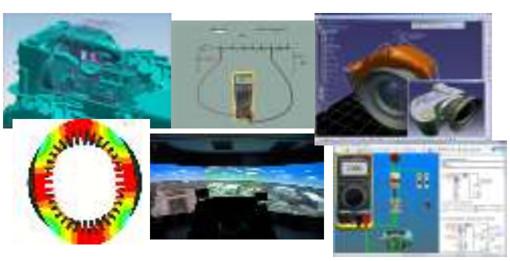
Kaedah dan Teknik P&P Simulasi Dalam Program Kejuruteraan dan Teknologi

12 Februari 2019

INTRODUCE YOURSELF

The Introduction to Simulation



Simulation is not New!

- **Simulation in Healthcare Education**
  - Health assessment skills (Wilson et al 2005, Yasmeen S. Alhatmi 2010, Shulian Zhang et. al 2012), Neonatal nursing skills (Mello 2004, Nicola North & Frances Hughes 2012, Margaret L. Sheng et al 2013), Peri-operative care (Grailing & Rusynko 2004, Michel Rod &Nicholas J. Ashill 2010, Outi Simonen et. Al, 2012)
- **Simulation in Astronomy**
  - Jihe Wang &Shinichi Nakasuka (2012) propose an intuitive and effective cluster flight orbit design method for fractionated spacecraft.
  - Yair, Shur and Mintz (2003) support the use of scientific visualization technologies in teaching astronomy
- **Simulation in Ecology**
  - Manjula S. Salimath & Raymond Jones III (2011) study on population ecology theory regarding to its implications for sustainability
  - Poland, Baggot la Velle and Nichol (2003) report on a case study involving the use of a virtual reality simulation in which students conducted a field study of turtles in the Mediterranean

Simul… not New!

- **Simulation in He… …n**
  - Health assess… …en S. Alhatmi 2010, Shuli… al 2012), … …North & Frances H… Margare… …Grailing & Rusy… …ichel Rod &Nich…
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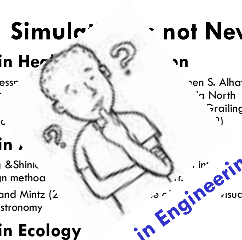


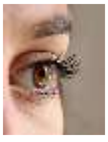
Simulation in Engineering Education???

Engineering student required?

- Practice in a safe environment
- Learn rare events
- Repetition of cases and experiences
- Develop problem solving skills and thinking
- Learn from errors without harm
- Practice teamwork
- Practice skills with increasing complexity
- Allows educators to evaluate competencies

WHY DOING SIMULATION IN CLASS

STEP 2: VAK LEARNING STYLES



What is the VAK Learning Styles ?

V – VISUAL

– AUDITORY

K – KINESTHETIC

LEARN MY WAY

Types of VAK LEARNING STYLES

V – VISUAL

a visually-dominant learner absorbs and retains information better when it is presented in, for example, pictures, diag

LEARN MY WAY

Types of VAK LEARNING STYLES

A – AUDITORY

an auditory-dominant learner prefers listening to what is being presented. He or she responds best to voices, for example, in a lecture or group discussion. Hearing his own voice repeating something back to a tutor or trainer is also helpful.

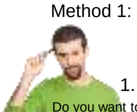
Types of VAK LEARNING STYLES

K – KINESTHETIC

a kinesthetic-dominant learner prefers a physical experience. She likes a "hands-on" approach and responds well to being able to touch or feel an object or learning prop.

Which one is your LEARNING STYLE?

Method 1: Recall on how you responded to your problem or challenges



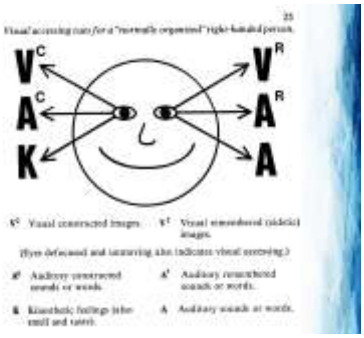
1. Think about how you complain?

Do you want to see the whites of someone's eyes (visual), harangue someone over the phone (auditory), hammer your fists on the table (kinesthetic), or fire off a curt email (reading/writing)?

2. Which presentation style do you prefer?

What was it that most stuck in your mind? Was it the charts or visual aids (visual), the words the presenter used (auditory), or any audience participation (kinesthetic)?

Method 2 : Eye Assessing Cues



Learning Strategies

LEARN MY WAY

Learning Strategies

Visual Strategies:

- Mind map or learning map.
- Sit where you have a clear view of your teacher when they are speaking.
- Take detailed notes using lots of color; develop your own color coding.
- Use a highlighter while reading.
- Review the pictures and diagrams from your textbook.
- Summarize material using charts, graphs, pictures, and diagrams.
- Use multimedia such as computer animations and videos.
- Visualize and create a mental picture of what you are learning.

LEARN MY WAY

Learning Strategies

Auditory Strategies:

- Find a study buddy or study group.
- Explain what you are learning to others.
- Ask lots of questions during class.
- Actively participate in all class discussions.
- Study in a quiet place away from verbal distractions.
- Create musical jingles and mnemonics when memorizing material.
- Read material out loud (the more dramatic the better).
- Use a tape recorder to summarize your notes and listen to them in the car
- Make frequent use of verbal analogies.

Learning Strategies

Kinesthetic Strategies:

- Take notes in class and then rewrite your notes.
- Read the textbook.
- Put a checkmark at the end of each paragraph or page to show that you understand the material.
- Make notes on index cards or post its and arrange in a logical sequence.
- Walk around while you read or listen to audio tapes.
- Shift your position while sitting.
- Take frequent study breaks.
- Create motions or gesture to help remember content.
- Chew gum while studying.

21st Century Learning

- Watch this video
https://www.youtube.com/watch?v=f0RyaAsVNGU

Write down your comment about this video.
https://padlet.com/aliza80/21centurycikguwannabe

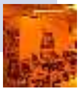
The Challenges

Domains are unfamiliar to the user	Principles are abstract	Enlarges Systems-level behavior complexity	Environments and tools for engineering insight are limited
• Often no hands-on physical • experience • Unfamiliar length and time scales	• Subtle until experienced • Ultimately must be understood in mathematical terms	• Multi-level metrics • Heterogeneous, hierarchical models • Dynamic & stochastic behavior	• Education and training • Broad engineering practice

materials & processes

transistors & chips

factory costs and operations/logistics



equipment

When is simulation most useful?

- When the system is not available
- When the physical experiments cannot be performed
- When the cost of experimentation is too high
- When the time scale of the system is not compatible with those of the experimenter
- Under controlled circumstance (e.g. no disturbances)

Definition of Simulation

REAL WORLD SYSTEMS OF INTEREST ARE HIGHLY COMPLEX!!!

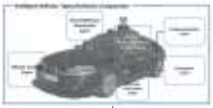
"A 'simulation' is an artificial environment in which a particular set of conditions is created in order to study or experience something that exists or could exist in reality"

Simulation requires
- A model description
- An experiment description

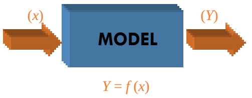
- **User Interface:** How users see and take action in the simulated environment.
- **User Experience:** What users notice, think, and feel during the simulation

EXAMPLES 1: Getting answers from models

1. Measure/estimate performance
2. Improve operation
3. Prepare for failures



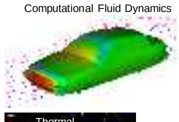
1. Allows comparisons of alternative designs or alternative operating policies.
2. Allows time compression or expansion.



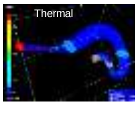
EXAMPLES 2: Understanding concepts

EXAMPLES 3: Models in Vehicle Design

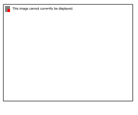
Computational Fluid Dynamics



Noise, Vibration, and Harshness

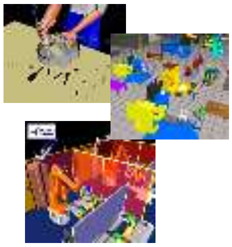


Stress Analysis



EXAMPLES 4: Manufacturing simulation

Take life cycle cost into account at the design stage



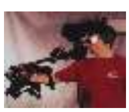
EXAMPLES 5: Training simulators

- Use the previously developed simulation models for training
- Train operators before prototypes are built
- Test whether user interface is user-friendly

EXAMPLES 6: Immersive Environments

- Allow user to interact with models through
  - 3-dimensional vision
  - Touch (tactile interface)
- Complete virtual prototype





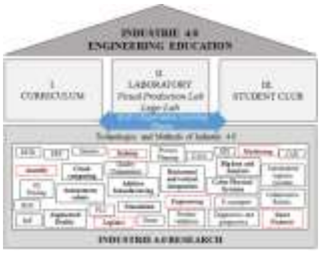
Let watch this video

Let watch this video

https://www.youtube.com/watch?v=iF5-aDJOr6U

Do you think that the simulation can change your student learning experience?

Simulation as an Learning Strategy



Simulation as an Learning Strategy

Simulation as an Learning Strategy

How we are going to teach?

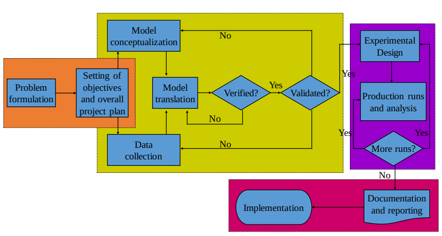
Skills are "front loaded" using a blended learning approach.

Emphasized that simulation is a tool for learning

Competency demonstrated **before** entering real "practice"

- Practical becomes the forum to implement what they have learned in simulated learning environments

STEPS IN A SIMULATION



HOW TO SIMULATE

YOU DECIDE AS THE SUBJECT MATTER EXPERT

HOW TO SIMULATE (APPS)

iCircuit

YOU DECIDE AS THE SUBJECT MATTER EXPERT

CONCLUSION

- LETS CONCLUDE IT TOGETHER!

SPECIAL TOPIC: SBES

- SBES: Simulation-Based Engineering Science
- Report of The National Science Foundation (2006)
  - Revolutionizing Engineering Science through Simulation

https://www.nsf.gov/pubs/reports/sbes_final_report.pdf

Major findings

- It is central to advances in *biomedicine, nano manufacturing, homeland security, microelectronics, energy and environmental sciences, advanced materials, and product development*.
- There is ample evidence that developments in these new disciplines could significantly impact virtually every aspect of human experience.
- SBES research challenges involve *resolving open problems associated with multi scale and multi-physics modeling, real-time integration of simulation methods with measurement systems, model validation and verification, handling large data, and visualization*.
- Significantly, one of those challenges is *education of the next generation of engineers and scientists in the theory and practices of SBES*.

Key Indicators

- SBES: A National Priority for Tomorrow's Engineering and Science
  - *Seldom have so many independent studies been in such agreement:*
    - *simulation is a key element for achieving progress in engineering and science.*
  - *SBES constitutes a new paradigm that will be indispensable in meeting the scientific and engineering challenges of the twenty-first century.*
- Simulation has become indispensable in predictive methods for weather, climate change, and behavior of the atmosphere; and in broad areas of engineering analysis and design.

The Payoff

- Driving Applications and Societal Benefits of SBES
  - SBES in Medicine
    - Both medical practice and engineering are problem-solving disciplines.
    - A program in SBES could also lead to new approaches to medical practice, collectively called Simulation-Based Medicine.
  - SBES in Predictive Homeland Security
    - SBES will allow the prediction of the consequences of threats and counter measure responses.
  - SBES in Energy and the Environment
    - An instrumented oilfield will result in more efficient, cost effective, and environmentally safer reservoirs, with enormous strategic and economic benefits.
  - SBES in Materials
    - With SBES, materials development becomes a unique opportunity for the integration of fundamental, interdisciplinary knowledge, with technological applications of obvious benefit to society.
    - Everywhere one looks there are problems important to society that require optimizing the functional properties of materials through control of their microstructure.
  - SBES in Industrial and Defense Applications
    - To increase the competitiveness, short design cycles are crucial if we are to keep up with the rapid pace of new products throughout the world.
    - If an industry is to replace testing with simulation, the simulation tools must undergo robust verification and validation procedures for effectiveness.
    - SBES has the potential to deliver, within a short design period, designs that are optimized for cost performance and total impact on the environment.

Core Issues

- Challenges, Barriers, and Opportunities in SBES Research
  - The Tyranny of Scales: The Challenge of Multi scale Modeling and Simulation
    - The development of effective multi scale modeling techniques will require major breakthroughs in computational mathematics and new thinking on how to model natural events occurring at multiple scales.
  - Verification, Validation, and Uncertainty Quantification
    - What level of confidence can one assign a predicted outcome in light of what may be known about the physical system and the model used to describe it?
    - The most confounding aspect of V&V has to do with uncertainty in the data characterizing mathematical models of nature.

    The use of stochastic models can represent gigantic increases in complexity in data volume, storage, manipulation, and retrieval requirements.

Core Issues

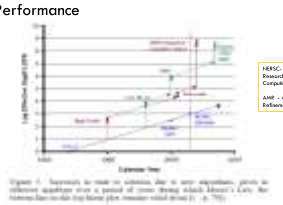
- Dynamic Simulation Systems, Sensors, Measurements, and Heterogeneous Simulations
  - This synergistic and symbiotic feedback control loop among applications, simulations, and measurements has the potential to transform the way science and engineering are done.
  - Dynamic data-driven application systems will rewrite the book on the validation and verification of computer predictions.
- New Vistas in Simulation Software
  - Entirely new approaches are needed for the development of the software that will encapsulate the models and methods used in SBES.
  - Not only will tomorrow's software developers have to cope with more complex algorithms, but they will also have to understand the important details of the applications.
  - The new paradigm for SBES software research and development will allow for specialization with cross-accountability.

Core Issues

- The Emergence of Big Data in Simulation and the Role of Visualization in SBES
  - The era in which data intensive computing and large-scale scientific computing were essentially disjoint camps is over.
  - Visualization is fundamental to our ability to interpret models of complex phenomena, such as multilevel models of human physiology from DNA to whole organs, multi-century climate shifts, or multidimensional simulations of airflow past a jet wing.
  - We need to create an SBES visualization framework for uncertainty and to investigate and explore new visual representations for characterizing error.

Core Issues

- Next-Generation Algorithms and Computational Performance



NERSC- National Energy Research Scientific Computing Center

AMR - Adaptive Mesh Refinement

1. Keyes, D., Colella, P., Dunning, Jr., T., and Gropp, W., (Eds.); A Science-Based *Case for Large-Scale Simulation - Volume 2; Department of Energy – Office of* Science Workshop Report, September 2004. *http://www.pnl.gov/scales/*

Lecturer Tasks

- There are several ways to create an imaginary simulation model of a educational purposes.
  - Buy on-shelf Computer Based Training (CBT) – lecturer need to explore.
  - Search the sources from internet (youtube, learning object repository, etc (Winconsin online) – more time needed
  - Develop our own simulation model – this is hard

Where to start

- Websites
  - http://people.revoledu.com/kardi/tutorial/index.html - using excel to build simulation for Mathematics/Statistics/AI
  - For modeling, optimizing and visualizing your process:
    - FlexSim:www.**flexsim**.com
    - Vensim: http://vensim.com/
    - Arena: www.**arenasimulation**.com
    - Matlab-Simulink: www.**mathworks**.com

Example Application: Simulation using Excel

- **Generating random numbers in Excel**
- Excel has a RAND() function for generating "random" numbers
  - The numbers are really coming from a formula and hence are often called pseudo-random
  - =RAND() generates a number between 0 and 1, where are values are equally likely (the so-called Uniform distribution)
- =RANDBETWEEN(low, high) generates a pseudo-random # between low and high, where all #'s are equally likely

Simulation using Excel

- **Generating random numbers in Excel**
- We can use RAND() to generate #'s from other distributions
- To generate values from the Normal distribution
  - =NORMINV(RAND(), mean, standard_deviation)
- E.g., =NORMINV(rand(), 10,5)
  - …will generate a random number from a Normal distribution with mean 10 and std. dev. 5.

Simulation using Excel

- **Generating random numbers in Excel**
  "Why bother generating random numbers?"

Simulation using Excel

- **Creating a Simulation**
- What is a simulation?
  - Investigating a real-life phenomenon, process, or problem using a model.
- The Excel features we have discussed can be blended together to create a simulation
  - The flexibility of Excel allows us to create many types of simulation models
- Why use a model?

Simulation using Excel

- **Value from simulation modeling**
- In business (and life), "do overs" are not always possible
  - Simulations let you experiment with different decisions and see their outcomes
- Humans have a poor ability to assess odds in some situations
- You can use repeated simulation "trials" to assess odds of various outcomes
- Companies typically use simulations to assess the likelihood of outcomes that may follow from different actions

Simulation using Excel

- **Creating a Simulation**
- Because you can simulate so many different kinds of situations, there is no one "recipe" to follow
  - Makes it challenging, and creative (even fun?!)
- Simulations typically require bringing together lots of Excel skills!
  - If you can do Excel simulations, then you are good at Excel

Simulation using Excel

- **Simulation modeling in Excel**
- First get your model of the problem (finance/profit/cost/capacity/whatever) correct, before making certain inputs random
  - Visually separate your model on the Worksheet
- Then make the necessary inputs random
  - Refresh the Worksheet many times to see the random values change and check whether your model's calculations seem to behave properly
- Then add a Data Table to automate many, many trials of your model, collecting the output(s) you want
- Then add some summarizing statistics (e.g., average) based on the results you obtained in your Data Table

Simulation using Excel

- **General tips on modeling in Excel**
- Organize – keep your worksheet neat
- Be clear on how to do any given calculation on paper first
  - Then identify the corresponding Excel function, using Google search if you don't know the name of the Excel function
- Don't embed data values within formulas
  - Put data values in visible cells and reference that data
- Don't put too much logic in one cell
  - If it starts to get complicated, split the logic across more cells
- Remember to use the power of the Data Table
  - …for trying different parameter values
  - …for replicating multiple trials of random #'s

Simulation using Excel

- **1st Simulation example: dice game**
- We play a game against 2 opponents
  - 3 players (we are player 1)
- Each player rolls a die
- To win, a player needs to roll a # bigger than the other two dice values
  - If it's a tie, then the game is called a tie
- You want to simulate a play of the game and report whether you win, lose, or tie

Simulation using Excel

- **2ndsim. example: inventory management**
- Demand is uncertain, and you want to determine how many of your product to stock
  - Let's assume that demand is uniform between 50 and 150 units
  - Each units costs you $6
  - Your price is $10
  - If you end up with unsold units, you will have to "dump" them at $2 salvage value
- Simulate one "play" of this game, where you stock a certain quantity and then see how much profit you make (given some random demand realization)

Simulation using Excel

- **Repeating simulation "trials"**
- The real power of simulations comes from being able to consider many trials
- In Excel, the Data Table concept provides a convenient means for doing so
- Previously, we used the Data Table concept repeatedly analyze a spreadsheet model for different parameter values, without randomness

Simulation using Excel

- **Repeating simulation "trials"**
- If our spreadsheet model contains a random input, we again can use a Data Table to repeatedly analyze the model
- To do this, we define a long column of trials as the left column defining our Data Table
  - Each trial corresponds to the need to re-run the sheet, creating the new random number(s), and seeing how results change
  - It's convenient to give each trial a # (e.g., 1,2,3,…) but usually you don't want to use those #'s in any formula you are using
    - Therefore, the Data Table's "column input cell" should point to an unused cell in your spreadsheet (again, because you don't want to use the trial-# for anything)

Simulation using Excel

- **2ndsim. example revisited**
- Let's now use a Data Table with the prior example
- The Data Table will automate the process of considering many different scenarios
  - In this case, the scenarios do not correspond to different interest rates (as in the last class), but rather to different random #'s
- Create a Data Table that will address 200 random scenarios
- At the end, we can average over those scenarios

Simulation using Excel

- **3rd simulation example**
- As a hotel manager, you are involved in a major renovation of a hotel that will have space for 100 standard hotel rooms. You are wondering whether some of that space should be used for "luxury suite" rooms, each of which would be twice the size of a standard room. For example, you could plan for 20 suites, in which case you would have remaining space for 60 standard rooms (100 – 2*20 = 60). Your overall construction costs won't be impacted by this decision, because a suite costs about twice as much to build as a normal hotel room.
- You predict being able to fetch $99/night and $169/night for standard and luxury rooms, respectively.
- Anticipated demand for…
  - Standard rooms – mean of 50, standard deviation of 10
  - Luxury suites – mean of 20, standard deviation of 10
  - Note: you can upgrade a customer from standard to luxury, if the better room is available.
- Occupied rooms incur the following nightly cost (for cleaning/upkeep/"utilities"):
  - Standard rooms – $12.50
  - Luxury suites – $25
- You estimate fixed costs (including amortized building costs and other overhead such as staff salaries) at $6000 per night.

Simulation using Excel

- **How would you deal with this problem?**
- Old school approaches
  - See what other hotels have done, hope that they had a better method than you
  - Use intuition
  - Ask colleagues / friends / family
- New school approach
  - Do the above, but also use modeling / data
- Sometimes, you won't have any "intuitive feel" for the right answer, when things get complicated
  - Even worse, you might think you have the intuition but it's wrong
- Sometimes you can develop a very accurate model, if the assumptions and inputs are quite clear

Simulation using Excel

- **Recall: Simulation modeling steps**
- First get your model of the problem (finance/profit/cost/capacity/whatever) correct, before making certain inputs random
- Then make the necessary inputs random
- Then add a Data Table to automate many, many trials of your model, collecting the output(s) you want
- Then add some summarizing statistics (e.g., average) based on the results you obtained in your Data Table

Simulation using Excel

- Presentations:
  - Model inputs
  - The model
  - Data Table (2 way)
  - Summary statistics

Simulation using Excel

- **What to make random?**
- Demand assumptions
  - Standard rooms – mean of 50, standard deviation of 10
    - =NORMINV(RAND(),50,10)
  - Luxury suites – mean of 20, standard deviation of 10
    - =NORMINV(RAND(),20,10)
- To remove unwanted non-integer and negative #'s, we will use:
  - =MAX(0,ROUND(NORMINV(RAND(),50,10),0))
- Luxury suites – mean of 20, standard deviation of 10
  - =MAX(0,ROUND(NORMINV(RAND(),20,10),0))
- The impact of ignoring neg. #'s should be small, because neg. #'s are over 5 and 2 std deviations below the mean
- See http://www.mathsisfun.com/data/standard-normal-distribution-table.html and click on "Z onwards" button

Question/Discussion?

THANK YOU