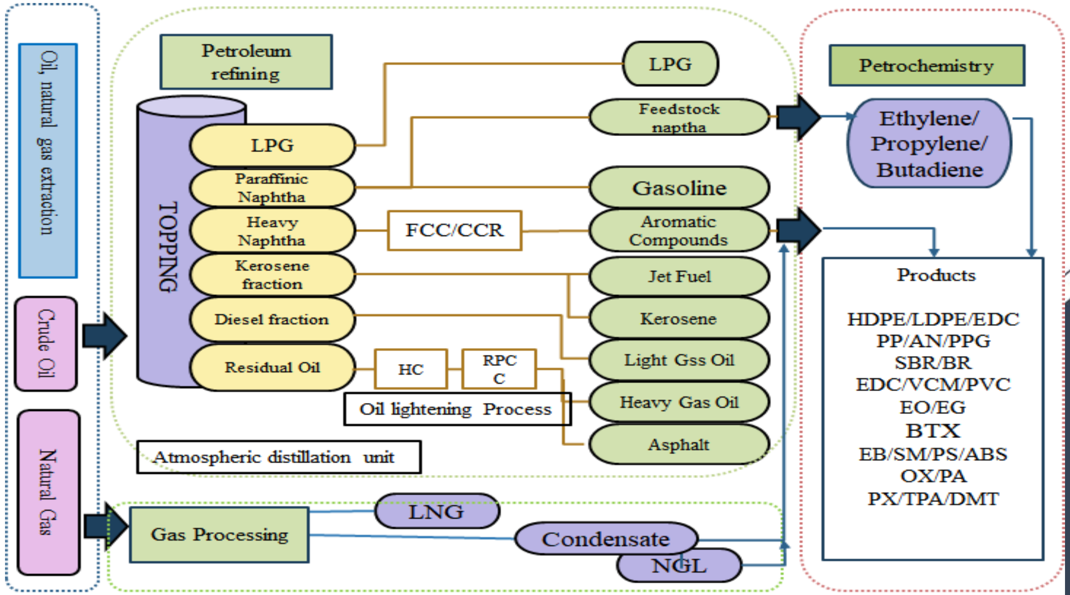


Petroleum refining, Infra/Utilities and Petrochemical

Research Background (1/2)

1 Introduction to Plant Engineering Process and FEED

Engineering Process

The lifecycle of an industrial plant starts with Business plan, through the stages of Pre-feasibility study, Concept design, Bankable feasibility study, Final Investment Decision, Basic design, FEED, EPC Tender, Procurement (supply & manufacturing with inspection/test), Construction (installation, erection, test & pre-commissioning), Commissioning, Operation & maintenance, Renewal plan, and closes Disposal

Implementing all technological services such as appreciating, developing, assessing, valuating, banking, designing, manufacturing, constructing, operating, monitoring, and maintaining from the business idea birthing to the operation & disposal of the factory and/or facilities.

FEED*

From the planning feasibility study of the project to the conceptual design and the forward value chain from the basic design to the core area that determines profitability of the whole project (Ministry of Knowledge Economy Engineering Industry Promotion Basic Plan. 2012)

Design that connects the front end of the execution design with the rear end of the basic design (Korea Plant Institute EPC Technical Committee, 2010)

Comprehensive basic design of the first half of the design activities of the plant construction (concept design, basic design, and local application design with full guarantee as well as risk and safety analysis, etc.)

*FEED: Front End Engineering Design

Research Background (2/2)

1 Trends in prior design technology

Project Bid Estimate is usually based on the FEED Package provided by the Owner, because it is the only most complete package of design and cost factors including local conditions as of the tender date, which becomes a mandatory in many companies

- Tenders for EPCs are usually based on the FEED level information and the Owner's requirements related. So without enough FEED knowledge it is risky to finish the task within the time and budget proposed.
- **Capable** companies experienced in FEED dominate the market up to now.

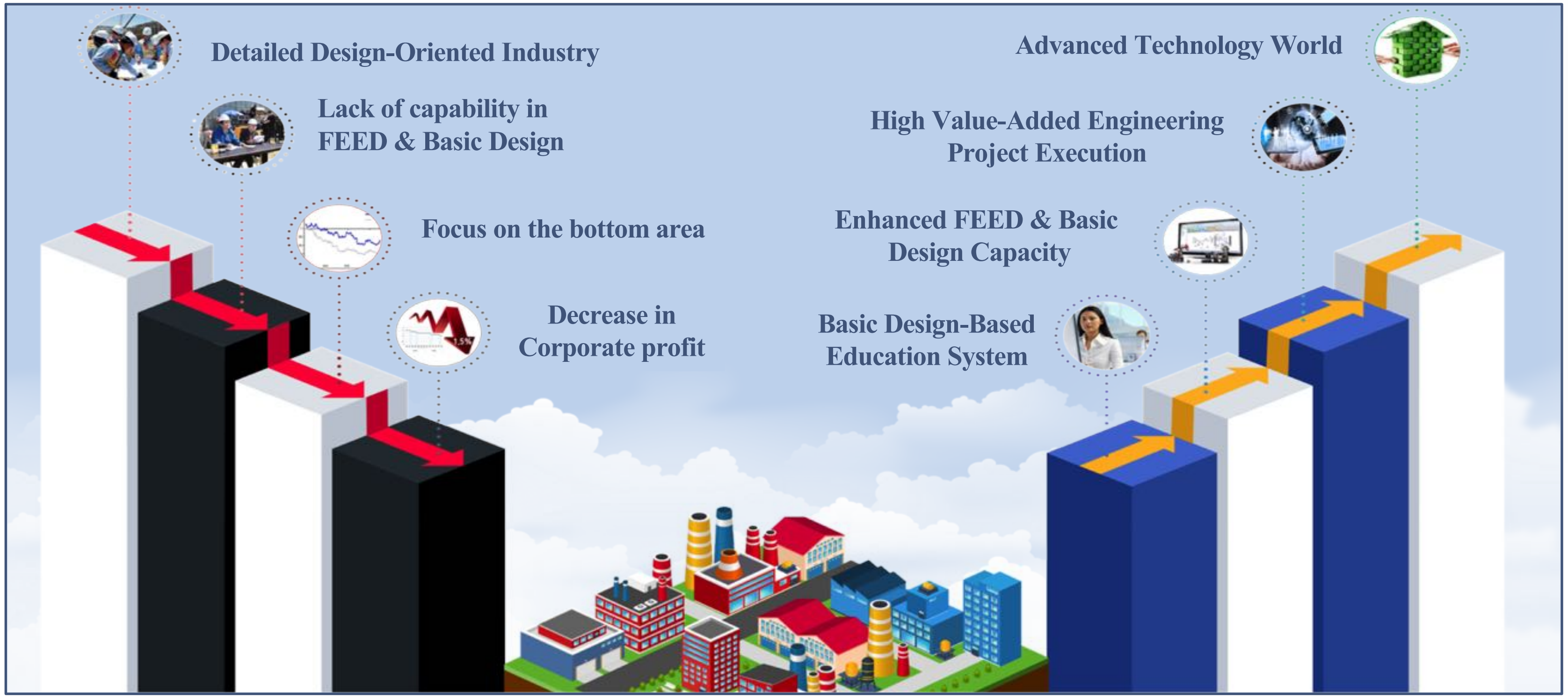
2 R & D needs in the field of upstream design

Optimal and efficient processes are all based on the extensive modelling & simulation work for the process within the limits and criteria.

- Higher FEED capacity may contribute in producing more accurate estimate of the project cost.
- In upstream design there are a lot of factors taken into consideration in design, i.e., Codes & Standards, international & local regulations, site conditions, etc.

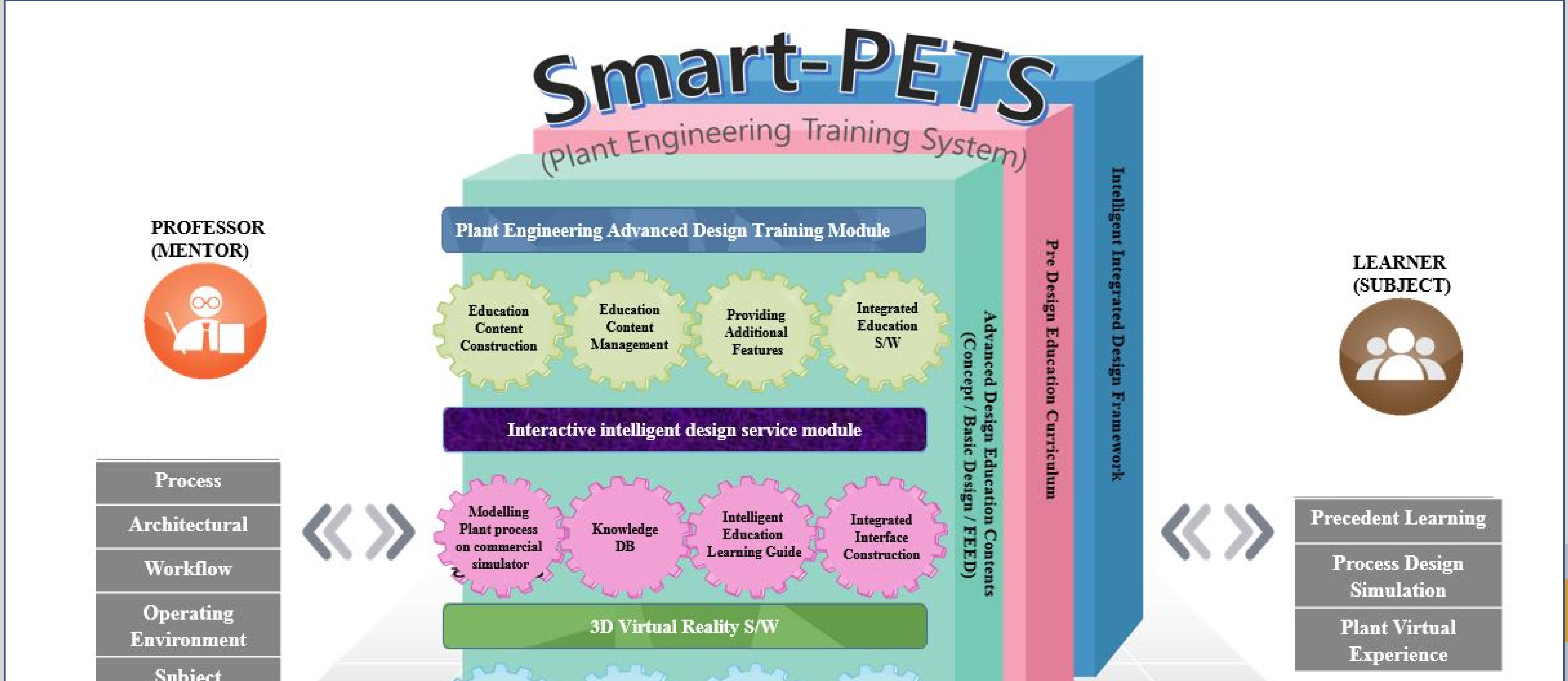
Need for Research (1/2)

- The detailed design and construction capacity, even if it is competitive, is not enough to lead the Owners to the way of profit making projects.
- In the very beginning the level of success or profitability of the project is decided, usually in concept design stage because the way of combination of processes and design & operation factors are decided including operating cost.



Need for Research (2/2)

- Intelligent engineering design education and training system clothed by interactive training environments based on LMS (Learning Management System) and knowledge of design know-how's
- **This project is supported by the Ministry of Commerce, Industry and Energy and the Industrial Technology**
- **Evaluation and Management Service (by KEIT) in 2017 ('10077963')**



Plant Engineering Advanced Design Integrated Training Framework

- Plant engineering for professional workforce training in plant engineering. Leading design Integrated training framework Design considerations
- Intelligent Integrated Design Framework = "Leading Design Course" + "Leading Design Education Content" + "Smart PETS"

Pre-Design Training Course

1. **Educational Objectives**
   1. Educational Objectives
   2. Educational Talent
2. **Educational System**
   1. Educational Method
   2. Educational Solution
   3. Basic Literacy/Fundamentals
3. **Curriculum**
   1. Major, Research, Foundation, Practical training Courses
   2. Designing curriculum
4. **Course**
   1. Individual Syllabus Design
   2. Detailed contents design such as teaching method, S / W utilization plan, case-based practical plan

Advanced design education contents

1. **Conceptual Design**
   1. Preliminary Process Design Basis
   2. Preliminary Process Simulation and H & M Balance Data
   3. Preliminary Process Flow Diagram (PFDs)
2. **Basic Design**
   1. Process Design Basis
   2. Heat & Material Balance (H&MB)
   3. Process Flow Diagram (PFDs)
3. **FEED Package**
   1. General Description of the Project Site
   2. Budget Pricing from Vendors on Major Equipment
   3. Relief System Design Basis

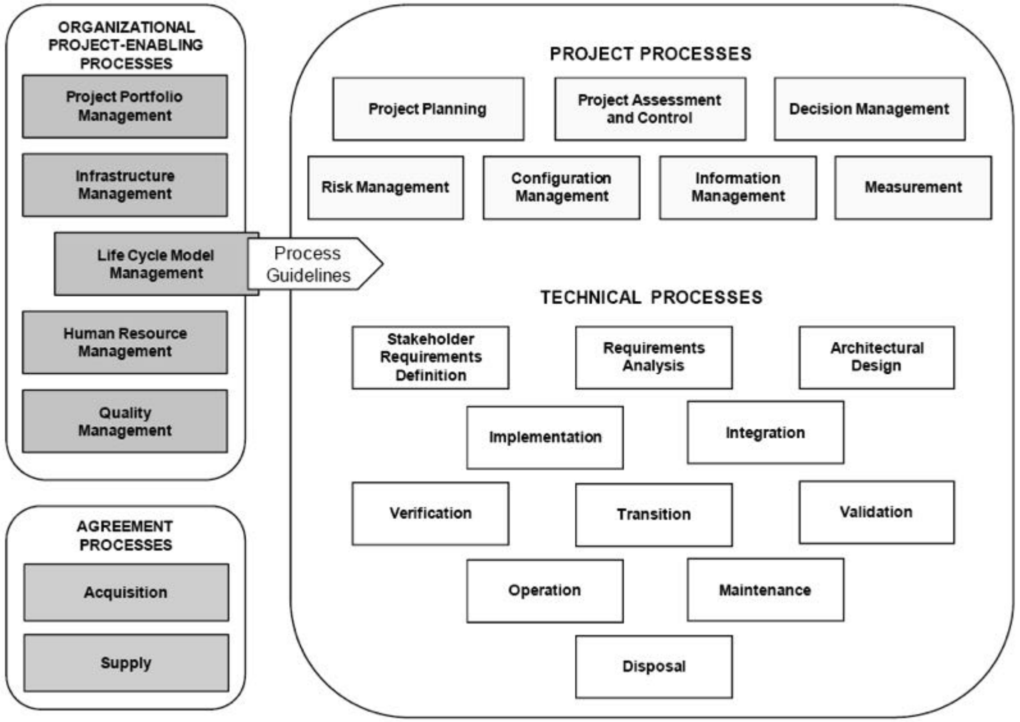
Smart PETS

1. **Interactive Intelligent Design Service**
   1. Modelling of Plant Process Based on Commercial Simulator
   2. Design know-how knowledge base database
   3. Intelligent Education Learning Guide
   4. Integrated interface construction
2. **3D Virtual Reality Service**
   1. 3D Plant Visualization
   2. Visualization of operating conditions
   3. Virtual Machine Manipulation
   4. User Interface
3. **Advanced Design Education Services**
   1. Education contents construction
   2. Educational content management
   3. Providing additional features
   4. Integrated Education S/W

Purpose of Study

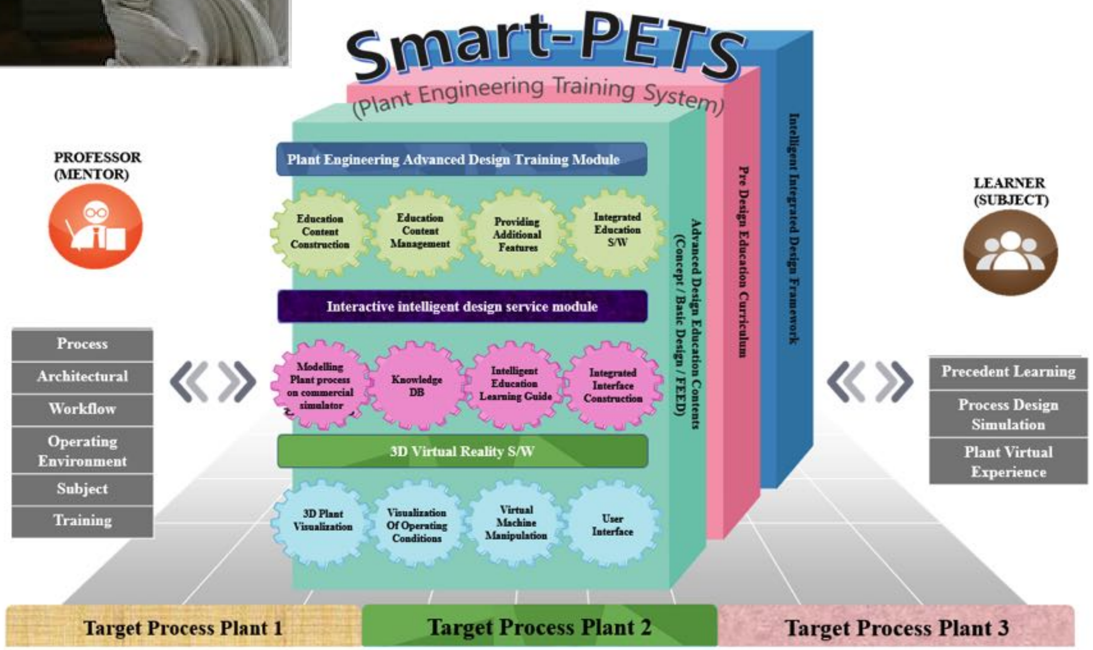
- In this study, for a smart plant engineering education system, systems engineering is used to design an integrated training framework for a plant engineering lead design
- Focus on the systems engineering technology processes

Process of ISO/IEC 15288 standard



Apply to

Smart-PETS



Plant Engineering Advanced Design Integrated Training Framework

- Ideal in developing intelligent FEED training programs of professional workforce training in plant engineering

Technical Process of ISO/IEC 15288 Standard

Technical Processes	Main Activities
Stakeholder Requirements Definition	1. Elicit stakeholder requirements 2. Define stakeholder requirements 3. Analyze and maintain stakeholder requirements
Requirements Analysis	1. Define system requirements 2. Analyze and maintain system requirements
Architectural Design	1. Define the Architecture 2. Analyze and evaluate the architecture 3. Document and maintain the architecture
Implementation	1. Plan the implementation 2. Perform implementation
Integration	1. Plan integration 2. Perform integration
Verification	1. Plan verification 2. Perform verification
Transition	1. Plan the transition 2. Perform the transition
Validation	1. Plan validation 2. Perform validation
Operation	1. Prepare for operation 2. Perform operational activation and check-out 3. Use system for operations 4. Perform operational problem resolution 5. Support the customer
Maintenance	1. Plan maintenance 2. Perform maintenance
Disposal	1. Plan disposal 2. Perform disposal

Tailored to

Tailored SE Process for Intelligent FEED Education Program

Technical Processes		Main Activities
Elicitation of Stakeholder's Requirements		1. Elicit stakeholder requirements 2. Define stakeholder requirements 3. Analyze and maintain stakeholder requirements
Requirements Definition		1. Define system requirements 2. Analyze and maintain system requirements
Architectural Design	Vision and Goal Design	1. Design education vision 2. Design education goals 3. Design education targets talents
	Framework Design	1. Design education philosophy 2. Design education operation concept 3. Design basic knowledge domain 4. Design basic technology domain
	Curriculum Design	1. Design Curriculum concept 2. Design Curriculum detail
	Course Design	1. Design Syllabus 2. Design description, grade of each course
Implementation		1. Develop Course Material 2. Develop practical training program
Integration		1. Assemble education systems
Verification		1. Verify results produced by the course design
Validation		1. Validate results of Curriculum design 2. Validate results of Philosophy design 3. Validate results of Vision and Goal design
Operation		1. Prepare for each course operation 2. Operate each course
Maintenance (Improvement)		1. Evaluate each course 2. Improve each course 3. Improve education curriculum

- Pre Defined Training Course (Vision and Goal Design, Framework Design)
- Advanced design education contents (Curriculum Design, Course Design)
- Smart PETS (Implementation, Integration, Verification, Validation)
- Pilot Project (Operation, Maintenance (Improvement))

Smart Plant Engineering Education Program Stakeholders

Stakeholder Defining Requirements process	System Defining Requirements process	Architecture Design Process				Implementation process	Integration Process	Verification process	Confirmation Process	Operation Process	Maintenance process
		Vision, purpose of promotion, Talent design	Educational System Design	Curriculum Design	Course Design						

Ministry of Commerce, Industry and Energy and the Industrial Technology

Keit
Korean Evaluation Institute of Industrial Technology

KENCA
Korean Engineering & Consulting Association

KOPIA
Korean Plant Industries Association

...

Developed Intelligent Advanced Design Education Program

Hyundai Oilbank

KEPCO
Korean Electric Power Cooperation

SAMSUNG
Samsung Heavy Industries Co., Ltd.

...

SOLTWORKS Solutions for you

...

PSE

POSTECH
Pohang Uni. of Science & Technology

Seoul National Uni.

Yonsei Uni.

...

Collecting stakeholder requirements

Stakeholder Defining Requirements process	System Defining Requirements process	Architecture Design Process				Implementation process	Integration Process	Verification process	Confirmation Process	Operation Process	Maintenance process
		Vision, purpose of promotion, Talent design	Educational System Design	Curriculum Design	Course Design						

	Name	Date	Key Stakeholders
VOC Meeting	1st VOC meeting	2017.01.20	Government agencies, engineering associations, engineering industries (Hyundai Oilbank, SK Innovation etc.)
	2nd VOC meeting	2017.02.24	Seoul National University Engineering Development Research Center (EDRC)
	3rd VOC meeting	2017.03.04	Seoul National University Engineering Project Management(EPM) , Hyundai Engineering
	4th VOC meeting	2017.04.09	Hyundai Oilbank
	5th VOC meeting	2017.05.18	Hyundai Oilbank Engineer, Hyundai Engineering
Workshop	1st Workshop	2017.01.20	Government agencies, engineering associations, engineering industries (Hyundai Oilbank, SK Innovation etc.)
	2nd Workshop	2017.07.26	Engineering companies (Hyundai Oilbank, SK Innovation etc.), IT related companies (Solt Works, PSE Korea), Universities (POSTECH, Seoul National University, Yonsei University)
	3rd Workshop	2017.08.30	Engineering companies (Hyundai Oilbank, SK Innovation etc.), IT related companies (Solt Works, PSE Korea), Universities (POSTECH, Seoul National University, Yonsei University)
	4th Workshop	2017.09.15-16	Engineering companies (Hyundai Oilbank, SK Innovation etc.), IT related companies (Solt Works, PSE Korea), Universities (POSTECH, Seoul National University, Yonsei University)
	5th Workshop	2017.10.19-20	Engineering companies (Hyundai Oilbank, SK Innovation etc.), IT related companies (Solt Works, PSE Korea), Universities (POSTECH, Seoul National University, Yonsei University)
	...	...	...
More than 10 VOC meetings and workshops with key stakeholders for approximately nine months from January 20, 2017			

Stakeholder requirements Example

Stakeholder Defining Requirements process	System Defining Requirements process	Architecture Design Process				Implementation process	Integration Process	Verification process	Confirmation Process	Operation Process	Maintenance process
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Name	Description	Type	Source
Preliminary design Educational contents development	Development of know-how knowledge base related to major equipment and instruments for each process and development of bi-directional intelligent algorithm for learner to recognize various situations that may occur during design process and present customized guide according to the situation and guide correct design	**Complex**	**VOC Meeting & Workshop**
Interactive intelligent Design service module development	Developed a module that can acquire knowledge-based design know-how from the conceptual design, basic design, FEED design, 3D virtual plant,	**Complex**	
Preliminary design Curriculum Development	Establish curriculum for designing chemical plant such as plant process basis, FEED field design standard code, FEED execution procedure, technical / economic assurance, etc., and develop subject contents and educational contents such as content and level	**Complex**	
Intelligent Integrated Design Framework Development	Designing the leading design process for each type of plant, structuring input / output elements for each process step, and designing educational elements for each of them, and designing and evaluating courses and curriculums	**Function**	
Project Period	From April 1, 2017 to 45 months, to December 31, 2019	**Constraint**	**RFP for "Plant Engineering Nurturing the experts of advanced design Development of Intelligent Integrated Design Education System "**
…	…	…	

System Requirements Example

Stakeholder Defining Requirements process	System Defining Requirements process	Architecture Design Process				Implementation process	Integration Process	Verification process	Confirmation Process	Operation Process	Maintenance process
		Vision, purpose of promotion, Talent design	Educational System Design	Curriculum Design	Course Design						

Name	Description	Type
Commercial S / W linkage	The intelligent education system should be able to link with the commercial simulator (g-PROMS)	Function
Provide related Devices	The intelligent education system should provide related equipment to be used in plant design education using VR.	Complex
Commercial S / W linkage	The intelligent education system should be able to link with the use VR.	Function
3D	The intelligent education service should visually provide the user designed plant in 3D virtual environment in S / W virtual environment.	Function
Data Information	Intelligent education services should provide information and type of input / output data.	Complex
Unit process information	Intelligent education services should provide unit process information.	Function
Connection Information	The intelligent education system should provide connection information between unit processes	Function
Parameter information	Intelligent education services should provide information on variables and parameters.	Function

Architecture Design Process

Stakeholder Defining Requirements process	System Defining Requirements process	Architecture Design Process				Implementation process	Integration Process	Verification process	Confirmation Process	Operation Process	Maintenance process
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Vision

Smart-PETS (Smart Plant Engineering Training)

Goals

- Global FEED Competency Training
- Advanced FFED technology Educational Platform Development

Target Talents

Technology center	Field-oriented	Problem-solving center
High technical expertise Engineering talent	With the theory Talented people who have practical competitiveness	A talented person who solves a technical problem creatively

Architecture Design Process

Stakeholder Defining Requirements process	System Defining Requirements process	Architecture Design Process				Implementation process	Integration Process	Verification process	Confirmation Process	Operation Process	Maintenance process
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Target Talents

- In-depth domain speciality
- Field implementation capability
- Experiential Learning capability

Education Methods

Apprenticeship education, Interactive training, Virtual Design training, Case-base learning, Problem-solving learning, Modularized training, Commercial package Linkage

Smart Pant Engineering Training System

Education Subject

Conceptual Design
- Preliminary Process Design Basis
- Preliminary Process Simulation and HB & MB
- Preliminary Process Flow Diagram (PFDs)
- …

Basic Design
- Process Design Basis
- Heat & Material Balance (HB&MB)
- Process Flow Diagram (PFDs)
- …

FEED
- Preliminary General Arrangement Drawings
- Preliminary Building Requirements
- General Description of the Project Site
- …

Design field: Conceptual Design, Basic Design, FEED

Educational Infra.: On / off-line (LMS) training, Virtual design(3D Simulator), Commercial software connection …

Architecture Design Process

Stakeholder Defining Requirements process	System Defining Requirements process	Architecture Design Process				Implementation process	Integration Process	Verification process	Confirmation Process	Operation Process	Maintenance process
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Smart-PETS

Object	Petroleum and oil companies Graduate students related to chemistry		
Stage	Conceptual design	Basic design	FEED
Beginner	Conceptual Design Basic Principles and Understanding - Preliminary Process Design Basis - Preliminary Equipment List	Basic design basic principles and understanding - Process Descriptions …	FEED Basic design principles and understanding - Preliminary Building Requirements …
Intermediate grade	Sequence and practice of concept design - Preliminary Process Flow Diagram(PFDs) - Preliminary Process Simulation and H & M Balance Data …	Basic Design Procedure and Practice - Preliminary Tie-in List …	FEED Design Procedure and Practice - Process specialty Items List …
High Class	Troubleshooting Conceptual Design Issues - Preliminary Capital & Operating Cost Estimate (±50%/-30%) …	Troubleshoot basic design issues - Hydraulic Design Reports …	Troubleshooting FEED design issues - Process Risk Analysis …
Remarks			

Architecture Design Process

Stakeholder Defining Requirements process	System Defining Requirements process	Architecture Design Process				Implementation process	Integration Process	Verification process	Confirmation Process	Operation Process	Maintenance process
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Terminology	Description
S (Self-directed)	-Intelligence -Self-learning system through diagnosis and prescription of online achievement
M (Motivated)	-Experiential Learning Creative Problem Solving and Process-oriented personalized assessment pursuit
A (Adaptive)	-Flexibility -Increased flexibility of the education system and individualized learning that matches the level and aptitude of students
R (Resource Enriched)	-Social networking -Expansion of collaborative learning and cooperative learning of domestic and overseas learning recourses using collective intelligence -Social learning etc
T (Technology Embedded)	-Openness -Educational environment in which information can be learned anytime, anywhere, and teaching methods are diversified and learning options are maximized

Architecture Design Process

Stakeholder Defining Requirements process	System Defining Requirements process	Architecture Design Process				Implementation process	Integration Process	Verification process	Confirmation Process	Operation Process	Maintenance process
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1 Curriculum

Conceptual Design

Basic Design

FEED

Foundation course(A to B)

Intermediate course(C to D)

Advanced course D to E)

2 Course Description

Chemical Process Simulation

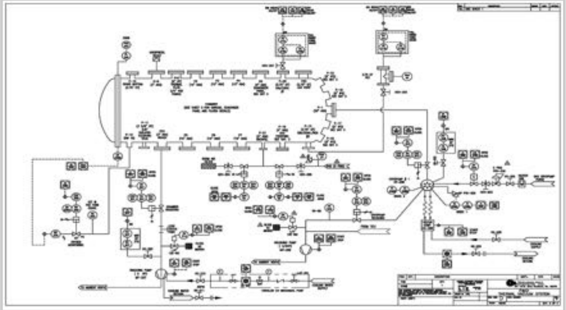
GEM623 Chemical Process Simulation(3-1-3)
This course teaches how to simulate various chemical and biological processes using Process simulation software. Students will make process models and find an optimal solution to ,maximize profits and minimize risks using model built. To fill the gap between theories and actual practices, students participate in a number of chemical

GEM627 Chemical Process Optimization(3-1-3)
This course teaches how to formulate optimization problems and solve the problems. It also deals with single and multiple variable optimizations under constraints. To fill the gap between theories and actual practices, students participate in a number of chemical process optimization practice to increase the ability for real world

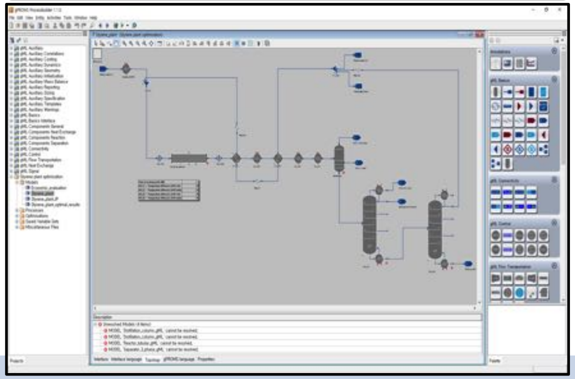
GEM628 Chemical Device Design(3-1-3)
This course teaches how to understand the principles of operation of the various unit operations and design such as reactors, distillation columns, absorption towers, heat exchangers, pumps, etc in the actual chemical process. It also investigates the phenomena occurring in each operation and deals with the problems of determining the optimal device at minimum cost. To fill the gap between theories and actual practices, students participate in a number of chemical equipment design software to improve the ability for real-world applications.

3 How to learn

Engineering and Design

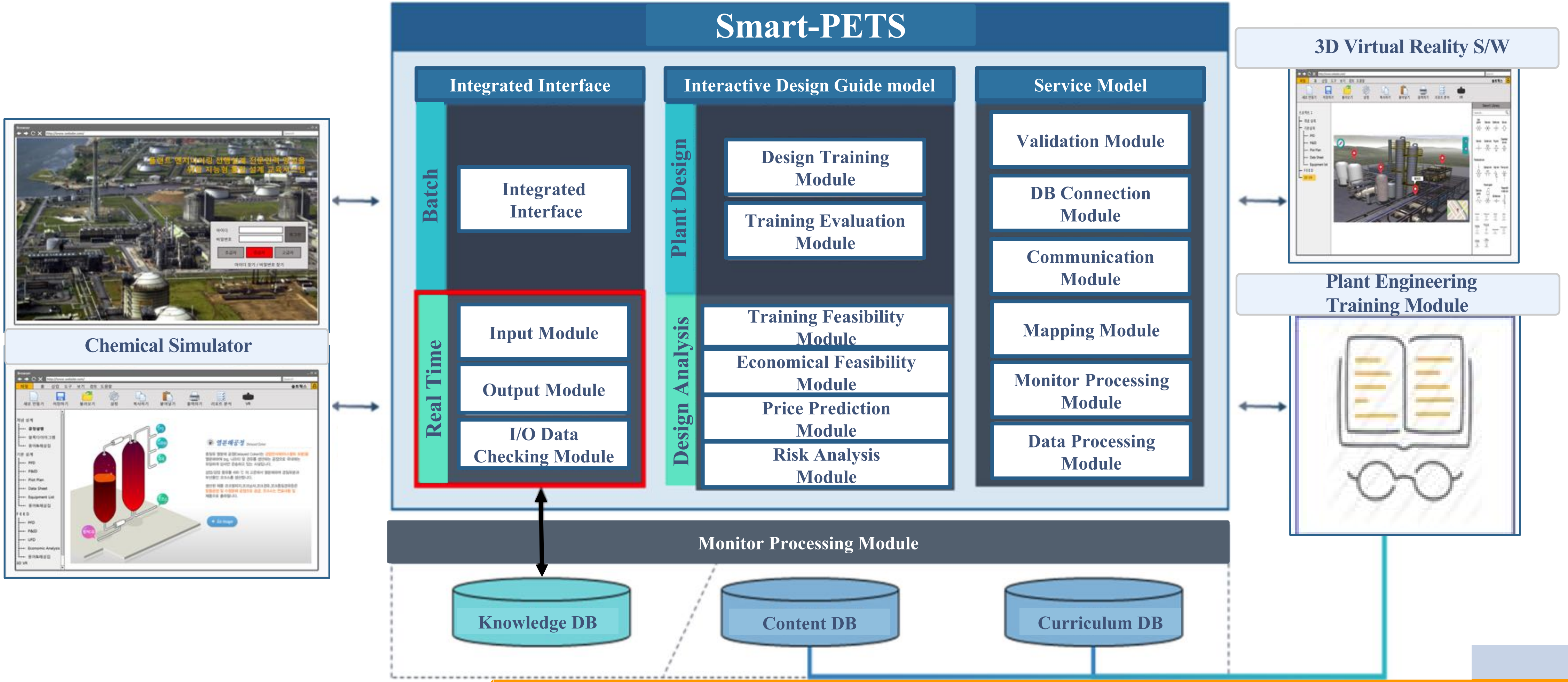


Simulation tool



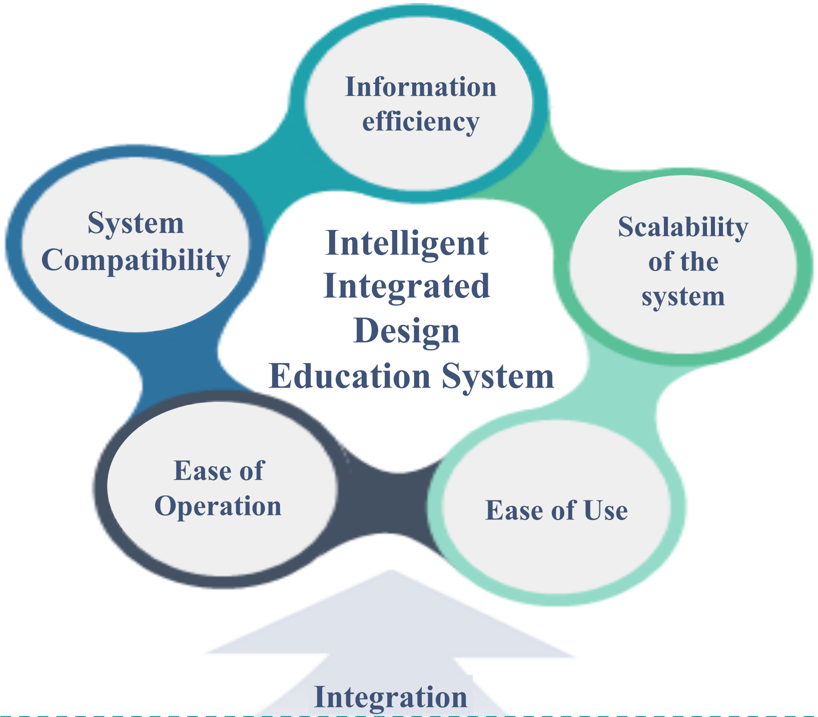
Implementation Process

Stakeholder Defining Requirements process | System Defining Requirements process | Architecture Design Process (Vision, purpose of promotion, Talent design; Educational System Design; Curriculum Design; Course Design) | Implementation process | Integration Process | Verification process | Confirmation Process | Operation Process | Maintenance process



Integration Process

Stakeholder Defining Requirements process | System Defining Requirements process | Architecture Design Process (Vision, purpose of promotion, Talent design; Educational System Design; Curriculum Design; Course Design) | Implementation process | **Integration Process** | Verification process | Confirmation Process | Operation Process | Maintenance process



Is it the bat or the boy ?

Application System

- User oriented system implementation
- Standardized system implementation
- Integrate Interface Implementation

Operating Environment

- Standardization of development environment
- System Distributed Processing
- Integrated Management

Information Technology

- Leverage standard Web Technology
- Distributed Processing Technology
- Open system environment
- Distributed Processing

Operating Environment

- User-centered design
- Seamless sharing of Information
- Responding to changes in the technological environment

Verification Process

Stakeholder Defining Requirements process | System Defining Requirements process | Architecture Design Process (Vision, purpose of promotion, Talent design; Educational System Design; Curriculum Design; Course Design) | Implementation process | Integration Process | **Verification process** | Confirmation Process | Operation Process | Maintenance process

1. Analysis

1. Requirement Analysis
1. Performance Verification Requirement Analysis
2. Defining Performance Verification Requirements

2.Establish a Project Execution Plan
1. Applied Technology Review
2. Scheduling
3. Establishment of Input Resource plan

2. Design

1. Performance Goals
1.Target Performance Difference Estimation

2. Implementation Procedure
1. Plan Performance Verification Process
2. Performance Verification Conditions
3. Resource Monitoring Plan

3. Script Design
1. Performance Verification Scenario Design
2. Performance Verification Test Data Explanation
3. Create performance Verification Script

3.Implementation

1. Unit Test
1.Performing Unity Verification
2. Unit Performance Verification Analysis

Perform Performance test and performance diagnosis for individual tasks and analyze the result

2. Integration Test
1. Perform integrated Performance verification
2. Integrated performance Verification analysis

Analyze the results by performing the integration performance verification by opening the entire system

3. Critical Test
1. Threshold Performance Verification
2. Critical Performance Verification analysis

Performance of peak load condition peak performance

4. Evaluation

1. Report Result
1.Creating the result report

Outputs

1. Requirement analysis definition
2. Applied technology review
3. Schedule Planning Form
4. Input Resource Plan

1. Target Performance Estimates
2. Performance Verification Procedure / Condition Plan
3. Performance verification Scenario
4. Explanation of Test Data
5. Performance verification Script

1. Unit Test Execution / Analysis
2. Integrated Test Execution / Analysis
3. Critical Test Execution / Analysis

Unit / Integration / Critical Performance Verification Report

Confirmation Process

Stakeholder Defining Requirements process	System Defining Requirements process	Architecture Design Process				Implementation process	Integration Process	Verification process	Confirmation Process	Operation Process	Maintenance process
		Vision, purpose of promotion, Talent design	Educational System Design	Curriculum Design	Course Design						

Purpose

- Improves applicant's quality and shortens system development time by early detection, correction and supplementation of risk factors and errors
- Improvement of development system quality by verifying, correcting and supplementing the program through which meets the performance and quality required by the design
- Accurate execution of programs to be operated in future system construction and guarantee performance of required functions

Application Policy

Unit test

- Function test , execution path and error processing test in the program, boundary test, interface test between other programs

Integration Test

- Interface function and performance test between systems
- Testing software and hardware networks that support integration systems under development environment

User Test

- In the actual operating environment, select the test information center, test conducted with the participation of user

Operation Process

Stakeholder Defining Requirements process	System Defining Requirements process	Architecture Design Process				Implementation process	Integration Process	Verification process	Confirmation Process	Operation Process	Maintenance process
		Vision, purpose of promotion, Talent design	Educational System Design	Curriculum Design	Course Design						

Pilot Operation & Verification

Object

POSTECH, Seoul National University Graduate School of Engineering Practice (서울대학교 공학전문대학원), Hyundai Oilbank

Curriculum

- Establishment of short-term / long-term curriculum (POSTECH Engineering Graduate School, Seoul National University Graduate School of Engineering)
- New employee training course using summer / winter term
- Establishment of short-term training course for corporate customers (Hyundai Oilbank, etc.)

S/W

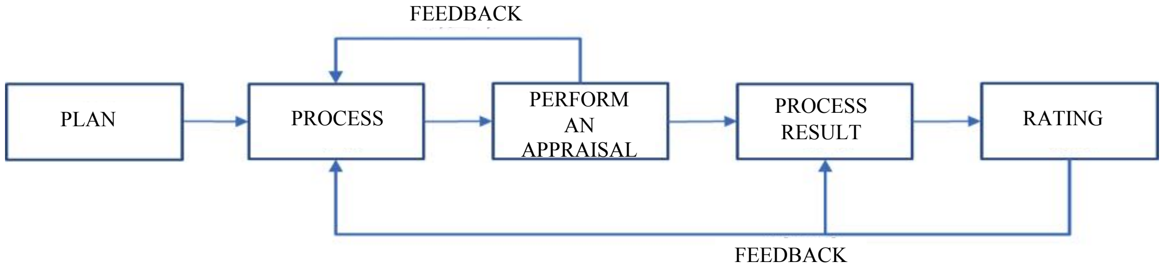
- Providing online / offline training
- Provide interactive design education system
  - Powered by the same system as a commercial simulator
  - Provide 3D virtual plant learning
  - LMS (Learning Management System) System application

Maintenance Process

Stakeholder Defining Requirements process | System Defining Requirements process | Architecture Design Process (Vision, purpose of promotion, Talent design; Educational System Design; Curriculum Design; Course Design) | Implementation process | Integration Process | Verification process | Confirmation Process | Operation Process | **Maintenance process**

Evaluation

- **Establish and operate a self-evaluation committee during the pilot period**
- **Establish and operate a self-assessment plan so that an autonomous quality management system can be implemented through feedback in real time**



CQI (Continuous Quality Improvement) using the concept of self-assessment

Detail

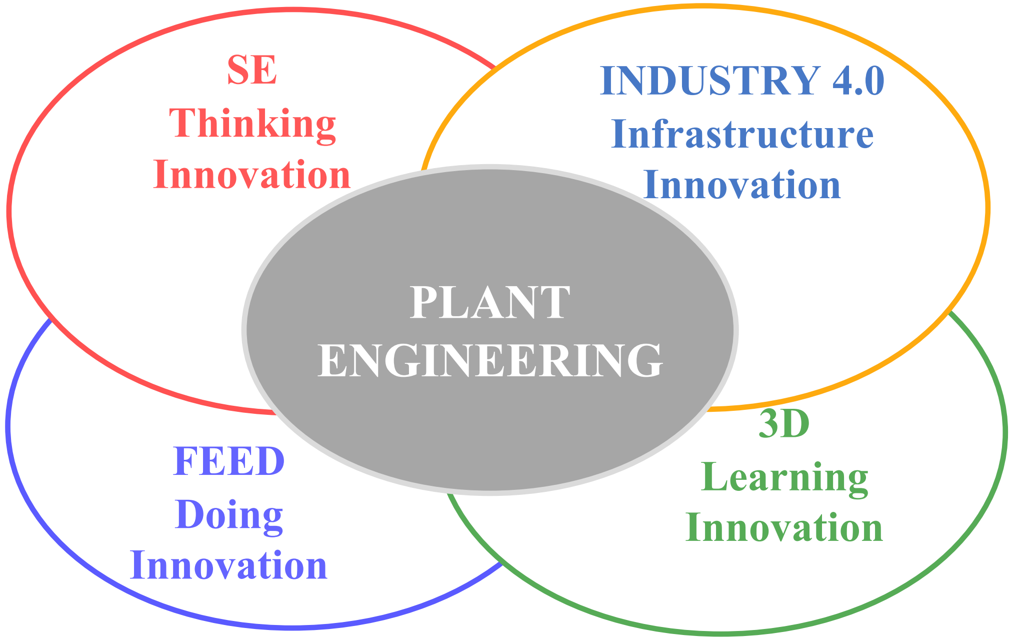
- **Detailed evaluation items**

Performance Goals	Performance Goals	Performance index	Evaluation Standard	Reflects the results of the analysis
○ Lecture Evaluation (4.0 or higher / 5.0 million)	○ Lecture Evaluation (4.0 or higher / 5.0 million)	○ Content Satisfaction ○ 3D virtual simulator satisfaction ○ Teacher's Teaching skill/method Satisfaction	○ Expertise of course content ○ Reflecting the content of lecture contents ○ Relevance of lecture topic ○ 3D simulator utilization	○ Change of curriculum after deliberation by self evaluation committee according to lecture evaluation

- **Verification and security system through pilot operation**

Conclusion

- Using system engineering to design a plant engineering leading design integrated training framework.
- To improve competitiveness of plant Engineering Industry
- Applying and developing the proposed integrated framework to smart plant engineering education system.
- This research is supported by the research fund of the **Ministry of Industry, Commerce, and Energy Industry (MOICEI: KEIT) in 2017 ('10077963').**



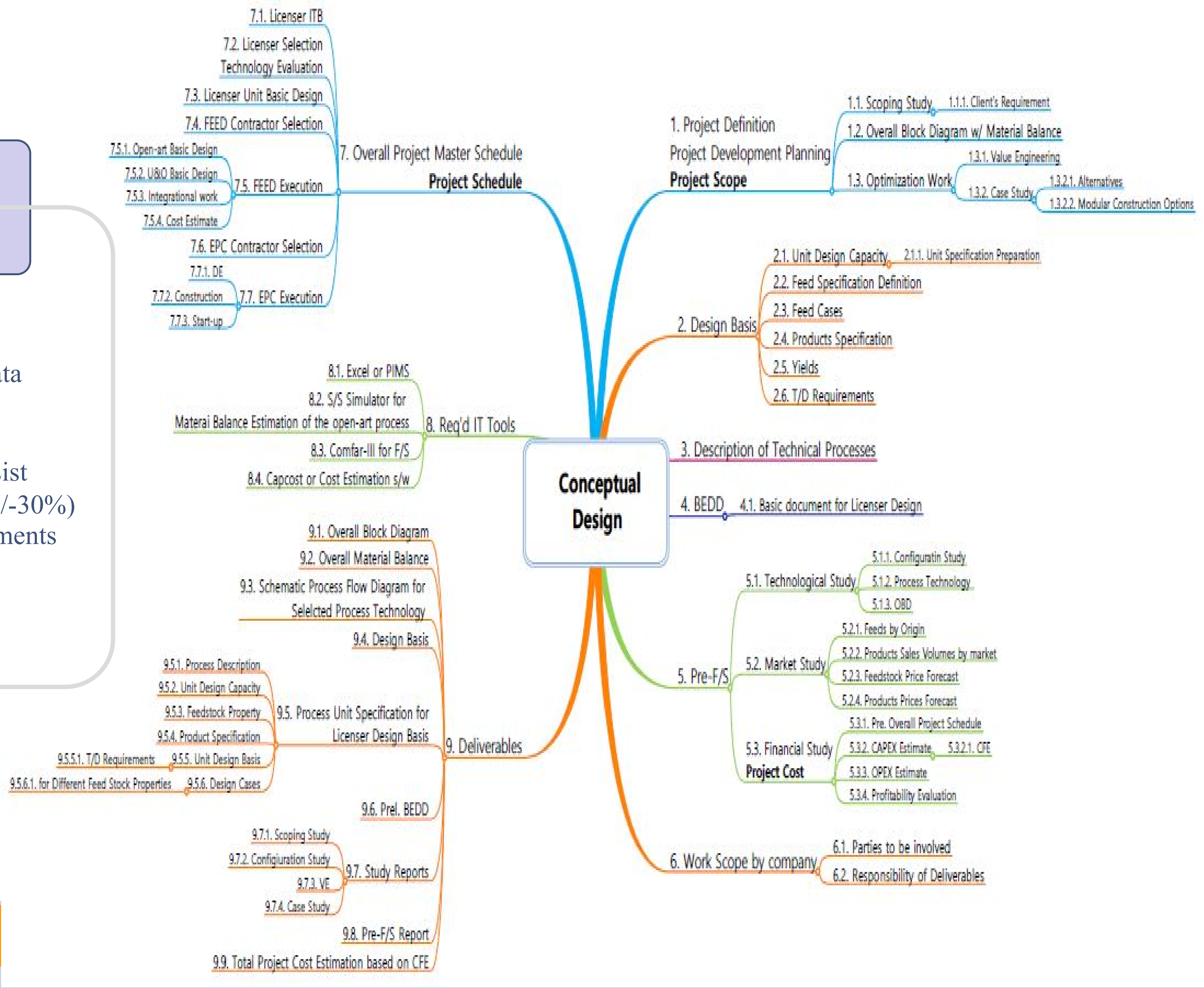
Thank you

Q&A

Appendix 1

Conceptual Design

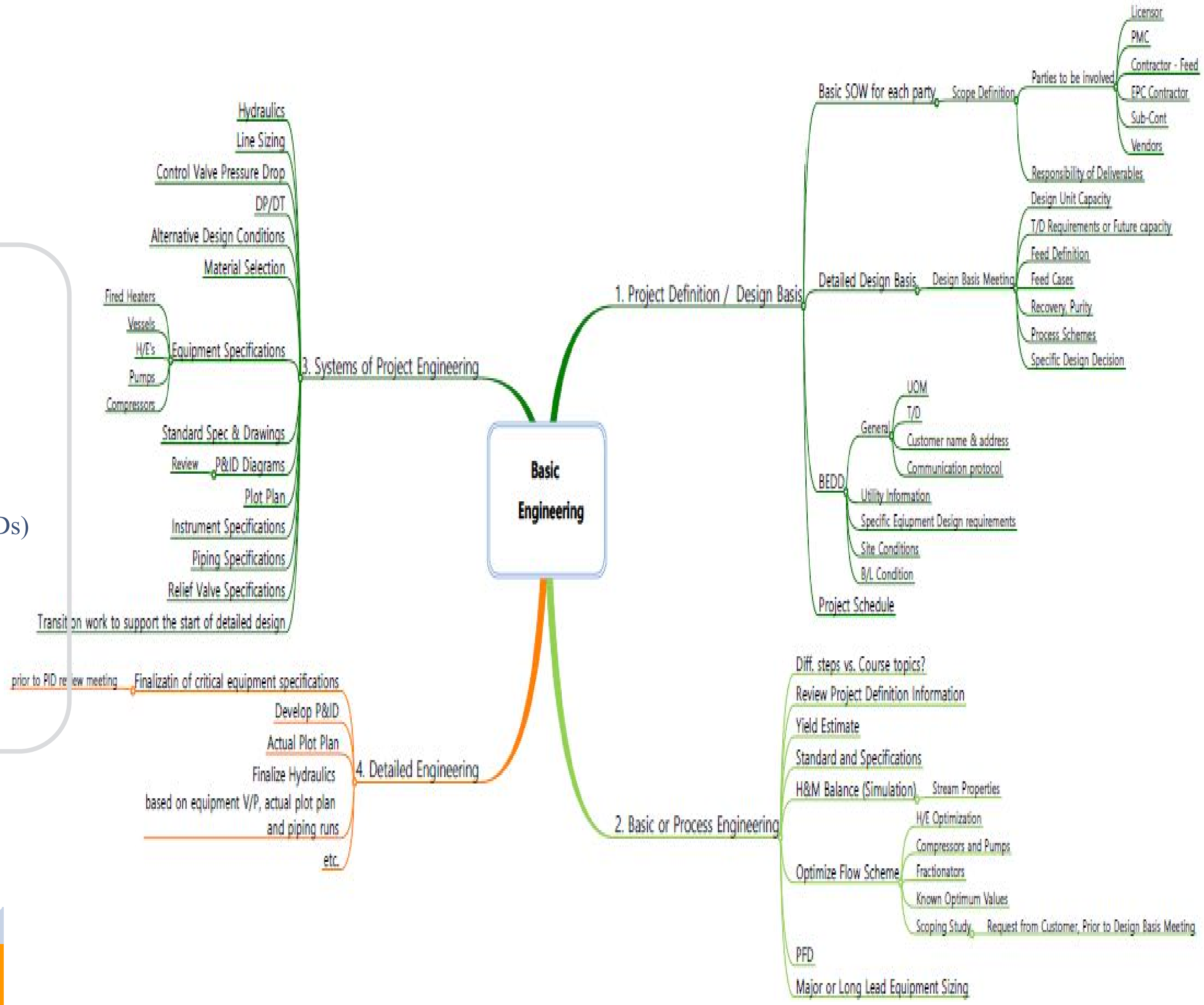
- Pre- Process Design Basis
- Pre- Process Simulation and H & M Balance Data
- Pre- Process Flow Diagram (PFDs)
- Pre- Equipment List
- Pre- Major Equipment Conditions of Service List
- Pre- Capital & Operating Cost Estimate (±50%/-30%)
- Pre- Summary of Raw Materials & Uti. Requirements
- Process Risk summary



Appendix 2

Basic Design

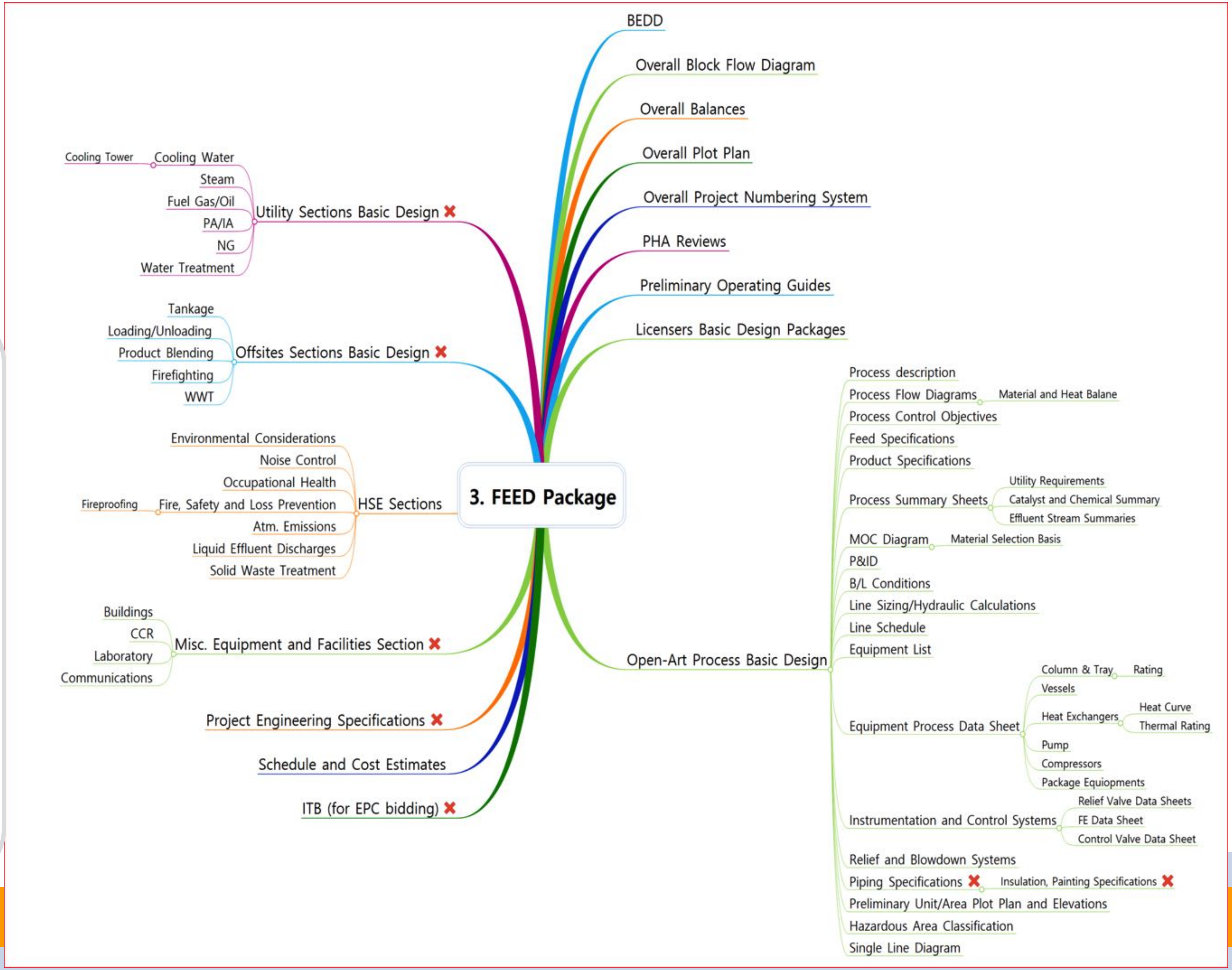
- Process Design Basis
- Heat & Material Balance (H&MB)
- Process Flow Diagram (PFDs)
- Process Descriptions
- Utility Balance & Utility Flow Diagram (UFDs)
- Preliminary Piping & Instrument Diagrams (P&IDs)
- Process Control Descriptions
- Preliminary Tie-in List
- Equipment Process Data Sheets
- Instrument Process Data Sheets
- Hydraulic Design Reports



Appendix 3

FEED

- Preliminary General Arrangement Drawings
- Preliminary Building Requirements
- General Description of the Project Site
- Budget Pricing from Vendors on Major Equip.
- Process Design Philosophies
- Relief System Design Basis
- Relief Scenario Datasheets & Relief Valve
- Process Datasheets
- Material Selection Diagrams (MSDs) & Piping Spec
- Tie-in List
- Identification of Power Source and Location
- Preliminary Single Line Diagrams
- Process specialty Items List
- Raw Mat'l, Product Storage & Handling Reqmts
- Process Effluent and Emissions Summary
- Process Risk Analysis (PHA/HAZOP/HAZID)
- Preliminary Operation Procedures
- Preliminary Project Schedule
- Preliminary Product & In-Process QC
- Sampling/Testing Plan



Training Content – Overall engineering