MSIE 4.0

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Course #3: Smart Operations Management

Curriculum Development
of Master's Degree Program in
Industrial Engineering for Thailand Sustainable Smart Industry

Course Objective

To develop competences on design and implementation of continuous and efficient operations while creating a digital copy of the end-to-end process. Using real world data to understand, evaluate, and simulate the end-to-end operation to improve and manage all operations efficiently. Emphasis is on cross-enterprise integration of the physical and virtual systems among various functions including operation strategy, process design, capacity planning, facility location and design, forecasting, production scheduling and inventory control.

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Learning Outcomes

- Apply knowledge and methods from the advanced science of industrial engineering to model, evaluate and improve industrial processes and systems in relation with company operating efficiency and customer service.
- Implement smart production concepts in planning and controlling company's operations.
- Utilize real time data analytics and software systems to support planning, scheduling and control of smart production processes and systems.
- Manage smart production processes and systems to efficiently respond to changes in operating conditions.

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Course Outline

- **Module 1**

  Advanced science of industrial engineering to model, evaluate and improve industrial processes and systems

- **Module 2**

  Smart production in planning and controlling company's operations integrated production planning and shop-flow control system concept

- **Module 3**

  Real time data analytics and software systems to support planning, scheduling and control of smart production processes and systems

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Module 1: Outline

Advanced science of industrial engineering to model, evaluate and improve industrial processes and systems

1.1 Operation management strategy in industry 4.0 context

1.2 Smart manufacturing concept

1.3 Smart operation concept

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Module 1: Teaching methods

- Various teaching methods were used in this module including;
  - Lecture
  - Group discussion
  - Workshop
  - Online game via kahoot.it
- This module consists of three workshops
  - Workshop I: Discussion of impact of industry 4.0 on modern operation management in strategic level
  - Workshop II: Impact of smart product in modern digital environment
  - Workshop III: Design smart manufacturing for sugar production process

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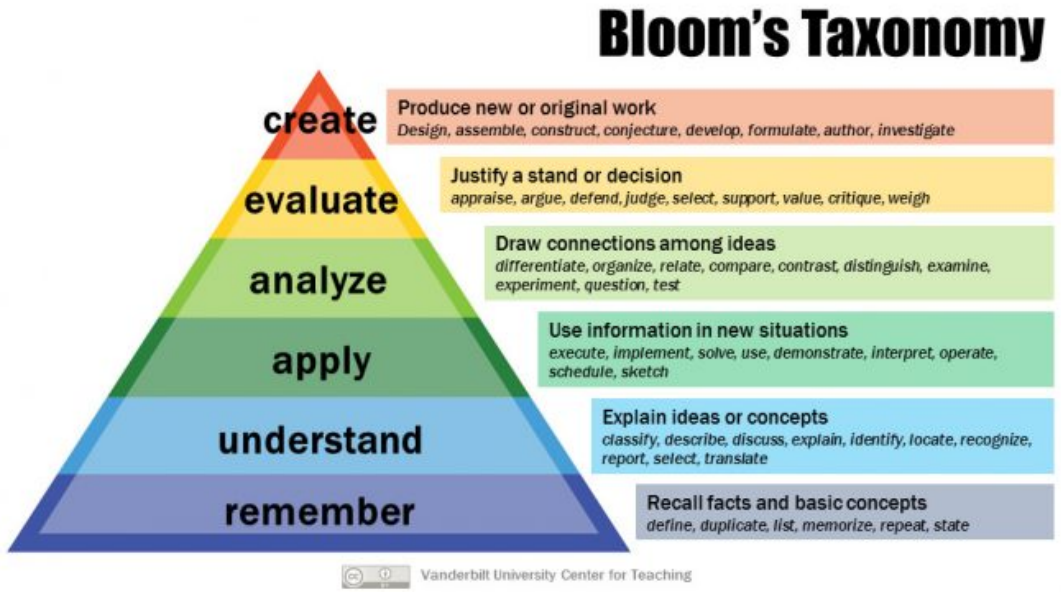
Workshop I: Discussion of impact of industry 4.0 on modern operation management in strategic level

- This workshop is a group discussion that consists of 6 questions designed according to Bloom's Taxonomy.



1. Pick one of the operation management task
2. Describe the operation management task that you picked
3. Propose a new system that apply industry 4 technologies to that operation management task?
4. What impact do they have on operation management?
5. What kind of organization could benefit the most from you proposed system?
6. Develop a diagram/flowchart of your proposed system.

Source: https://cft.vanderbilt.edu/guides-sub-pages/blooms-taxonomy/

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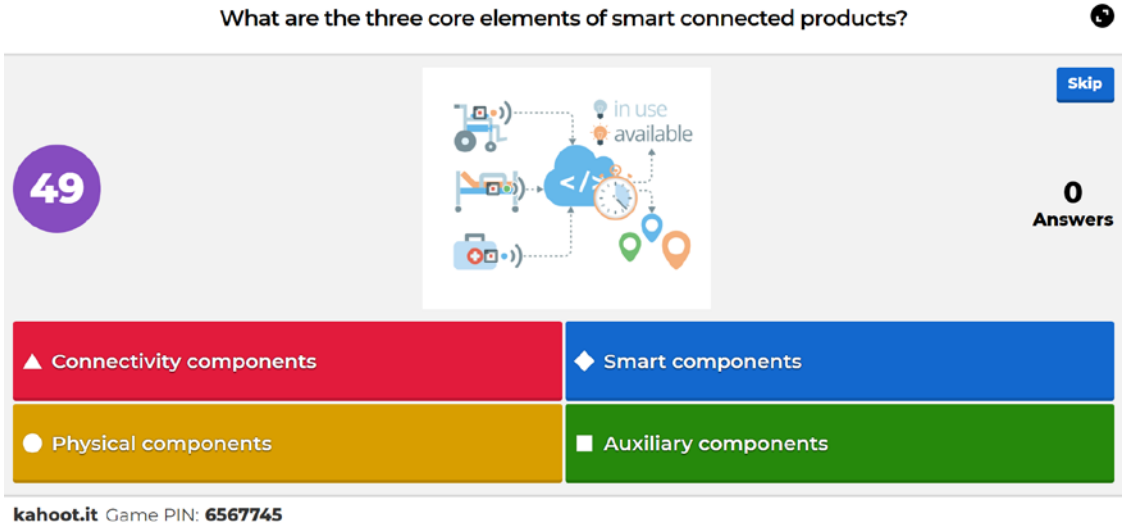
Workshop II: Impact of smart product in modern digital environment

- In this workshop, students are assigned to read “Porter, Michael E., and James E. Heppelmann. "How Smart, Connected Products Are Transforming Competition." Harvard Business Review 92, no. 11 (November 2014): 64–88.”
- Then students have to play Kahoot’s game that consist of 17 questions.



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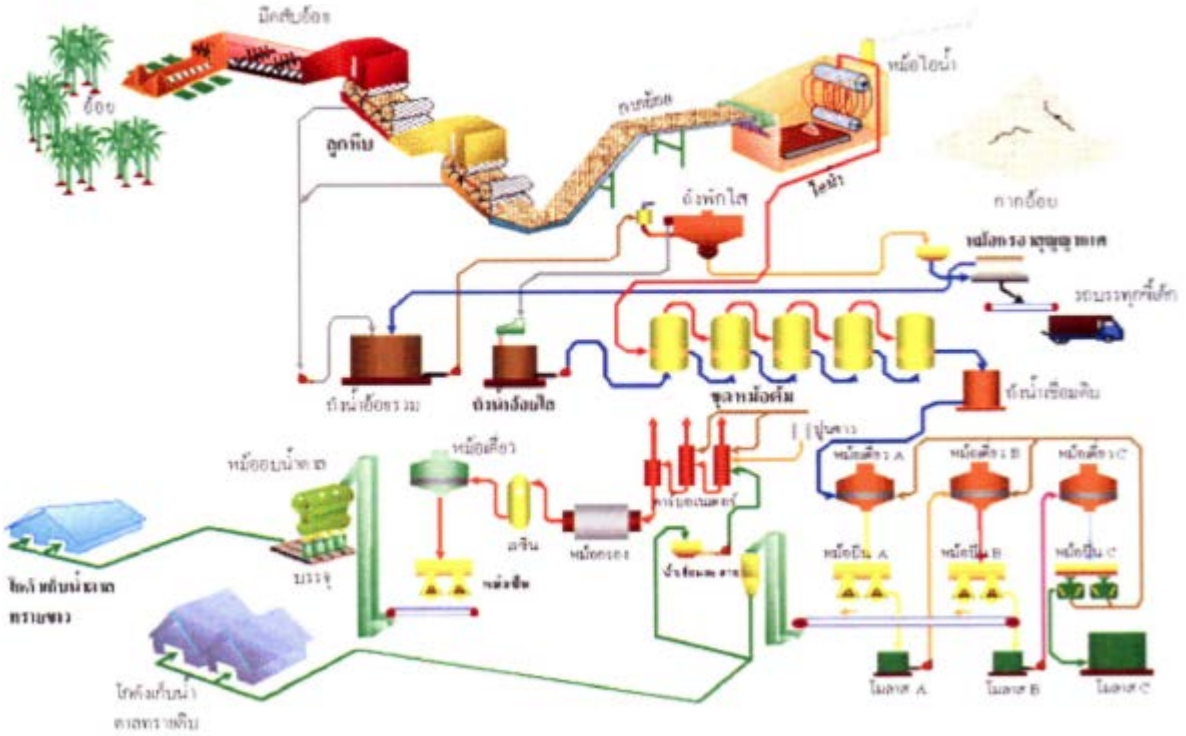
Workshop III: Design smart manufacturing for sugar production process

- The students are given process flow diagrams and details of each process in sugar production process
- The students work as a group of 2 or 3 to design a smart manufacturing model for sugar
- Each group presents the designed model

Sugar production process



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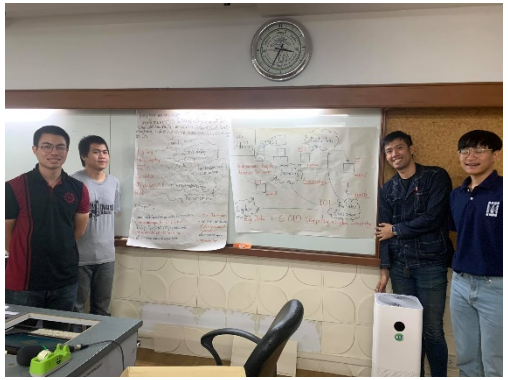
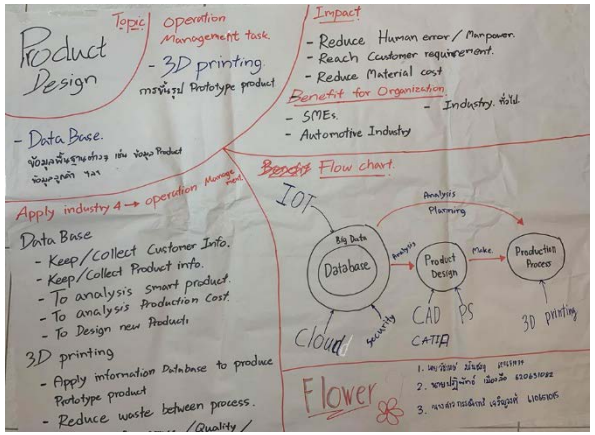
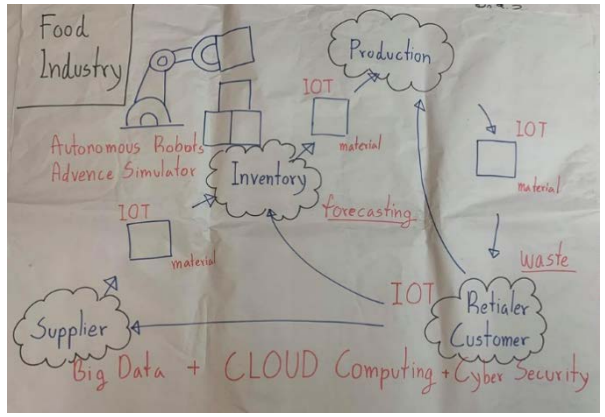
Module 1: Outcome of workshop I

- 10 Students were divided into 3 groups

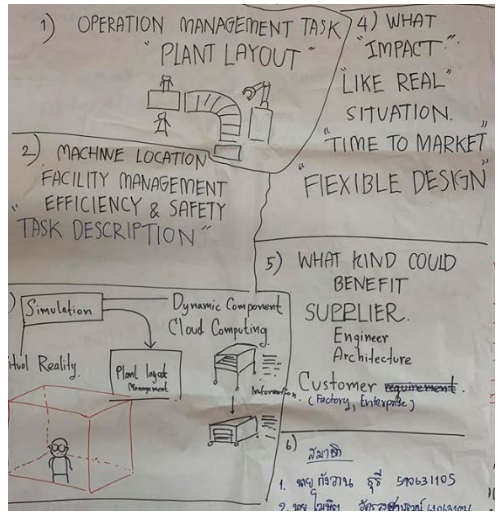




Industry 4.0 Technology in product design



Industry 4.0 Technology in inventory management



Industry 4.0 Technology in layout design

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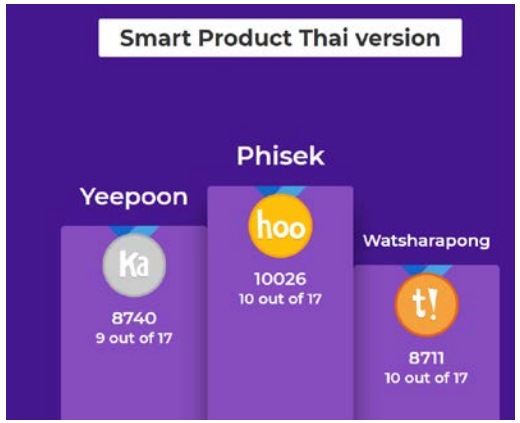
Module 1: Outcome of workshop II

- Kahoot game result
  - 10 students joined the quiz of 17 questions
  - 47.06% of total correct answer
  - The highest score is 10026 (10 correct answers)
  - The average score is 7395.7



All (10) | Need help (1) | Didn't finish (10) | Search

Nickname	Rank	Correct answers	Unanswered	Final score
Phisek	1	58%	2	10 026
Yeepoon	2	52%	2	8 740
Watsharapong	3	58%	2	8 711
Chaichana	4	47%	2	7 555
Soithong084	5	52%	2	7 177
Suphanat	6	47%	2	7 147
Kosit	7	47%	2	7 007
pisit	8	41%	2	6 842
Patiphat M.	9	41%	2	6 764
Kangwan	10	23%	2	3 988

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Module 1: Outcome of workshop III

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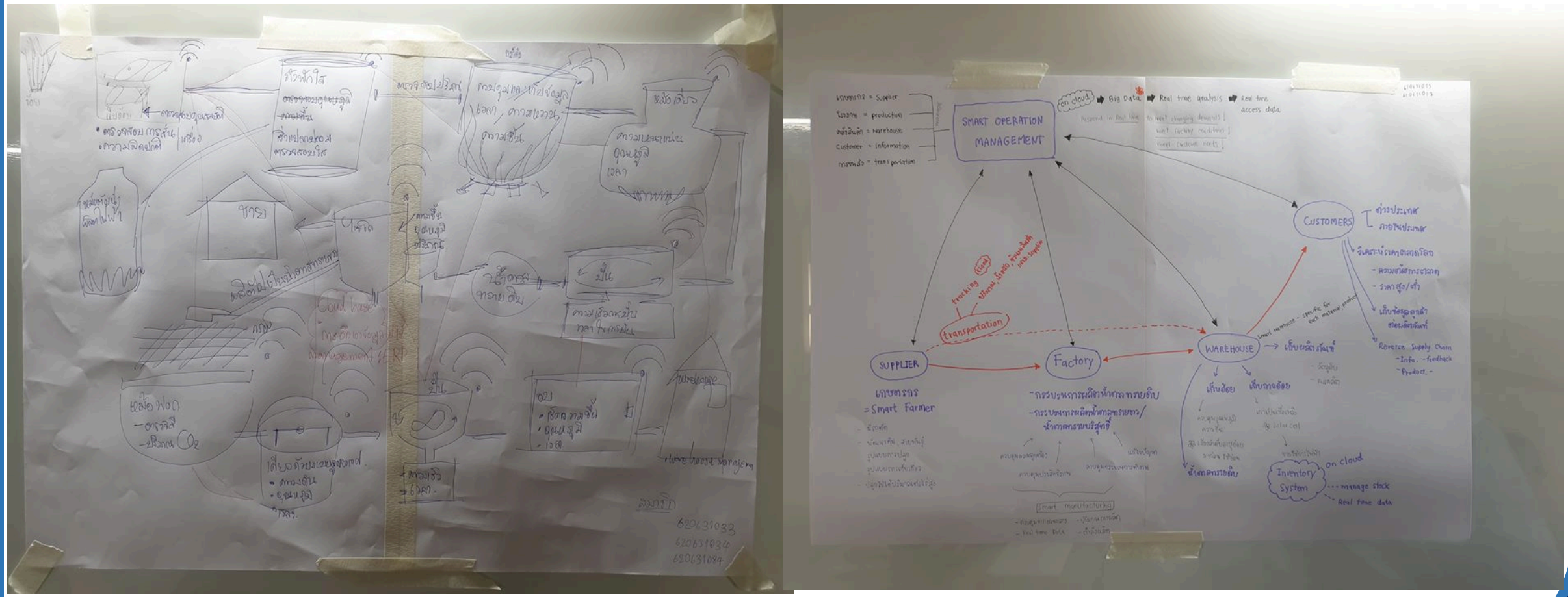
Module 1: Outcome of workshop III



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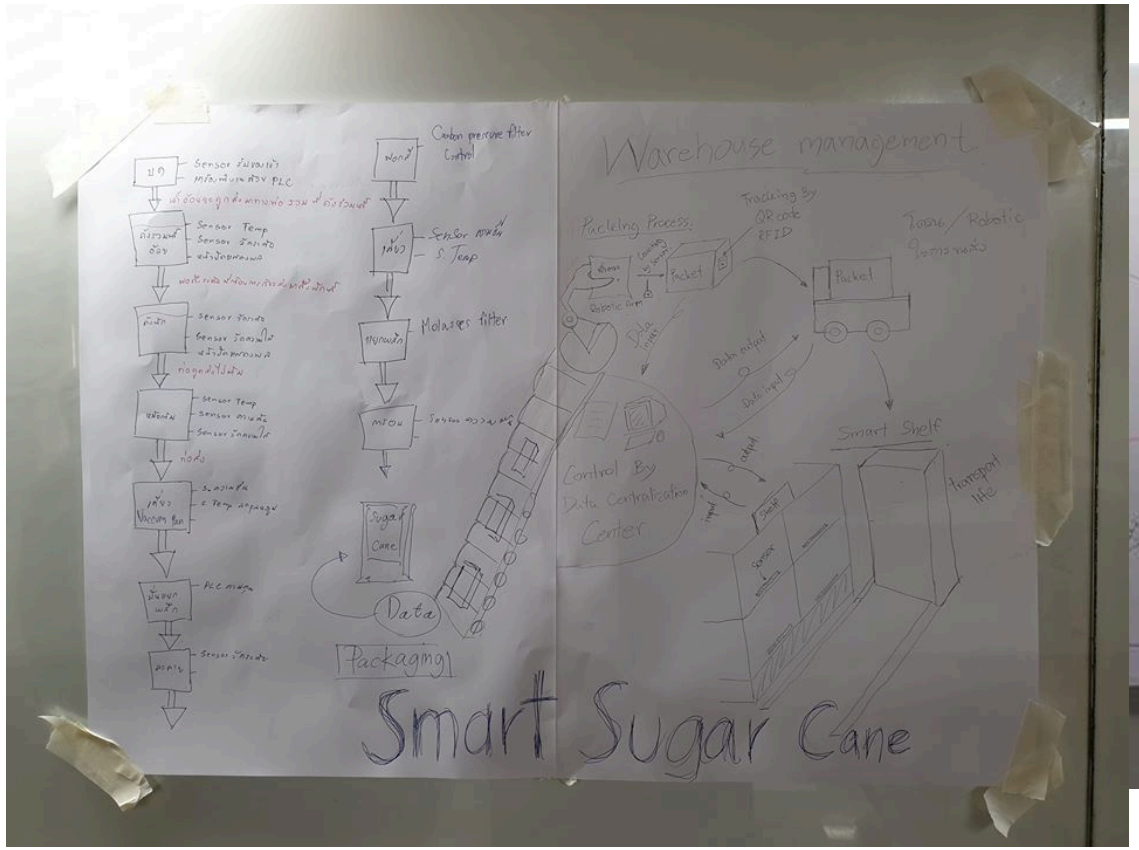
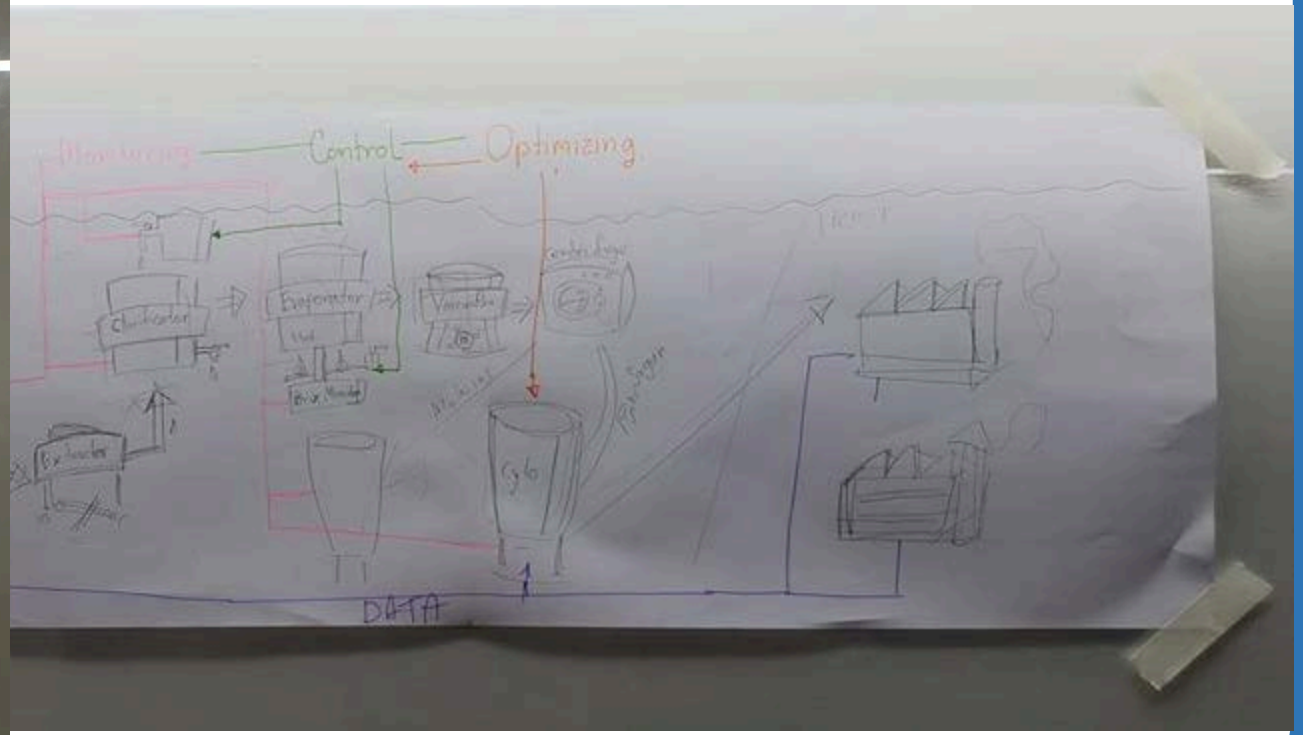
Module 1: Outcome of workshop III





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Module 1 Assessment

CLO1

- Formative: Workshop & Assignment
- Summative: Open Exam

CLO4

- Formative: Discussion
- Summative: Oral Presentation

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Module 2 (Smart PPC) Outline

Smart production in planning and controlling company's operations integrated production planning and shop-flow control system concept

2.1 Implementation Forecasting Model under Real-time Situation:

2.2 Inventory Management under Real-time Situation:

2.3 Advanced Integrated Production Planning

2.4 Advanced Shop Floor Control

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Module 2: Teaching methods

- Various teaching methods were used in this module including;
  - Lecture
  - Group discussion
  - Group assignment
  - Reading assignment
- This module consists of five workshops
  - Workshop I: Oral presentation & discussion on the overall of advanced production planning and control
  - Workshop II: Workshop & discussion on real-time data forecasting
  - Workshop III: Case study & oral presentation on inventory management under the concept of Industry 4.0
  - Workshop IV: Discussion & oral presentation on advanced integrated production planning
  - Workshop V: Paper discussion & oral presentation on advanced scheduling

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Workshop I: Oral Presentation & Discussion

- Toward Industry 4.0 With IoT: Optimizing Business Processes in an Evolving Manufacturing Factory.

[Ref.: Belli L, Davoli L, Medioli A, Marchini PL and Ferrari G (2019)]

Discussion 1

- The difference between classical system and Industry 4.0.
- Keywords of PPC when Industry 4.0 is adopted.
- Transformation from manual works to smart system

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Workshop II: Workshop & Discussion

- Forecasting practice with real-time data

Discussion 2

How to utilize real-time data in PPC?

If the real-time data are available, what will happen in PPC?

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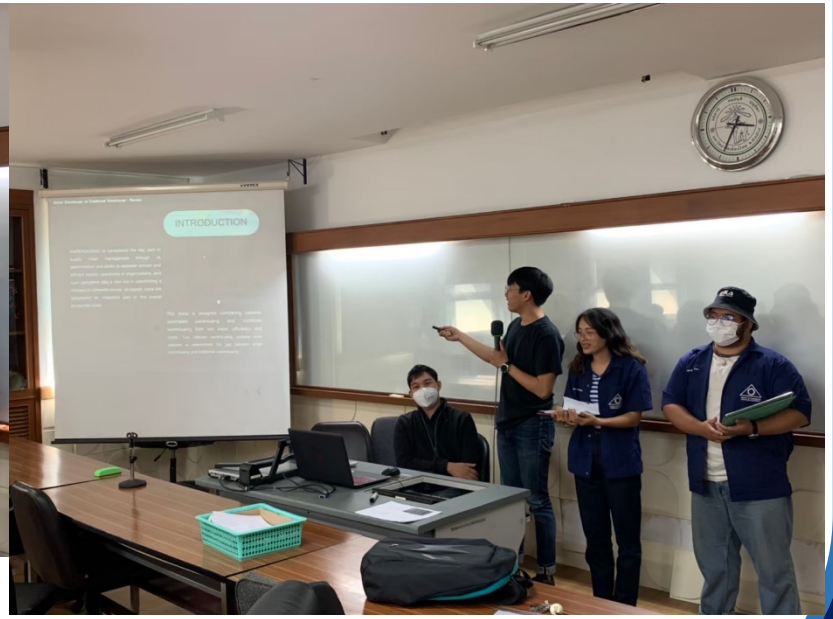
Workshop III: Case Study & Oral Presentation

- Case Study of Inventory Management under the Concept of Industry 4.0
  - ➢Comparison between classical system and Industry 4.0 system



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Workshop IV: Discussion & Oral Presentation

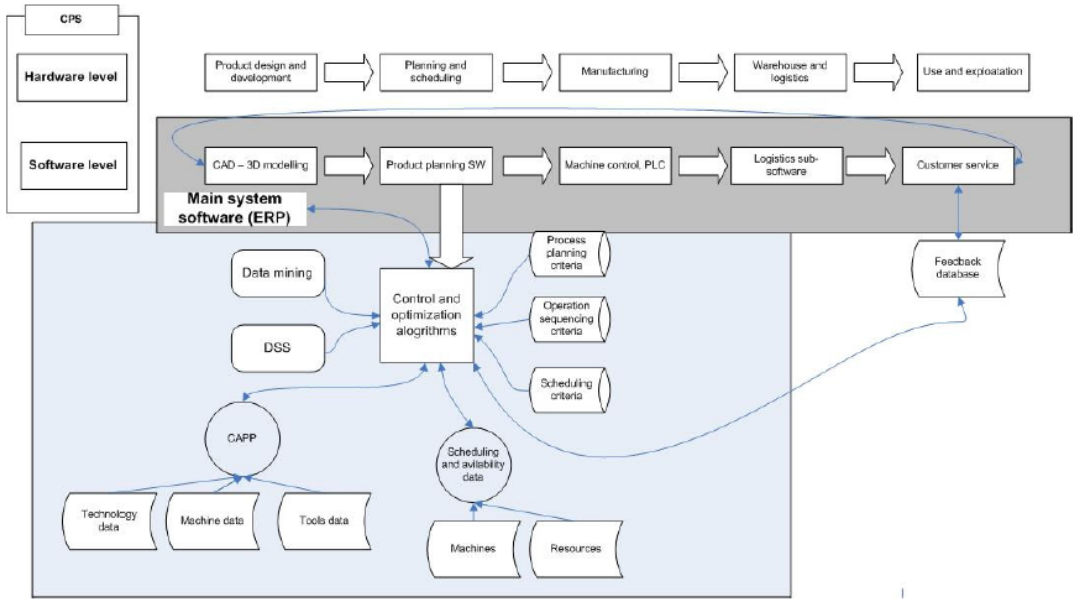
Discussion 1:

1. Do you think the emerging of Industry 4.0 will replace the ERP ?
2. If not, can ERP integrate with Industry 4.0 ?

Explain with rational reasons and provide the necessary characteristics when ERP integrated with Industry 4.0.

ERP Readiness & Challenges	Organizational Challenges	FoF's Future
• Technically & operationally ready • Machine to machine and machine to ERP communication and integration challenges	• Economic feasibility of FoF is difficult to justify • BPR & change management • Management/employee awareness & technology transfer • Heavy reliance on HR in the supply chain & manufacturing cycles	• Might be more suitable to some industries than others • The switch from an existing traditional factory to a FoF is difficult • Full automation could be feasible for the "to be established" factories • Could be economically feasible and also dramatically decrease HR and employee turnover costs

Reference: Moutaz Haddara, Ahmed Elragal (2015) “The Readiness of ERP Systems for Factory of the Future”, Procedia Computer Science 64.



Reference: Maja Trstenjak, Predrag Cosic, (2017), “Process planning in Industry 4.0 environment”, Procedia Manufacturing 11.

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Workshop IV: Discussion & Oral Presentation

Presentation: Design Smart Production Planning System with ERP by implementing Industry 4.0 Technologies

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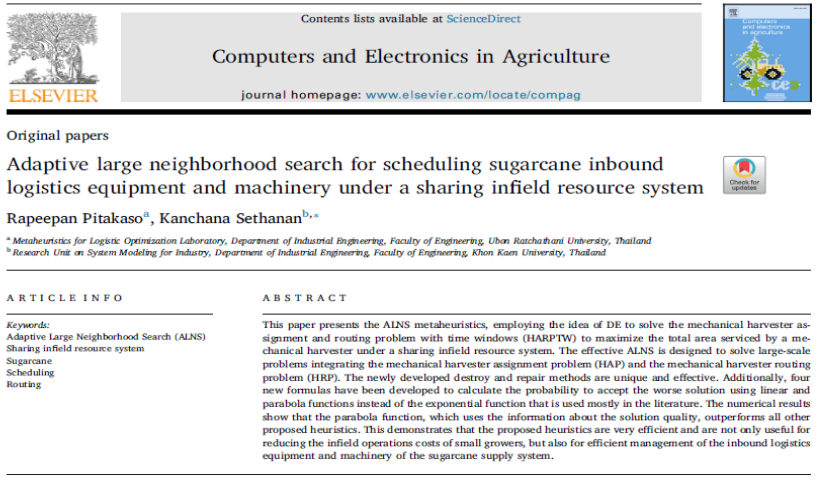
Workshop V: Paper Discussion & Oral Presentation

Discussion 2:

1. What difference from traditional scheduling system (Manufacturing Scheduling System, MSS)?
2. How scheduling in I4.0 era will be?
3. How advanced and how smart it will be?

Reference: Pitakaso and Sethanan (2019) Adaptive large neighborhood search for scheduling sugarcane inbound logistics equipment and machinery under a sharing infield resource system, Computers and Electronics in Agriculture, 158 , 313-325.



Contents lists available at ScienceDirect

Computers and Electronics in Agriculture

journal homepage: www.elsevier.com/locate/compag

Original papers

Adaptive large neighborhood search for scheduling sugarcane inbound logistics equipment and machinery under a sharing infield resource system

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[b] Research Unit on System Modeling for Industry, Department of Industrial Engineering, Faculty of Engineering, Khon Kaen University, Thailand

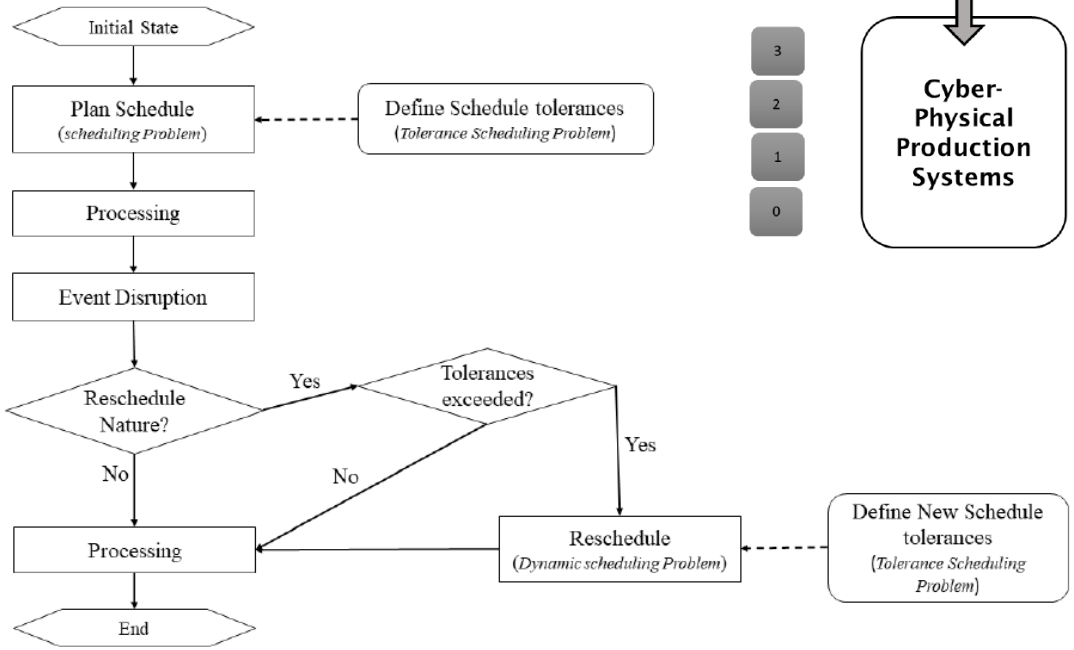
ARTICLE INFO

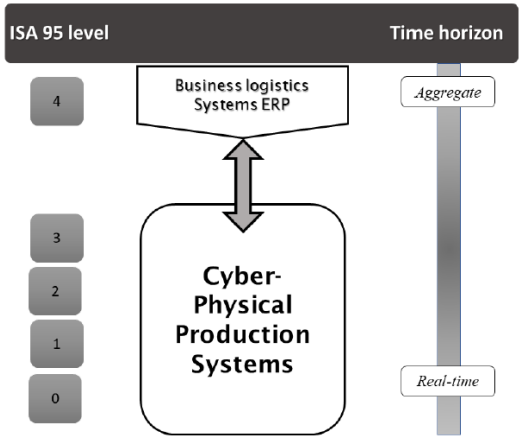
Keywords:
Adaptive Large Neighborhood Search (ALNS)
Sharing infield resource system
Sugarcane
Scheduling
Routing

ABSTRACT

This paper presents the ALNS metaheuristics, employing the idea of DE to solve the mechanical harvester assignment and routing problem with time windows (HARPTW) to maximize the total area serviced by a mechanical harvester under a sharing infield resource system. The effective ALNS is designed to solve large-scale problems integrating the mechanical harvester assignment problem (HAP) and the mechanical harvester routing problem (HRP). The newly developed destroy and repair methods are unique and effective. Additionally, four new formulas have been developed to calculate the probability to accept the worse solution using linear and parabola functions instead of the exponential function that is used mostly in the literature. The numerical results show that the parabola function, which uses the information about the solution quality, outperforms all other proposed heuristics. This demonstrates that the proposed heuristics are very efficient and are not only useful for reducing the infield operations costs of small growers, but also for efficient management of the inbound logistics equipment and machinery of the sugarcane supply system.

Reference: Rossit, Fernando Tohmé & Mariano Frutos (2019) Industry 4.0: Smart Scheduling, International Journal of Production Research, 57:12, 3802-3813





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Workshop V: Paper Discussion & Oral Presentation

Presentation: Design Smart Scheduling System for sugarcane inbound logistics

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Module 2 (Smart PPC) Assessment

CLO2

- Formative: Workshop, Case Study & Discussion
- Summative: Oral Presentation & Open Exam

CLO4

- Formative: Case Study & Discussion
- Summative: Oral Presentation

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Module 3: Outline

Real time data analytics and software systems to support planning, scheduling and control of smart production processes and systems

3.1 Real-time monitoring system

3.2 Real-time data analytics

3.3 Operation system for predictive analytics, predictive modelling, and forecasting

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Module 3: Teaching Methods

- Various teaching methods were used in this module including;
  - Lecture
  - Case study
  - Group discussion
  - Workshop
  - Group assignment
- This module consists of four workshops
  - Workshop I: Case study & group discussion on real-time manufacturing system
  - Workshop II: Workshop on how to get real-time manufacturing data
  - Workshop III: Workshop on how to do real-time data analysis
  - Workshop IV: Class project

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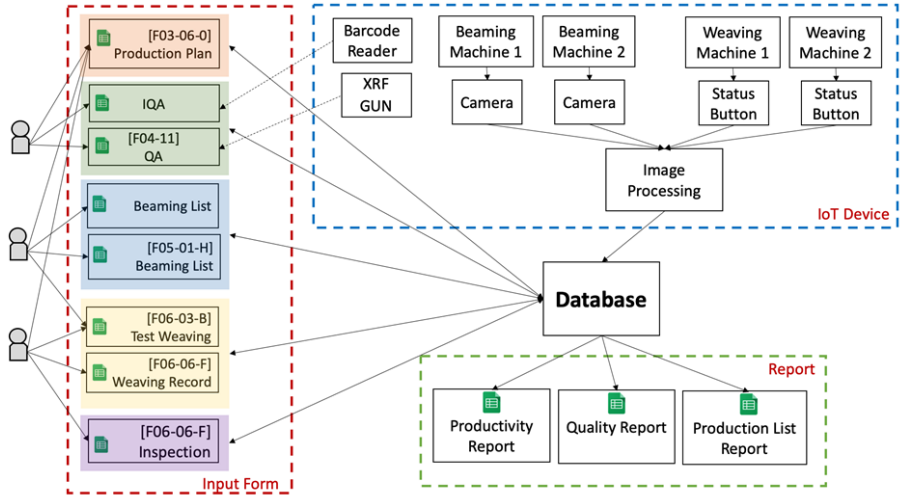
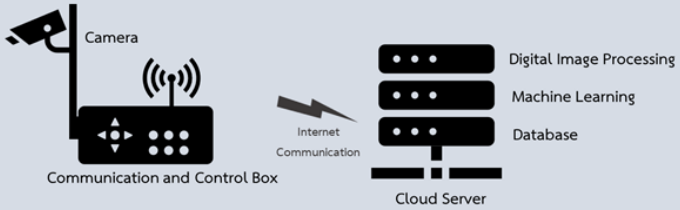
Workshop I: Case study & group discussion

- Discussion

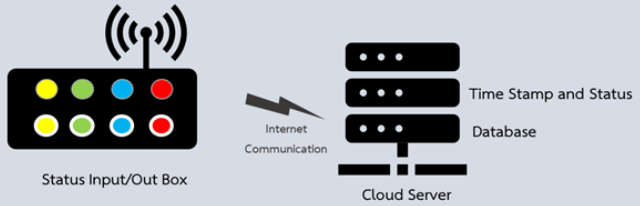
1. Why real-time monitoring system is important?
2. What is the RumMIP?
3. What is the RumPST?





RumMIP

Realtime Unconnected Machine Monitoring using Image Processing



RumPST

Realtime Unconnected Machine for Process Status Tracking

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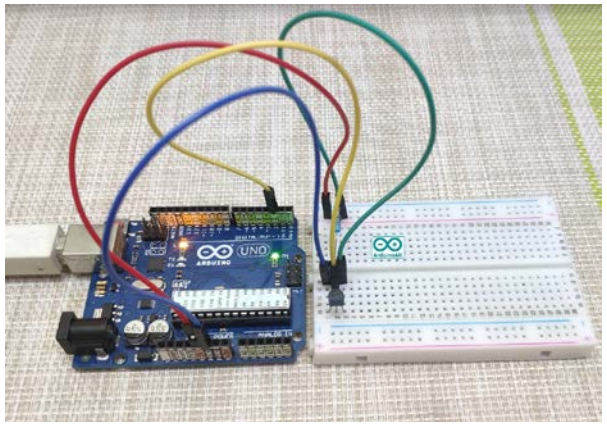
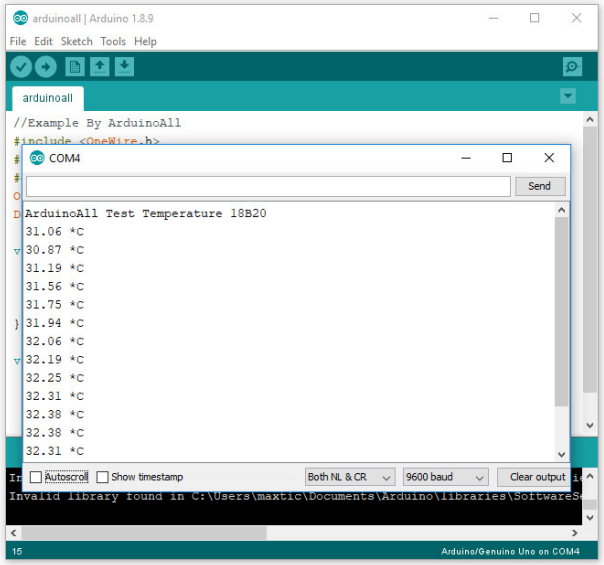
Workshop II: How to get real-time mfg data





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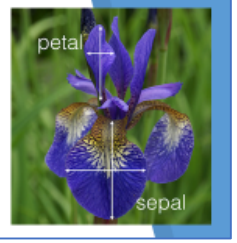
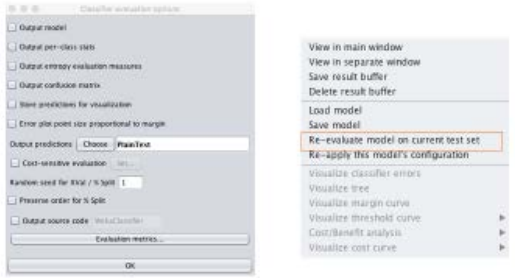
Workshop III: How to do real-time analysis

Activity 1 – Loading Data

- Use text editor to view data/iris.arff
- Use Weka Explorer
- Analyze iris.arff
  - Preprocess tab
  - Visualize tab



Activity 3 – Make Predictions



What is Machine Learning?

Learn from experience

Learn from ~~experience~~ Data

Follow instructions

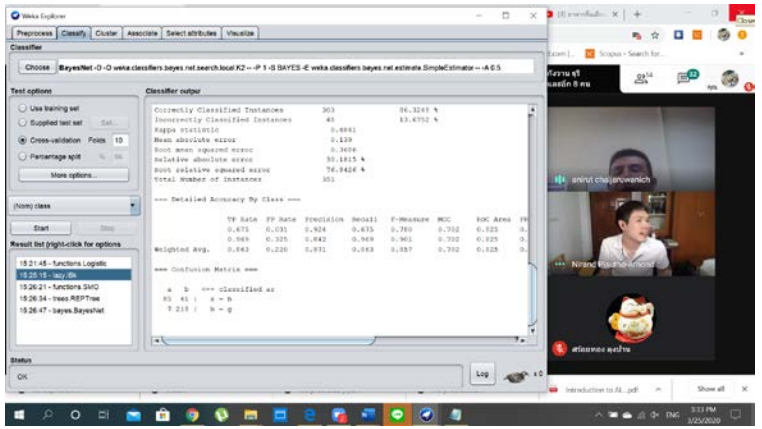
Activity 2 - Training

- Train the model with rules.ZeroR
  - Zero Rule Algorithm
- Train the model with trees.J48
  - C4.5 Algorithm (Decision Tree)
- Train the model with laze.Ibk
  - K-Nearest Neighbors Algorithm
  - Try K=1 and K=11

Activity 4

Algorithm	Weka Name
Logistic Regression	function.Logistic
Naive Bayes	bayes.NaiveBayes
Decision Tree	trees.REPTree
K-Nearest Neighbors	lazy.IBk (Instance Based - K)
Support Vector Machines	function.SMO (Sequential Minimal Optimization)

Top results are in the order of 98% accuracy.



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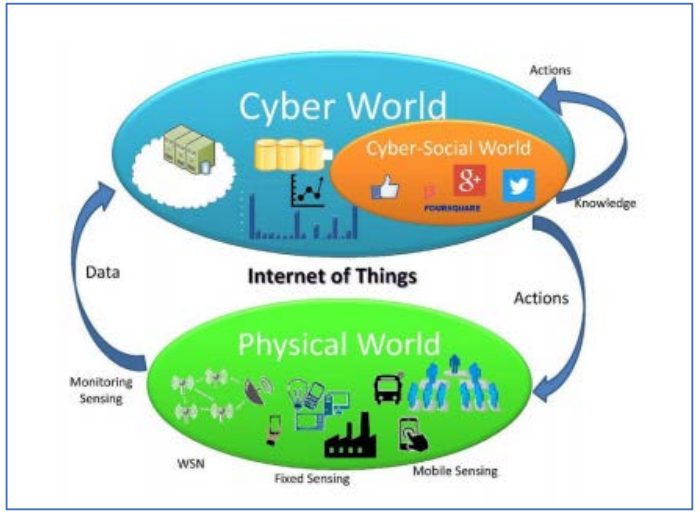
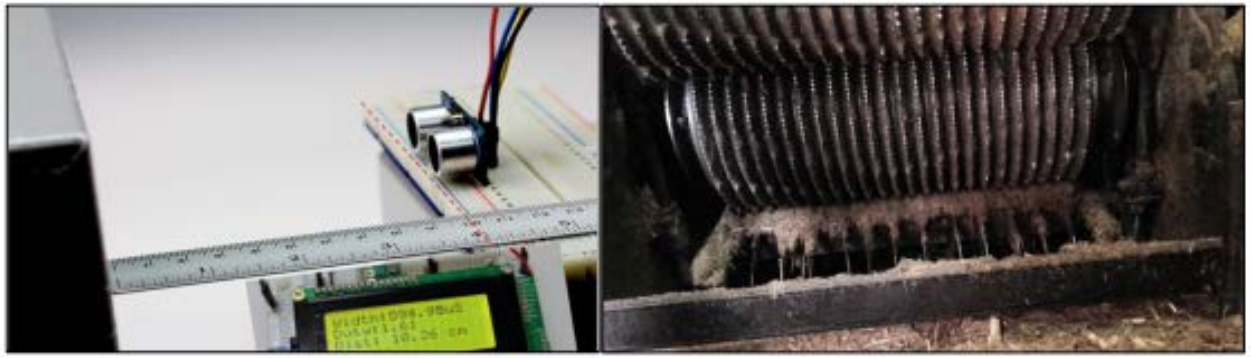
Workshop IV: Class Project

รูปที่ 2 เซนเซอร์วัดความเข้มข้น





ภาพที่ 3.1 ตัวอย่างเซ็นเซอร์และชุดลูกหีบ

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Module 3 Assessment

CLO3

- Formative: Case Study & Workshop
- Summative: Class Project

CLO4

- Formative: Discussion
- Summative: Oral Presentation & Report

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Student Comments

- Excellent in teaching and learning.
- Encourage students to have more participate in class ^^.
- Teaching methods of this course are very impressed comparing with other courses teaching as lecture-based. For me, I feel that I willing to spend more effort and more attention for this course because both teaching methods and lecturers. The teaching and learning methods of this course can help me in working on my thesis, as well.
- Group working and brain storming support student to work as a teamwork. I would like to thank all lecturers who conduct this course to let students to show his/her potential and knowledge in applying theory for real applications.

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