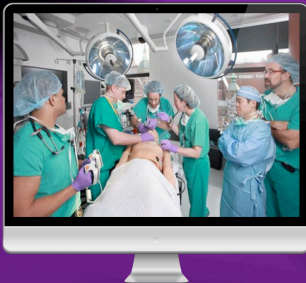


Modeling And Simulation

*A Model High School Curriculum
Modified for use within the State of Florida
by the National Center for Simulation*



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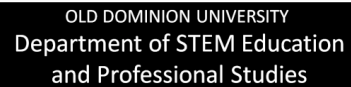
Opportunity Inc. of Hampton Roads
500 E. Plume St. Suite 700
Norfolk, VA 23510



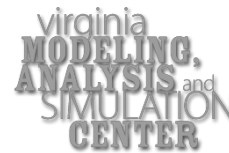
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The original, very comprehensive, work developed under the WIRED grant was subsequently modified and expanded for use by the State of Florida by the National Center for Simulation, Orlando, Florida, with the permission of the authors. The modifications made in this Florida Version include reorganizing the units, adding units on real-time virtual simulation, project management, logistic support and innovation and commercialization techniques. Additional hands-on exercises for students are included.

Students who complete this curriculum may elect to take a National Center for Simulation Certification Exam, demonstrating competency in modeling and simulation. Achieving certification facilitates the student to seek employment in industry or government and/or enter post-secondary education.

Thomas L. Baptiste, Lt Gen, USAF (Ret)
President/Executive Director
National Center for Simulation

3 December 2012

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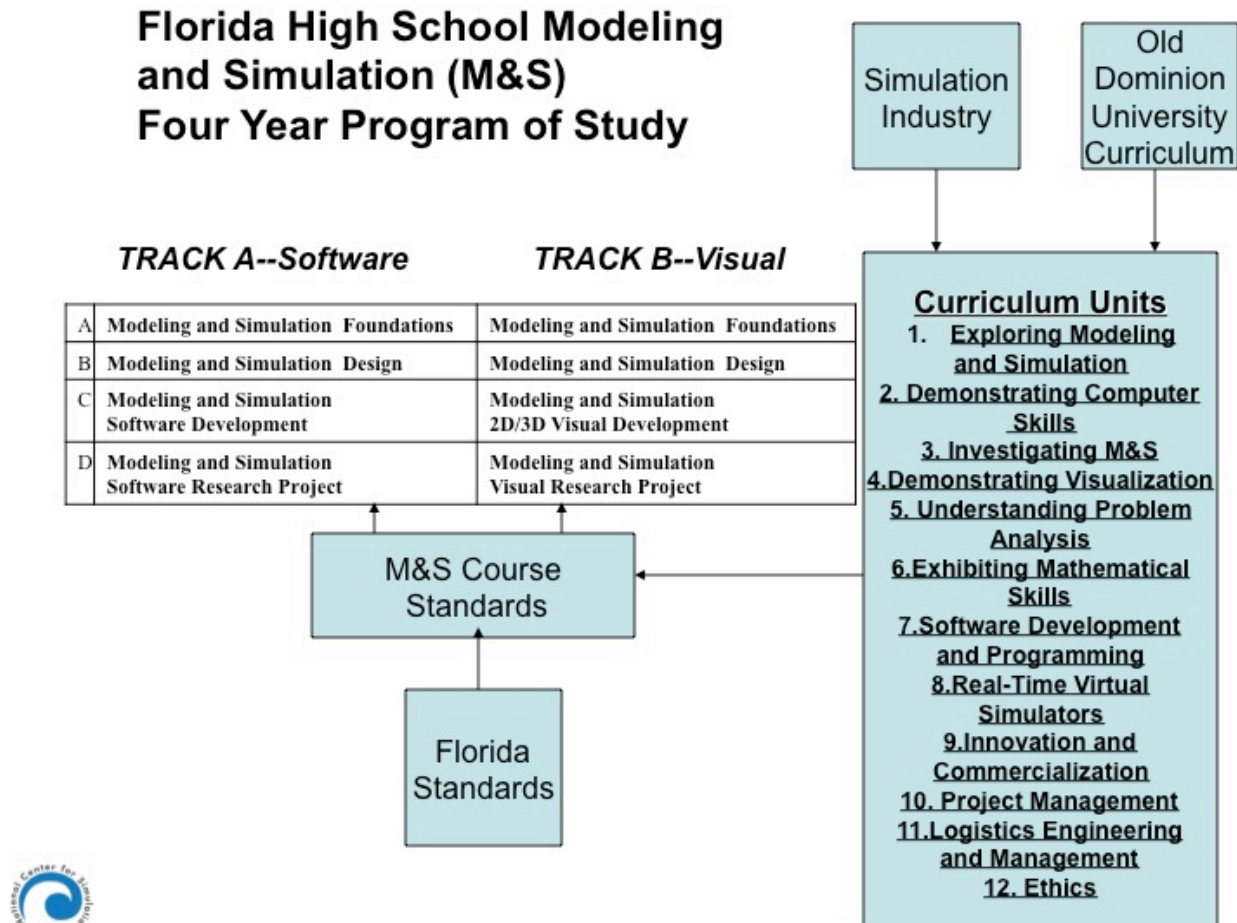
Introduction

Modeling and Simulation (M&S) is a dynamic field that is utilized in engineering, science, health care, business, education, training and many other disciplines. Due to its dynamic nature, the M & S field has tremendous potential for creating student interest in science, technology, engineering, and mathematics (STEM) disciplines. Content includes, but is not limited to, geospatial technologies (i.e. GPS, GIS, remote sensing), gaming, medical and scientific imaging, animation, engineering drawing, transportation, distribution, warehousing, and architectural drawing.

Program Description

In *Modeling and Simulation*, students will develop an understanding of the systems, processes, tools, and implications of this field. Individual and group activities are designed to help students understand, use, manage, and assess historical, current, and emerging developments. This is a four year high school program preparing students for post-secondary education or entry level positions in industry or government.

The units presented are not taught in the sequence shown. The units represent content that was further distributed in the course outline for each course. The figure below shows the relationship between the curriculum units, four year framework, academic tracks and courses.



How to Use This Guide

The materials contained in this instructional framework guide have undergone a rigorous developmental process. A straw list of competencies was initially created by a group of secondary and post-secondary instructors based on the professional literature. A survey was then sent to modeling and simulation professionals in southeastern Virginia to validate the competencies and provide guidance on curriculum content and student experiences. Instructional materials were created by secondary and post-secondary instructors using the survey responses. Finally, independent reviewers provided feedback, and revisions were made based on these responses as well as data obtained during field testing. The following Virginia participants have contributed as writers, reviewers, or field testers.

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In Central Florida, the **National Center for Simulation**, conducted workshops and reviews by industry and educators from Orange and Seminole Counties. Using the Virginia version of the curriculum, the NCS Education and Workforce Development Committee and the STEM/M&S Curriculum Task Force undertook the task of developing the State of Florida Framework for M&S and the course standards for the four year program. The final products are posted on the NCS website at <http://www.simulationinformation.com>.

NCS member companies and organizations that made significant contributions are as follows:

AEgis, Inc.
AVT Sim
Department of Defense Advanced Distributed Learning Co-Lab
Dynamics Research Corporation
EA Sports
Florida HiTech Corridor Council
General Dynamics
Henry C. Okraski and Associates
Lockheed Martin
MT3
Nicholson Center, Florida Hospital
Naval Air Warfare Center Training Systems Division (NAWCTSD)
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Duane Hume (Framework/Standards Guidance), Florida Department of Education

Instructional Delivery

The technological method is central to the high school technology education curriculum. Using the technological method, students recognize technological problems and follow logical procedures to find solutions. The technological method enables students to create new opportunities, effectively communicate ideas and solutions, and analyze the technological benefits and consequences.

Teachers may use four instructional approaches to help students understand and use the technological method:

The Design Brief – Recognizing Technological Problems: A design brief helps students learn to recognize technological problems within a context or situation from the real world. Using critical thinking, students first clarify the problem and state it in written form before they follow the other steps in problem solving. Effective design briefs stimulate the application of math, science, and other disciplines to technological solutions. Teachers can use design briefs to focus learning on the specific content, materials, or processes that students need to study.

Problem Solving – Following Logical Procedures: Teachers who use this approach challenge students to find creative solutions to practical problems. The steps of problem solving are flexible; however, each step (analyze the problem, consider alternatives, make solutions, evaluate results) engages students in thinking, planning, and using various resources. Teams of students work cooperatively to solve problems and present solutions with models, products, displays, and/or graphic illustrations.

Design Portfolio – Communicating Ideas and Solutions: The portfolio documents the thinking process, serving as a graphic and written record of student work and accomplishment. Students benefit from presenting their ideas for others to consider. Portfolios allow students to record their progress, recycle ideas, and communicate with team members, teachers, and parents. In addition, a well-done portfolio is a resource for job and college interviews, bringing to light otherwise hidden skills.

Technology Assessment – Analyzing Impacts: Technological knowledge and application are incomplete until the appropriateness of technology to society, the environment, and an economic system is determined. Using techniques of assessment, students learn to analyze the impacts of technology and make decisions based on their findings. Assessment ensures that new designs are appropriate solutions for today and tomorrow.

Resources

NOTE: Each unit includes a list of resources for that particular area. The resources contained below pertain to multiple areas.

Print

Defense Modeling and Simulation Office Education Consortium. (2004) *Defense Modeling and Simulation Body of Knowledge* (Version 5b). Department of Defense Modeling and Simulation Coordinating Office.

Jackson, W.S. (2007). *Modeling and Simulation Curriculum Guide*. Virginia Beach, VA: Virginia Beach City Public Schools.

Mielke, R.R. (2007). *An Undergraduate Modeling and Simulation Engineering Program*. Proceedings of the Huntsville Simulation Conference, Huntsville, AL.

Mielke, R.R., Scerbo, M.W., Gaubatz, K.T., & Watson, G.S. (2007). *A Multidisciplinary Model For M&S Graduate Education*. Norfolk, VA: Old Dominion University.

Pruden Center for Industry and Technology. (2008). *Proposed Curriculum for Modeling and Simulation Support Specialist*. Suffolk, VA: Suffolk Public Schools.

Electronic

Clark, A. (2007). VisTE: Visualization in Technology Education. Retrieved December 8, 2007 from <http://www.ncsu.edu/viste/>.

Virginia's CTE Resource Center. (2011). *Virginia's Workplace Readiness Skills*. Retrieved April 8, 2011 from <http://www.cteresource.org/attachments/wrs2010.pdf>

Unit 1: Exploring Modeling and Simulation (M&S)

Unit Length:

This unit will last approximately 20 days.

Goals:

- 1.1. Know and understand Modeling and Simulation (M&S) Terminology
- 1.2. Understand the disciplines related to simulation
- 1.3. Explore Modeling and Simulation concepts
- 1.4. Demonstrate knowledge of the history of Modeling and Simulation
- 1.5. Gain familiarity with emerging research techniques and technologies



Rationale:

Modeling and simulation has been described as one of the key enabling technologies of the 21st century. Modeling and simulation techniques have applications in fields as diverse as physics, chemistry, biology, economics, medicine, computer science, training and engineering. It is imperative that the student receives a well-rounded overview of M&S history, terminology, and related disciplines in order to have a successful understanding of M&S technology.

Given a precisely defined model of a system, it is possible to produce computer programs that implement the model and allow the system to be simulated. Modeling and simulation work hand-in-hand. The term "simulation" is normally used to describe the process of executing such a program with user-selected parameters and input data so as to emulate the system under prescribed conditions.

Unit 1.1: Modeling and Simulation Terminology

Unit Length:

This unit will last approximately 4 days but objectives will continue throughout the course.

Goals:

Know and understand Modeling and Simulation terminology.

Rationale:

Most vocabulary words are learned from context. The more words one is exposed to, the better vocabulary one will have. Learning a word won't help very much if you promptly forget it. Research shows that it takes from 10 to 20 repetitions to really make a word part of your vocabulary.

A good vocabulary will make a difference on the standardized tests, like the SAT or certification exams, which could determine the college you attend or the job you get. It will also determine the quality of your communication. So be in it for the long haul. Let building your vocabulary be a lifelong ambition.

Objectives:

1. Define essential modeling and simulation terms, and use in context.

Recommended Instructional Activities:

1. Daily Context Vocabulary Quiz – List selected words on projector or white board and allow teams of students to define words and earn benefit points for correct answers.
2. Use mnemonics (memory tricks). For example, consider the word EGREGIOUS (extremely bad). Think, EGG REACH US - imagine we've made a mistake so bad that they are throwing eggs at us and a rotten EGG REACHes US.
3. Choose 5 words daily that are unknown to you from the list provided. Look up and write down the definition, part of speech and use the new word in a sentence of more than 6 words. Practice using the new word.
4. Write a story, postcard, and letter or create a journal entry using 5-15 words in context.

Sample vocabulary terms:

Across, Action, Activation, Algebraic, Allocated, Ambient light, Animation, Antithetic, Arbitrary, Argument, Array, Artificial, Attached, Auxiliary, Behavior, Binary, Boolean, Bounded, Class, Clone, Constrained, Continuous, Continuous-change, Controlled, Coordination, Correlated, Decision, Declared, Declared Random, Deformation, Dependent, Descriptive, Deterministic, Diffuse, Discrete, Discrete-change, Discrete-time, Discriminate, Dual, Dummy, Editing, Ellipse, Endogenous, Essential, Exogenous, Experimental, Experimentation, External, externally generated, Flow, Formal, Free, Fuzzy, Gaussian, Geometry, Gizmo, Global, Goal, Helix, Hierarchy, Holistic, Independent, Inheritance, Initialized, Input, Instance, Instantiated, Instrumentable, Instrumental, Instrumented, Intermodal, Internal, Internally generated, Interpolated, Irrelevant, Key, Keyframe, Lag, Lagged, Latent, Lattice, Lead, Level, Linguistic, Linking, Local, Logical, Mapping, Materials, Mesh, Modifiers, Monitored, Nonnumeric, Nonobservable, Numerical, Observable, Output, Panning, Parametric, Qualified, Qualitative, Quantified, Quantitative, Random, Rate, Relevant, Reflection, Refraction, Render, Run control, Simple, Slack, Specular light, Spline, Stabilized, State, Statistical, Stevedores, Stochastic, Storyboard, Subscripted, Temporal, Temporary, Through, Time, Transform, Transparency, Transition, Uncontrollable, Uninitialized, Vortex, Yoked.

References:

A Glossary of DOE Terminology -

<http://www.itl.nist.gov/div898/handbook/pri/section7/pri7.htm>

Computer terms interactive quiz - <http://www.quia.com/quiz/255345.html>

Engineering Statistics Handbook Glossary -

<http://www.itl.nist.gov/div898/handbook/glossary.htm#B>

IEEE standard glossary of modeling and simulation terminology

An Introduction to Computer Simulation by M. M. Woolfson and G. J. Pert, Oxford University Press, 1999

Simulation games and activities - <http://www.youdagames.com/online-simulation-games/>

M&S Dictionaries - http://www.site.uottawa.ca/~oren/SCS_MSNet/MSdictionaries.htm

The Fun Way to Build Vocabulary Skills! - <http://www.vocabulary.co.il/>

Use these links to practice for the Computer Skills test. -

<http://www.ctdlc.org/remediation/indexComputer.html>

Unit 1.2: Disciplines Related to Simulation

Unit Length:

This unit will last approximately 4 days.

Goals:

Understand the disciplines related to simulation.

Rationale:

The work world revolves around many varied systems, some small and some extremely large and complex. Manipulating these systems can provide for more efficient and effective operations. Modeling and simulation is a discipline for developing a level of understanding of the interaction of the parts of a system, and of the system as a whole. Such an understanding is required in Industrial and Mechanical engineering, as well as in other engineering disciplines, including civil, electrical, and chemical engineering. Other professions that use M&S extensively include transportation, acquisition, testing, weather forecasting, education / training, scientific research, industrial management, quality control assurance, geographical information systems (GIS), psychology, social sciences, and medical, among others.

Mathematical models are widely used, for example, in engineering. The dynamic, time- dependent changes in many engineering systems can be described using differential equations. Business systems are more likely to be based on queuing theory and discrete-event modeling. In a discrete-event model, the state of a system is assumed to remain unchanged with time until an event occurs that changes the state of the system. Training simulators involve the systems integration of individual components to replicate the physical and functional characteristics of a prime system being simulated. As you can see, M&S is involved in many different disciplines therefore employment opportunities are numerous.

Objectives:

1. Identify disciplines which use modeling and simulation tools.
2. Identify modeling and simulation related careers.
3. Discuss educational requirements to enter the modeling and simulation career field.
4. List personal characteristics of modeling and simulation professionals.

Recommended Instructional Activities:

1. Show YouTube video on M&S 101 available at www.trainingsystems.org
2. Show the Naval Modeling and Simulation Office web-based course “Essentials of Modeling and Simulation” available at <https://nmso.navy.mil/ems/>
3. Invite guest speakers to share M & S professional experiences with students. Examples (City or school GIS coordinator, School Improvement Coordinator, Military M&S Technician, Computer Science Instructor, Flight Simulator users, Law Enforcement simulator users, etc)
4. Arrange a guided tour of local M&S facilities. Write a summary critique of the experience and include in your ePortfolio.
5. List five career professionals who use modeling and simulation techniques. Write a two-page synopsis of one of these career professionals. Be sure to include personal characteristic traits, education and training, unique skill set, and successes resulting from using M&S techniques.
6. Explain in 3 paragraphs how any of the following disciplines would use M&S to solve a problem. Examples are, but are not limited to: interior design, emergency medical technology, material handling, law enforcement, aviation, medicine, architecture, enterprise decision support, optimization, product design, testing, life cycle support, experimentation and prototyping, gaming technology in education and training.
7. Break the class into groups and present challenges to the groups for solving those problems through M&S. Allow the students to brainstorm feasible solutions to the problems presented.

References:

Doron trucking simulators - <http://www.doronprecision.com/450truck.html>

Helbing, D., Molnar, P. (1995). Social force model for pedestrian dynamics. *Physical Review E*, 51(5), pp. 4282-4286.

Integrated Land Use, Transportation, Environment (Ilute Modeling System
http://www.civ.utoronto.ca/sect/traeng/ilute/ilute_the_model.htm

Java Simulation of road traffic - <http://www.traffic-simulation.de/>

Marsella, S. C., Pynadath, D. V., Read, S. J. (2004) PsychSim: Agent-based modeling of social interactions and influence, 6th International Conference on Cognitive Modeling, July 30-Aug 1, Pittsburg, PA.

Near real time visualizations of recent significant seismic events in the Southern California Region - <http://shakemovie.caltech.edu/>

Old Dominion University VMASC overview of graduate programs in M&S -

<http://www.vmasc.odu.edu/ACADEMICS/academics.html>

SCS Simulation News - <http://www.scs.org/newsletter/>

Sokolowski, J. A., Banks C. M. (2008). *Modeling global events: A focus on insurgencies*. Proceedings of the Huntsville Simulation Conference HSC 2008. October 21-23, Huntsville, AL. pp. 235-240.

The Military Operations Research Society (MORS) - <http://www.mors.org/>

The Modeling and Simulation Information Analysis Center (MSIAC) web site - [http://www.dod- msiac.org/resources.html](http://www.dod-msiac.org/resources.html)

The MOVES Institute Defense Modeling and Simulation - <http://www.movesinstitute.org/>

US Department of Transportation, Federal Highway Administration traffic simulations - <http://www.tfhrc.gov/safety/pubs/03050/04.htm>

What makes a Modeling and Simulation Professional - [http://www.informs- sim.org/wsc97papers/1375.PDF](http://www.informs-sim.org/wsc97papers/1375.PDF)

Unit 1.3: Modeling and Simulation Concepts

Unit Length:

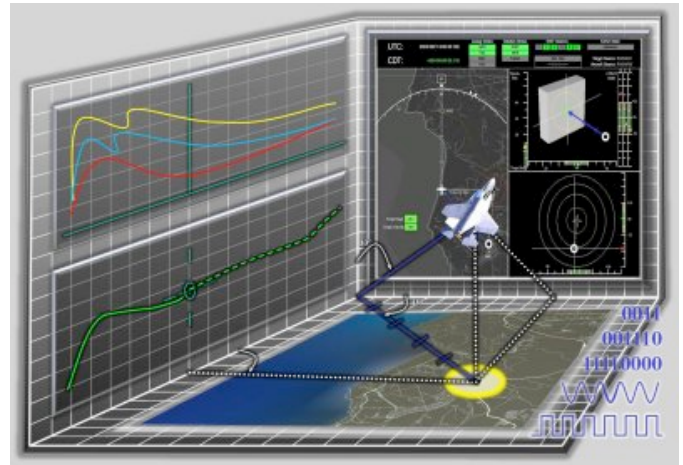
This unit will last approximately 4 days.

Goals:

Explore modeling and simulation concepts.

Rationale:

The following concepts of M& S should be considered:



Discrete-event and **continuous-time modeling** – Discrete-event models assume the fundamental underlying model revolves around occurrences of specific events; for example, arrival of a customer, completion of a transaction, etc. Continuous-time simulation, on the other hand, calculates the state of the system in continuous time intervals; for example, the velocity of an accelerating vehicle over time. These paradigms are covered in more detail later in the course.

It is also important to understand how the following simulations are used as tools.

Live simulations involve real humans and/or equipment and activity in an actual setting, for example, soldiers practicing in the field as part of an exercise. Time is continuous, as in the real world. Another example of live simulation is a disaster response team responding to mock emergency. In this scenario the people and equipment are real but the situation is simulated.

Virtual simulations involve real humans with equipment that is partially, or completely, simulated. Examples include, a human operating a flight simulator, driving simulator, or nuclear power-plant simulator.

Constructive simulations involve humans and equipment that are both simulated. Most military strategic simulations are constructive. Other examples include crowd evacuation, disease spread, and weather predictions models. A constructive simulation for weather could anticipate the path of a hurricane using variables such as current and changing temperature, pressure, wind current and other weather factors.

In summary, the differences among live, virtual, and constructive can be summarized as follows:

Live: real people – real equipment

Virtual: real people – simulated equipment

Constructive: simulated people – simulated equipment

Objectives:

1. Define the major modeling and simulation concepts.
2. Identify and analyze the differences between modeling and simulation concepts.
3. Identify and analyze similarities among modeling and simulation concepts
4. Explain and expand upon the usage of different modeling and simulation concepts.

Recommended Instructional Activities:

1. Search YouTube for “simulation.” Select a number of simulations and have the students categorize them.
2. Have each student identify a problem or challenge that can be solved with live, virtual and constructive simulations.
3. Taking the ideas of the students from Unit 1.1, ask the students to categorize the types of solutions that might be appropriate. (Live, Virtual, Constructive).

References:

A [Library of Materials](http://www.clexchange.org/), most freely downloadable, created by classroom teachers and other educators, that addresses diverse curricular and organizational topics of interest to K-12 educators -
<http://www.clexchange.org/>

A Primer on Modeling and Simulation-
<http://www.corporatepress.com/clientfiles/ntsa/>

Checkland, P. 1981. Systems Thinking, Systems Practice. New York: John Wiley & Sons. Descartes, R. 1927. Discourse on the Method of Rightly

Conducting the Reason and Seeking for Truth in the Sciences. In Descartes Selections, R.M. Eaton (ed). New York: Charles Scribner's Sons. Flood, F.L. and E.R. Carson. 1988.

Dealing with Complexity: An Introduction to the Theory and Application of Systems Science. New York: Plenum Press.

Just what is "simulation" anyway - <http://www.ist.ucf.edu/background.htm>

ProModel is a simulation-based, decision making tool - <http://www.promodel.com/>

The Modeling and Simulation Information Analysis Center (MSIAC) web site -
<http://www.dod-msiac.org/resources.html>

University of Central Florida - <http://www.ist.ucf.edu/background.htm>

Unit 1.4: History of Modeling and Simulation

Unit Length:

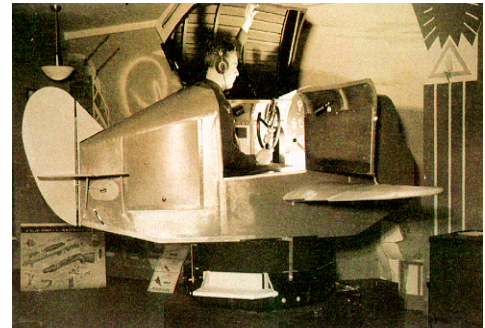
This unit will last approximately 4 days.

Goals:

Demonstrate knowledge of the history of Modeling and Simulation.

Rationale:

Did you know the first model simulator, the Sanders Teacher, was a complete aircraft mounted on a universal joint and facing into the wind; it was able to rotate and tilt freely. Another early flight simulator of about 1910 was built using a section of a barrel mounted on a hoop. The Link "Blue Box" (shown) was developed by Edwin Link in 1929 for instrument flight training. Computer simulation was developed hand-in-hand with the rapid growth of the computer, following its first large-scale deployment during the Manhattan Project in World War II to model the process of nuclear detonation. It was a simulation of 12 hard spheres using a Monte Carlo algorithm. It's been said time and time again that if you don't know where you have been, you can't know where you are going. Hence, it's imperative to know the history of M&S to round out your knowledge in the field.



Objectives:

1. Explain the past, present, and future importance of modeling and simulation.
2. Explain and use details to support the physical models by important historical models.
3. Use graphic technology to create a visualization of a historic simulator or synthetic environment.

Recommended Instructional Activities:

1. Use graphic technology to make a visualization of a historic simulator or synthetic environment.
2. Discuss physical models created by Leonardo da Vinci in response to the challenges of siege warfare.
3. Write a report on Christopher Weikmann or Koenigspiel (1644) considered the birth of modern M&S.

4. With a partner or individually research and present to the class using PowerPoint on any of the following topics: Lanchester equations which codified firepower relationships (1916), ENIAC computer, The Sanders Teacher, First pilot trainer of Link (1929), Celestial Navigator Trainer, Manhattan Project, SAGE System air defense simulation (1959), DARPA (1958), ARPANET (1969), SIMNET (1982), Man Space flight simulations.
5. Have students or teacher use digital media, such as an iPad, to demonstrate apps or other programs involving simulation. Explain the concepts being used.
6. Have students research the use of simulators by people in history such as Amelia Earhart, astronauts and test pilots.

References:

A brief look at the history of flight simulation -

http://www.acecombatsix.com/flight_Simulations/index.html

Adorian, P., W.N. Staynes, and M. Bolton. *The Evolution of Flight Simulators*. Presented at the Royal Aeronautical Society Conference 23-25 April 1979

Cutler, A.E. Environmental Realism in Flight Simulators. *The Radio and Electronic Engineer*, January 1966, pp 1-12.

Drummer, G.W.A. Aids to Training - The Design of Radar Synthetic Training Devices for the RAAF. *IEE Journal*, Vol 96, Pt. III March 1949, pp 101-116.

Dunn, W.H., C. Eldert, and P.V. Levonian. A Digital Computer for use in an Operational Flight Trainer. *IRE Transactions on Electronic Computers*, June 1955, pp 55-63.

Haward, D.M. The Sanders Teacher. *Flight* Vol 2 No. 50 December 10, 1910 pp

1006-1007. Hellings, G. and E.T. Emms. *A Visual System for Flight Simulators*.

British Communications and Electronics Vol 7 No. 5 May 1960 pp. 334-337.

Kelly, L.L. *The Pilot Maker*. (Grosset & Dunlap, 1970, New York).

Notes on History of RAAF Training 1939-44 Air Ministry, Air Member for Training (Public Record Office Reference AIR 20/1347).

Piper, Roger. *The Story of Computers*; Harcourt, Brace, and World, Inc., New York, 1964; Comprehensive study of computers, their history and its applications to possible careers

Ringham, G.B. and A.E. Cutler. Flight Simulators; The Journal of the Royal Aeronautical Society Vol 58, No. 519, March 1954, pp 153-172.

Rolfe, J.M. and Staples, K.J. Flight Simulation; Cambridge Aerospace Series, 1988, New York,

Smith, Roger. The Five Forces Driving Game Technologies:
citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.107.4788&rep=rep1&type=pdf

Wikipedia: History of Modeling and Simulation
http://en.wikipedia.org/wiki/Computer_model#History

Unit 1.5: Research Techniques and Technologies

Unit Length:

This unit will last approximately 4 days but objectives will be reinforced throughout the course.

Goals:

Gain familiarity with emerging research techniques and technologies.

Rationale:

Given the connectivity of the modern global Internet, human connections can be more powerful than ever before. It is an essential workplace skill to be able to find reliable information on a topic competently and at a moment's notice. Never before in human history have learners had access to global knowledge that they have today. Powerful software on the Internet referred to as search engines can search millions of resources for very specific information in seconds and are very easy to learn and use. With such access to information, students must understand and respond appropriately to the ethical, legal and limitation issues they might be confronted with. Students must learn how to make a difference in the world and in the lives of others locally and at a distance.

Objectives:

1. Describe types of emerging technologies.
2. Identify Internet safety issues and procedures for complying with acceptable use standards.
3. Use technology tools to collaborate and generate a deliverable product.
4. Develop and present a digital presentation.
5. Develop and show/display an electronic portfolio.
6. Demonstrate research skills using browsers, search engines, directories, and databases.
7. Create and evaluate a list of materials found online for relevance, appropriateness and bias.
8. Present a multimedia presentation, including text, sound, and graphics, based on content from class work.

Recommended Instructional Activities:

1. Read, Pair, and Share Activity - With a partner read portions of the acceptable use policy in your school. Each person reads a section while the other person relates back what he/she understood. This would be repeated in reverse throughout the reading.

2. Use the Internet to identify the skills and education required for employment in the modeling and simulation field.
3. Use the Internet to find three jobs in M&S located in your geographical area and present your findings in a PowerPoint presentation to the class.
4. Develop an Electronic Portfolio (ePortfolio) of your best work as you proceed through the course. Students will periodically evaluate the content of their ePortfolio by sharing with teacher and classmates.
5. Take Internet Basics Quiz and report results to teacher

References:

* Internet Basics Quiz -

http://www.classzone.com/books/research_guide/page_build.cfm?content=prequiz&state=none

Internet Research guide - <http://www.vickiblackwell.com/shelter.html>

Online seminar on Internet Research Skills -

<http://www.virtualchase.com/researchskills/intro.html>

Online lessons on Doing Research on the Web -

http://www.classzone.com/books/research_guide/page_build.cfm?content=web_research&state=none

SCS Simulation News - <http://www.scs.org/newsletter/>

Search Engines, Tools and Strategies: Make the most of your time

online - <http://www.teachers.ash.org.au/researchskills/resources.htm>

Simulation job postings - <http://www.job-search-engine.com/keyword/modeling-simulation/>

The Modeling and Simulation Information Analysis Center (MSIAC) web site -

<http://www.dod-msiac.org/resources.html>

The Seven Steps of the Research Process -

<http://olinuris.library.cornell.edu/ref/research/skill1.htm>

Virginia Department of Education Guidelines and resources for internet safety in schools

http://www.doe.virginia.gov/support/safety_crisis_management/internet_safety/guidelines_resou_rces.pdf

All about ePortfolio - http://www.ehow.com/how_4425510_create-eportfolio-using-powerpoint.html

How to Create an ePortfolio with Google pages -

<http://electronicportfolios.com/google/handout.pdf>

Design Brief: Create an ePortfolio

Context

The ePortfolio is a learner-centered collection designed to empower students to acquire the self-organizational skills needed to succeed in today's workplace and to become self-confident and competent citizens.

The ePortfolio is a means of sharing an array of skills and interests that you have gained both in and out of school with peers, teachers and prospective employers as it encourages the celebration of these achievements.

In short, the ePortfolio provides a forum for developing personal competencies, such as goal setting and accomplishment, self-organization, self-confidence, and developing a vision of professional life.



Challenge

Each student will demonstrate an understanding of creating an ePortfolio. There are numerous software programs you can use to create an electronic portfolio, such as FrontPage, Dreamweaver, Word, or PowerPoint. To begin, create a list of the attributes/skills/competencies that you and your teacher want to highlight. Identify supporting documents (artifacts) that demonstrate those competencies. Artifacts can include: Word documents, Excel files, assignments, research papers, digital images, audio files, scanned letters of recognition, etc. Create an ePortfolio which will:

1. Show participation in activities
2. Demonstrate internship/work experiences
3. Announce professional memberships
4. Explain contributions to community - community service projects
5. Create a plan of study
6. Maintain a dynamic resume of your experiences in life, work, study, and at play
7. Store examples of your achievements (documents, photos, graphics, spreadsheets, web pages)
8. Create media rich information to share with family, friends, employers, faculty, and others
9. Showcase your accomplishments!

Objectives

1. Upon completion of the design brief, students will be able to do the following:
2. Identify Internet safety issues and procedures for complying with acceptable use standards.
3. Apply information literacy skills (including searching and evaluation strategies) while using electronic resources.
4. Use technology tools to collaborate and publish student work.
5. Develop a digital presentation.
6. Develop an Electronic Portfolio (ePortfolio).
7. Demonstrate appropriate use of online library catalog.
8. Present a multimedia presentation, including text, sound, and graphics, based on content from class work.

Materials

1. Internet
2. Computer and printer with appropriate software
3. Digital storage device
4. Notebook with dividers
5. Pencil and paper
6. ePortfolio

References

All about ePortfolio - http://www.ehow.com/how_4425510_create-eportfolio-using-powerpoint.html

Electronicportfolio.org by Dr Helen Barrett- <http://electronicportfolios.org/>

Dr. Helen Barrett's Professional Portfolio –
<http://electronicportfolios.com/google/handout.pdf>

How to Create an ePortfolio using Sharepoint template -
http://www.teachertube.com/viewVideo.php?video_id=35003&title=How_to_create_an_ePortfolio_site_using_a_Sharepoint_template

How To Create an ePortfolio with Google Pages -
<http://sites.google.com/site/eportfolios/How-To-Create-ePortfolios-with-GoogleApps>

<http://www.teachers.ash.org.au/researchskills/resources.htm>

Simulation job postings -
<http://www.job-search-engine.com/keyword/modeling-simulation/>
<http://www.simulationinformation.com>

The Modeling and Simulation Information Analysis Center (MSIAC)
web site - <http://www.dod-msiac.org/resources.html>

Evaluation

1. What is an ePortfolio?
2. List information that could be placed in an ePortfolio.
3. Explain the benefits of having an ePortfolio.

Unit 2: Demonstrating Computer Skills

Unit Length:

This unit will last approximately 10 days but objectives will be reinforced throughout the course.

Goals:

Demonstrate knowledge, skill, and application of information systems to accomplish job objectives.

Rationale:

Computer skills are a basic fact of life for most workers. Even if you don't work with computers in order to complete your primary work duties, it is likely that you run into them from time to time. In fact, most jobs, from supermarket management to restaurant service, require basic computer knowledge. And more and more jobs are demanding that workers become increasingly familiar with and comfortable using a wide range of computer applications.

Unit 2.1: Basic Computer Skills

Unit Length:

This unit will last approximately 10 days.

Goals:

Demonstrate knowledge, skill, and application of information systems to accomplish job objectives.

Rationale:

If you are longing to move up in your future job or if you are interested in moving into a new career, you may be wondering what computer skills you will need to accomplish these goals. Well, as computers become more and more important in most workplaces, computer skills are often the greatest asset a worker can possess. And though you may be able to get your work done with basic computer know-how, in order to really succeed in the workforce it is important to have some complex computer skills. Reaching complex computer skills requires that you have exceptional basic computer skills.

Objectives (Standards):

1. Demonstrate knowledge of different operating systems.
2. Demonstrate proficiency navigating the Internet, intranet, and the WWW.
3. Demonstrate proficiency using HTML commands.
4. Manipulate file structures.
5. Develop an awareness of micropocessors and digital computers.
6. Develop an awareness of the information technology industry.
7. Develop an awareness of programming languages.
8. Develop an awareness of emerging technologies.
9. Demonstrate proficiency using common software applications.
10. Demonstrate proficiency in computer skills.
11. Identify hardware constraints on simulations including processors and I/O devices.
12. Identify computer components and their functions.
13. Develop and apply spreadsheet skills.

Recommended Instructional Activities:

1. Review computer history timeline.
2. Have students clean and secure their workspace daily. Other students should be required to supervise this activity providing students the opportunity to lead and be led.
3. Open, edit, and save a word and other application files.
4. Locate and print to a remote printer. Allow students to load the printer with paper and toner when necessary. Allow students to trouble shoot minor printer errors.

5. Require students to backup data daily using a systematic approach

Read, Pair, and Share Activity - With a partner read portions of the acceptable use policy in your school. Each person reads a section while the other person relates back what he/she understood. This would be repeated in reverse throughout the reading.

1. Require students to type all assignments to improve their word processing skills.
2. Reinforce using proper spacing, page numbering, punctuation, capitalization, headers and footers, and tables etc.
3. Have students practice typing at online typing tutorial sites or use typing software.
4. Have students complete a typing speed test to get an official certificate of speed. This is an excellent portfolio addition.
5. Develop a professional resume for inclusion in the ePortfolio. Have students exchange resumes then proof and edit accordingly.
6. Have students strive to acquire Brainbench free certifications in IT.
<http://www.brainbench.com/xml/bb/common/testcenter/freetests.xml#sponsored>
7. Make selected folders on your storage device to keep your assignments in order. Use a naming convention that is functional.
8. Create a file backup system and routinely backup your work.
9. Practice using * wildcard symbol to find a file.
10. Practice converting one file type as another e.g. bmp to jpg
11. Search for specific files on a classmates jump drive based on partial information.
12. Post a brief biography of yourself to the intranet to let other students get to know you.
13. Using the discussion board, respond to at least two other students. Read something interesting about them and have questions you would like to ask them. Get to know your classmates.
14. Email the course instructor and attach file.
15. Visit a computer network closet of room in your building.
16. Invite a computer network professional or network instructor into your classroom as a guest speaker.
17. Prepare a schematic of various network topologies using PowerPoint, Visio or similar software.
18. Pair students to review Microsoft Excel website for new releases and information vital to novice users - <http://office.microsoft.com/en-us/excel/default.aspx>
19. Discuss this introduction to spreadsheets with students -
www.armytoolbag.com/Tools/ComputerTng/Excel1.ppt
20. Complete Microsoft [Excel tutorials](#) as needed from introduction to remediation.
21. WebQuest: Digital Camera Selection - <http://fp.ainet.com/edit4710/>

22. Review the following excel introduction - [Spreadsheets in the Classroom Using Excel](#) - Easy Quick Tips to follow to learn how to use Excel with students.
23. Complete this fun spreadsheet activity - [Fast Food Fun](#) - This site is a great way to get students to realize nutrition facts by using spreadsheet calculations for analyzing fat calories and their eating habits.
24. Discuss Bar graph analysis - [Bar Graph Analysis and Creation](#) - Check this site out to help students learn to 'picture' the data and interpret its results.

References:

Computer History Timeline - http://www.computerhistory.org/internet_history/

Papert, Seymour. Mindstorm: Children, Computers and Powerful Ideas. Basic Books, Inc., Publishers/New York, 1980; Interesting concepts are explored concerning learning, computers as a form of learning, and development of learning skills in all children.

Free online Typing course - <http://www.goodtyping.com/>

Free online Typing tutorial - <http://www.nimblefingers.com/>

Get your Typing Certification now - <http://www.learn2type.com/TypingCertificate>

goodtyping.com - Typing speed test - <http://www.goodtyping.com/test.php>

Resume Writing 101 Get Your Resume in Shape for Jobs and Internships - <http://www.collegeboard.com/student/plan/high-school/36957.html>

Microsoft Developer Network (MSDN): Naming a File - <http://msdn.microsoft.com/en-us/library/aa365247.aspx>

How File Systems Work - <http://ezinearticles.com/?How-an-Operating-Systems-File-System-Works&id=980216>

File system Hierarchy Standard - http://en.wikipedia.org/wiki/Filesystem_Hierarchy_Standard

Working with Files and Folders - <http://www.jegsworks.com/Lessons/win/filesandfolders/index.html>

An Introduction to Computer networks - <http://www.boloji.com/computing/networking/n001.htm>

Basics of computer networks Sanford University PPT - <http://www.stanford.edu/class/cs244a/>

How Ethernet Works - <http://computer.howstuffworks.com/ethernet2.htm>

Introduction to Computer Networks - <http://functionx.com/networking/Lesson01.htm>

[Introduction to Computer Networking -
http://www.ncte.ie/documents/networking/Introduction_Computer_Networkin
g.doc](http://www.ncte.ie/documents/networking/Introduction_Computer_Networking.doc)

Excel introduction - <http://home.ubalt.edu/ntsbarsh/excel/excel.htm#rintro>

Microsoft Excel tutorials - <http://office.microsoft.com/en-us/training/CR100479681033.aspx>
Spreadsheet Fast Food Activity -
<http://www.ncwiseowl.org/kscope/techknowpark/Kiosk/index.html#>

[Center for Technology and Teacher Education](#) - Microsoft Excel Interactive Projects

[Classrooms That Excel Resources](#) - Guides, Tutorials, Applications and Lesson Plans

[Integrating Spreadsheets in the Classroom](#) - Tutorials, Assessment, Charting & Graphing, Real- time data, Lesson Plans and WebQuests

[Internet4Classrooms](#) - Excel learning modules on a variety of topics; other Excel links
[Integrating Spreadsheets in the Classroom](#) - Get students to see data represented in graphs often.

[Classroom Resources for Spreadsheets](#) - How to use spreadsheets is explored through these many links.

[Developers Guide to Excelets](#) - Mathematical samples of interactive Excel are linked to this page.

Downloadable examples of interactive Excel can be found on this page - <http://academic.pgcc.edu/~ssinex/excelets/>

[Spreadsheet Basics](#) - This online tutorial helps understand and visualize the vocabulary associated with spreadsheets while you have an Excel file open.

[A Viewlet for Learning Excel Basics](#) - This site runs a program to view how to set up a spreadsheet which analyzes temperatures.

[Online Training with Excel](#) - This site has the basics of Excel broken down into sections with Quicktime video used to explain each section. This site is great for the audio and visual learner.

[A Day in the Life of a Meteorologist](#) - Based on the weather maps and data students collect over a period of two weeks, they create a PowerPoint

Tutorial on Graphs - Gives advantages and disadvantages and purposes of using graphs. This site covers the types of charts and graphs and helps students know how to choose the right one for a task –

http://spreadsheets.about.com/od/excelcharts/ss/Chart_wiz_step.htm

[Internet 4 Classrooms Excel Tutorial - Microsoft Excel Modules](#) - A very easy to understand tutorial for MS Excel and sample workbooks to download.

[Tech Train: Overview of Microsoft Excel](#) - A great online

tutorial. National Council of Teachers of Mathematics -

<http://www.nctm.org/>

[Comparing Graphs](#)

Three different sets of data (earnings, votes, heights) are shown with three different types of graphs (line, bar, circle). The student is to compare the different graphs to determine which is best.

[Comparing Data](#)

The student enters data and then the spreadsheet generates several measures of that data such as mean, median, mode, quartiles, and range, which the user can investigate and compare.

[Effects of Parentheses](#)

The user inputs a mathematical expression, and then alters it with parentheses to see how many different answers can be generated. Great site for teaching order of operations.

[Exploring Slope](#)

Students learn about slope by experimenting with different values for "m" in the slope-intercept equation, then looking for patterns, relationships, and generalizations.

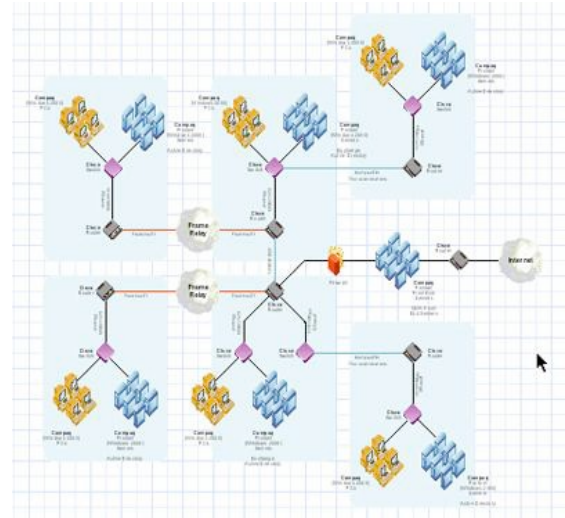
[Scatter plots](#)

As the user enters ordered pairs; the spreadsheet graphs a scatter plot, creates a line of best fit, and displays its equation (in linear or polynomial form).

Design Brief: Design a Computer Network

Context

A network is a set of computers which are linked together on a permanent basis. This can mean two computers cabled together on the same desk or thousands of computers across the world. Coworkers thousands of miles apart can share information instantaneously, just as hundreds of workers in a single location can simultaneously review research data maintained online. Creating a basic network diagram is an effective way to design and document a simple network. A basic network diagram can help you show logically how different devices will be installed to meet business needs.



Managing a computer network today is no small task. In addition to controlling access to printers and files over the network, most administrators must also manage security and access, optimize traffic flow across Local Area Networks (LANs) and Wide Area Networks (WANs), coordinate repair and maintenance of network equipment, and oversee data backup, storage, and recovery.

Challenge

Each student will demonstrate an understanding of a simple computer network by using a graphical diagramming program or pencil and paper to graphically show the arrangement of simple network components. Basic network diagrams must show the primary pieces of your network and how those pieces are connected. When choosing a network type (topology) four things should be considered: Cost, expandability, location of PC's, and speed

Objectives

Upon completion of the design brief, students will be able to do the following:

1. Identify computer network components.
2. Identify basic types of topologies.
3. Apply technology to communicate and collaborate.
4. Describe a LAN and WAN.
5. Discuss the differences between an Internet and Intranet.

Materials

- Internet and researched information
- Computer with appropriate graphical software
- Pencil and paper
- ePortfolio

References

Easy Home Networking Tutorial - <http://www.homenethelp.com/web/howto/HomeNet-start.asp>

How Stuff Works: How Home Networking Works - <http://www.howstuffworks.com/home-network.htm>

Basics of computer networks Sanford University PPT - <http://www.stanford.edu/class/cs244a/>

How Ethernet Works - <http://computer.howstuffworks.com/ethernet2.htm>

Introduction to Computer Networks - <http://functionx.com/networking/Lesson01.htm>

Introduction to Computer Networking - http://www.ncte.ie/documents/networking/Introduction_Computer_Networking.doc

Evaluation

1. You have two or more computers. How do you connect them to share files and printers?
2. You need a home network. *First start by selecting a cabling method - Ethernet, wireless, PhoneLine, etc.*
3. What is the most popular network type for both home and business? *The Ethernet.*
4. Ethernet can operate at 10Mbps or 100Mbps. *T/F*
5. What is Bandwidth? *Every line has an upper limit and a lower limit on the frequency of signals it can carry.*
6. *This limited range is called the bandwidth.*
7. What is MAC address? *The address for a device as it is identified at the Media Access Control (MAC) layer in the network architecture. MAC address is usually stored in ROM on the network adapter card and is unique.*

Unit 3: Investigating Modeling and Simulation

Unit Length:

This unit will last approximately 70 days.

Goals

- 3.1 Become familiar with basic Modeling and Simulation.
- 3.2. Explain distributed simulation.
- 3.3 Explain visual simulation.
- 3.4 Explain sound/audio simulation
- 3.5 Explain Human Behavior Models
- 3.6 Explain intelligent systems.
- 3.7 Explain environmental models.
- 3.8 Build a simple scenario for experimentation or training.

Rationale:

At this point, students should have enough review and background information to be able to navigate solutions to modeling and simulation problems. Students get a better appreciation for these types of problems by applying a hands-on methodology. This unit provides the application of modeling and simulation.

Unit 3 .1: Modeling and Simulation Basics

Unit Length:

This unit will last approximately 7 days.

Goals:

Become familiar with basic modeling and simulation.

Rationale:

This unit serves as an introduction to modeling and simulation. Up to this point, you've been learning a lot of modeling and simulation skills although they were not specified during every unit. The approach now is to get you to start using more terminology and software as it directly applies to the M & S area of study.

Objectives:

1. Explain uses of M & S.
2. Perform a hand simulation for a defined problem.
3. Identify the various components of a simulation.
4. Apply the use of discrete event simulation.
5. Describe categories of M & S.
6. Describe virtual training simulators and their use
7. Use Monte Carlo simulation.
8. Explain verification and validation.

Recommended Instructional Activities:

1. Ask students if they think they've ever used simulation in their lives. Explain that we've been doing this for many years, but with the advent of the computer system, we are able to run more complex simulations faster and with a higher degree of accuracy.
2. Define *simulation*, *modeling*, *system*, and *computer simulation*.
3. Describe why people use modeling and simulation (i.e. when it's too costly, too dangerous, or physically impossible to do something in the real world.)
4. Distinguish between physical models and logical/mathematical models.
5. Create a hand simulation around a topic of your choice. For example include: the spread of the Black Plague, our political system, simulate how the internet works. The idea is for students to understand that one does not necessarily need a computer to run a simulation. Additionally, students should understand that although there is an element of randomness in many simulations (i.e. rolling a die), simulation is inherently algorithmic.
6. Download the Stella software from
<http://www.iseesystems.com/community/downloads/EducationDownloads.a>

- [spx](#) and run the Predator Prey Dynamic Model. Discuss how the model enables a complicated problem to be understood more easily.
7. Access Insight Maker from <http://insightmaker.com>. Locate the Prey Predator Model. Discuss the components of the model and relationships. Try various changes to the model and observe the results. Can the model be used to predict outcomes?
 8. Explain the use of the terms *entity*, *behavior*, *interaction*, *attributes*, *resources*, *queues*, *events*, and *simulation clock* as they relate to simulations.
 9. Introduce Monte Carlo simulations as a mechanism for solving problems using random numbers and probability. Provide students with the properties and steps in a Monte Carlo method.
 10. Provide students with a simple example using an Excel spreadsheet and the random functions in the software.
 11. Explain *discrete event simulations* and how they are useful in optimizing manufacturing, food industry, and other industries.
 12. Provide a tutorial on the chosen software for discrete event simulation. (Some software choices include Arena by Rockwell software at the site <http://www.arenasimulation.com>)
 13. Assign students to observe either the high school cafeteria line or fast food chain line. Students should observe the various stations that customers pass through in order to order, purchase, obtain, their food. Some software has an data input analyzer that will fit the data to the best distribution, however students may wish to actually simulate the real line, having customers arrive at the times noted during their observations. After the simulation is run, students should analyze the output to determine when or if there was a bottleneck in the simulation, determine what corrective action might be taken and run the simulation with their changes. Finally, students may submit a report with their data, analysis, and conclusions.
 14. Explain the types of simulations that are currently most commonly used, live, virtual, and constructive. Plan a field to trip to a local company or invite a speaker into the classroom who will be able to demonstrate some the differences as well as discuss how the various types of simulations can work together.
 15. Describe the types of real-time training simulators in use such as driver trainers, flight simulators, etc. Discuss, with the class, the common characteristics of each example given.
 16. Explain the terms verification and validation and emphasize the difference between the terms. Students should provide evidence of verification and validation of their models and simulation in the exercise created in #13 above.

17. Paper simulation of household appliances-The students will have a hands-on opportunity to conduct a “paper” simulation of a real-world problem by building a static mock-up as follows:

The problem to be addressed centers around their grandparents who have a new glass-top stove and microwave in their retirement apartment. They are having difficulty in understanding the functions of the touch pads on the microwave and the operation of the stove is confusing to them. It is difficult to identify the correlation between the burner controls with the burners. In addition, they need to understand the differences in temperature possible with the two different size burners. Further, the stove remains hot after the switch is turned “off” and this presents a safety issue. The challenge for the class is to construct a paper or cardboard mock-up of both appliances to demonstrate the functions of the various controls.

Students will “story board” the functions of the appliances in various scenarios to teach their grandparents how to use these appliances. They research the internet to find out what temperatures are possible with the stove. In addition, they will use the internet to describe the use of the microwave touch pad from the manufacturer. They can plot the declining temperature of the burner after the switch is turned off. Students will be guided to understand how a computer-based simulation might be constructed to teach the operation of both appliances. If appropriate software is available, the students might construct such a simulation.

18. A fun interactive simulation in food service industry- Go to the web site <http://Ninjakitchengame.org>.

Designed to teach players about the dangers of food contamination and the conditions under which bacteria grow and spread, Ninja Kitchen is aimed at middle schoolers but fun for all ages. Bold animation and quirky graphics keep players' attention. The game is so engaging that players internalize the basics of food safety without noticing, though **Ninja Kitchen** takes focus and memory skills.

Customers suffer graphic foodborne illness if you serve them contaminated food, and gameplay reinforces habits of handwashing, sanitizing fruits and vegetables, cooking meat to the proper temperature, and avoiding cross-contamination. Once hooked on **Ninja Kitchen**, players will segregate raw meat from veggies, wash their hands after taking out the trash, and be wary of contaminated surfaces. This engrossing game inspires them to put their all into assembling difficult orders safely, to receive a piece of wisdom from the sensei and take on the next level's challenge.

Learning objectives include:

1. Learning the importance of washing hands before eating and cooking
2. Understanding the dangers of leaving food in the food danger zone, where bacteria thrive.

3. Preventing cross-contamination by cleaning plates and work spaces after prepping high-risk foods like raw meat and unwashed vegetables.
4. Realizing that meat must be cooked to the proper temperature. Judging whether food is contaminated based on how it has been handled, since contamination can be invisible.

Ninja Kitchen is a project of the NMSU Learning Games Lab, producer of award-winning games for science and math learning, and Carol Byrd-Bredbenner, professor and Extension specialist at Rutgers University and innovative educator in nutrition and food safety.

19. Simulating the battles of WORLD WAR II- Go to the website:

<http://usacac.army.mil/cac2/csi/docs/European%20Theater.ppt#258,1,Slide>

[1http://usacac.army.mil/cac2/csi/docs/CombatStudiesInstitute-200804010025-DOC.ppt#263,1,Slide](http://usacac.army.mil/cac2/csi/docs/CombatStudiesInstitute-200804010025-DOC.ppt#263,1,Slide) 1

The simulation steps through the battles of the European and Pacific theater battles in a historic time sequence. Students can receive a lesson in world history while experiencing the simulation. The simulation is not complex, uses power point but it demonstrates how 2D graphics with limited audio can reinforce the instruction. As an exercise, students can research the major battles identified and capture more specific information about those battles. In addition to a history lesson, students learn a great deal about geography. Students could give a stand-up presentation about World War II using the simulation, elaborating on the circumstances of selected battles.

20. Virtual Reality for teaching deaf and hearing impaired children- Students will design a virtual reality system for teaching elementary school deaf and hearing impaired children living skills.

First, the students as a class go through a “brainstorming” session where they identify the critical skills necessary for that segment of society. For example, these students may have difficulty in ordering at a fast food restaurant and making change properly.

After the scenarios to be modeled are identified and prioritized, the class will be divided into teams that will proceed with designing a virtual reality system to provide that training. The degree of design detail is a function of the grade involved and the resources available.. It may be that the level of detail of design is simply a block diagram of the system. This gives students an opportunity to learn how to identify simulator requirements and how those requirements can be met through a simulator. Each team will present their design concept and defend it, taking questions from the rest of the class.

21. Office of Naval Research Sea Perch Program:

<http://www.seaperch.org>

SeaPerch is an innovative underwater robotics program that equips teachers and students with the resources they need to build an underwater Remotely Operated Vehicle (ROV) in an in-school or out-of-school setting. Students build the ROV from a kit comprised of low-cost, easily accessible parts, following a curriculum that teaches basic engineering and science concepts with a marine engineering theme. The SeaPerch Program provides students with the opportunity to learn about robotics, engineering, science, and mathematics (STEM) while building an underwater ROV as part of a science and engineering technology curriculum. Throughout the project, students will learn engineering concepts, problem solving, teamwork, and technical applications.

Building a SeaPerch ROV teaches basic skills in ship and submarine design and encourages students to explore naval architecture and marine and ocean engineering principles. It also teaches basic science and engineering concepts and tool safety and technical procedures. Students learn important engineering and design skills and are exposed to all the exciting careers that are possible in naval architecture and naval, ocean, and marine engineering.

SeaPerch is...

- A hands-on educational tool
- Fun and challenging
- A curriculum that meets national learning standards
- Integrates STEM (Science, Technology, Engineering, Mathematics)
- Teaches the teachers
- Builds teamwork and inspires young minds
- Introduces STEM career discussions

A Hands-On Activity

Students learn best by doing and during the process of building SeaPerch, they follow steps to completely assemble the Remotely Operated Vehicle (ROV), test it, and then participate in launching their vehicles.

After the SeaPerch robot is constructed, students are encouraged to test their vehicles, deploy them on missions, and compete in a culminating event, the SeaPerch Challenge - a district-wide one-day design competition, to take what they have learned to the next level. The Challenge fosters an end goal, rewards sportsmanship, spirit and presentation skills, as well as mastery of the concepts. Events at the Challenge can include:

- Vehicle performance - maneuvering and recovery
- Innovative design (optional)
- Team presentations - oral presentations to judges
- Design
- Notebooks - document planning, design, construction, testing, and learning
- Team spirit and sportsmanship at the event

Winners of local or regional Challenges can compete in the [National SeaPerch Challenge](#), held each spring.

A Teacher Training Program.

One of the most important aspects of SeaPerch, and one that differentiates it from similar programs, is that it includes training for teachers. The two methods of training are online, either with a webcast or video training modules, or on-site training. The on-site training is offered in several locations at set times throughout the year, and if the teacher has travel funds available for hotel, transportation and travel expenses, and can travel to the site, the training on-site is at no charge, all meals included during the 1 or 1.5 day training. Continuing education and/or professional development credits may be offered, as educators are often required to attend workshops throughout the year.

An Established Curriculum.

The SeaPerch curriculum has been designed to meet many of the national learning standards identified by the government, as well as the new Common Core standards. With one project, schools are able to teach many of the concepts required for their grade level using a fun, hands-on activity for students. Some of the concepts the students learn during the build include:

- Ship and submarine design
- Buoyancy/displacement
- Propulsion
- Soldering/tool safety and usage
- Vectors
- Electricity/circuits and switches
- Ergonomics
- Waterproofing
- Depth measurement
- Biological sampling
- Attenuation of light
- Moment arm, basic physics of motion
- Career possibilities

Program Benefits:

Meets National Learning Outcomes: The SeaPerch Program meets many of the national learning outcomes for science.

Supports Diversity: The program focuses on presenting the possibilities of technical careers to minorities, girls, and underrepresented populations.

Design Brief: Programming a Calculator

Context

Programming in Modeling and Simulation is a critical tool and one that requires some experience before becoming proficient. Equally important to the final project is to be on schedule and within the provided budget. From designing the project plan, to implementing the final product, there are a variety of positions when working as a team on a project. This project encompasses many of the skills learned during the programming unit to include functional programming, loops, and decision structures. As an introductory project, students will plan, design, and implement the functions of a basic calculator.



Challenge

Students will work in groups to design and implement a program utilizing methods, variables, loops, and decision structures. Students should design and implement the functions of a basic calculator. The program should accept both integers and decimal values and users should be able to add, subtract, multiply and divide two or more values. As time permits, students may come up with an object oriented design and implement a graphical interface.

Objectives

Upon completion of the design brief, students will be able to do the following:

1. Succinctly describe the goal of the program.
2. Produce a project schedule.
3. Update a project schedule.
4. Produce an object oriented design.
5. Prepare a design document for the implementation of the program
6. Declare variables.
7. Get user input and display output.
8. Use programming decision structures.
9. Use programming repetition structures.
10. Implement functions.
11. Document code
12. Provide instructional documentation for the program.
13. Use arrays as time permits.

Materials

1. Computer.
2. Programming language of choice.
3. Spreadsheet software.

4. Word processing software.
5. Flowcharting software.

References:

The Basics of Monte Carlo Simulation

<http://www.chem.unl.edu/zeng/joy/mclab/mcintro.html>

A Brief History of Flight Simulation

<http://homepage.ntlworld.com/bleep/SimHist1.html>

Estimation of Pi Simulation (Applet)

<http://www.mste.uiuc.edu/activity/estpi/>

The Future of Simulation

<http://www.dtic.mil/cgi-bin/GetTRDoc?AD=ADA473368&Location=U2&doc=GetTRDoc.pdf>

An Introduction to Simulation in Statistics

<http://home.ubalt.edu/ntsbarsh/simulation/sim.htm#rrprobat>

Kelton W. David, Sadowski, Randall P., Sturrock, David T. Simulation with Arena, McGraw- Hill Professional, 2007
ISBN 0072919817, 9780072919813

Live Virtual and Constructive Simulation

<http://www.peostri.army.mil/PRODUCTS/LVCA/>

Model Verification and Validation PowerPoint

http://jtac.uchicago.edu/conferences/05/resources/V&V_macal_pres.pdf

Reese's Pieces Simulation (Applet)

<http://statweb.calpoly.edu/chance/applets/Reeses/ReesesPieces.html>

Simulation in Anesthesiology

<http://www.springerlink.com/content/604v67q76036227k/fulltext.pdf>

Simulation, History and Computer Games

<http://www.knaw.nl/smartsite.dws?id=25792&lang=ENG>

Simulink Verification and Validation

<http://www.mathworks.com/products/simverification/>

Verification, Validation and Certification

http://www.ece.cmu.edu/~koopman/des_s99/verification

Unit 3.2: Distributed Simulation

Unit Length:

This unit will last approximately 8 days.

Goals:

Explain distributed simulation.

Rationale:

Distributed simulation is one of the most important aspects of modeling and simulation in terms of economic development. Due to increased costs of transporting people to a specific location for training, distributed training and, in turn, distributed simulations are becoming ever more critical. Distributed simulation implies that one or more simulations are communicating via a network connection in real time or pseudo real time. Currently, distributed simulations are a primary training tool for the military, but as other industries such as education and medical training adopt the technologies, the need for experts in this field will increase.

Objectives:

1. Explain networking concepts.
2. Explain distributed simulation protocols.
3. Apply programming skills to create a networked simulation or game.

Recommended Instructional Activities:

1. Review the components necessary for networking systems to include: *protocols, network cards, Ethernet cables, Internet Protocol Addresses, Subnet masks, operating system, ping command, and ipconfig, TCP/IP and UDP.*
2. Explain the use of packets in computer communication and that the Internet uses the TCP/IP protocol. Give examples of other protocols such as HTTP, SMTP, etc.
3. Acquire a switch or hub for a classroom demonstration for setting up a network. To accomplish this, Administrator privileges may be required. By the end of the demonstration, students should be able to completely set up a small network and ensure that the computers are communicating.
4. Explain that simulations have a number of communication protocols built on top of TCP/IP including the High Level Architecture (HLA), Distributed Interactive Simulation (DIS), Test and training Enabled Architecture (TENA). Students should understand that these are the currently accepted protocols, but that it is not necessary to use them.

5. Allow students to work in groups and develop their own protocol. Remind students that they will need to agree upon how the data will be transmitted and in what format. When the students have completed the assignment, at least one group will probably try and pass a large quantity of data in a single interaction or object. Discuss the idea of network bandwidth and the need for fast communications, especially in the use of real time simulation.
6. Explain that the most frequently used communication protocol is currently HLA. Provide a brief introduction to HLA by identifying the following terms about HLA: *objects, interactions, federation, federation object model, simulation object model, Runtime Infrastructure (RTI)*.
7. Provide students with a simple distributed game. For example, create a simple application that allows a distributed hello. For a more complex example, Java easily allows the implementation of simple graphics so one might create a game where students move over a grid. Initially students will not be able to destroy each other, but via the implementation of interactions and objects, weapons will be able to be fired and collisions will take place. An RTI software package will be required for this exercise.
8. Invite a speaker into class to discuss the applications of distributed simulation in his or her field.

References:

Delta3D.org – Open Source Gaming Engine that can be used in distributed simulation <http://www.delta3d.org/>

Department of Defense High Level Architecture
<http://www.informs-sim.org/wsc97papers/0142.PDF>

A Distributed Interactive Simulation using Java
<http://web.nps.navy.mil/~brutzman/vrtp/dis-java-vrml/download.html>

Distributed Simulation and Industry: Potentials and Pitfalls
<http://www.informs-sim.org/wsc02papers/088.pdf>

A GIS-enabled Distributed Simulation Framework for Natural Resource Management <http://www.tiem.utk.edu/gem/paper2/GIS.pdf>

Hamilton, John A, Nash, David A., Hamilton, Pooch, Udo W., Distributed Simulation, CRC Press, 1997
ISBN 0849325900, 9780849325908

Introduction to TCP/IP

<http://www.yale.edu/pclt/COMM/TCPIP.HTM>

Magnatar Games RTI – freely downloadable IEEE 1516 RTI

<http://www.magnetargames.com/Products/Chronos/>

Networking Concepts – University of Waterloo

<http://ist.uwaterloo.ca/cs/sew/courses/literacy/netconcepts.pdf>

Open DIS – Open Source of Distributed Interactive

Simulation Protocol <http://open-dis.sourceforge.net/>

SISO Product Support Groups

<http://www.sisostds.org/StandardsActivities/SupportGroups.aspx>

Public Domain Scalable Simulation Framework

<http://www.ssfnet.org/homePage.html>

Test and Training Enabled Architecture Software Development Site

<https://www.tena-sda.org/display/intro/Home>

TCP/IP Tutorial

<http://www.w3schools.com/tcpip/default.asp>

TCP vs. UDP

<http://delphi.about.com/od/adptips2005/qt/udpvstcp.htm>

Transportation Model Using the High Level Architecture

<http://txspace.tamu.edu/handle/1969.1/440>

UDP Concepts

<http://www.networksorcery.com/enp/protocol/udp.htm>

Understanding the UDP Protocol

http://www.windowsnetworking.com/articles_tutorials/Understanding-UDP-Protocol.html

Unit 3.3: Visual Simulation

Unit Length:

This unit will last approximately 10 days.

Goals:

Explain visual simulation.

Rationale:

The uses of two dimensional and three dimensional visualizations are a growing piece of the simulation community. The ability to view the data transition visually allows for a better understanding of the overall simulation being observed. In addition, models of specific tools such as those used in welding, shipbuilding, and space travel are becoming increasingly important in the overall design of the product. Very often, a visualization of the data being translated in a distributed simulation will be integrated into the overall simulation. This visualization becomes critical to get a better understanding of the training or educational activity being simulated. Finally, visualization is a critical aspect of the gaming industry and in great need.

Objectives:

1. Define visual simulation.
2. Explain uses of visual simulation.
3. Explain the use of visual simulation in distributed simulation
4. Explain the functions of the image generator, displays and databases to support visual simulation.

Recommended Instructional Activities:

1. Define visual simulation.
2. Explain the uses of visualization simulations to include applications in the health industry, defense, sciences etc. It is critical to understand that a visual simulation is only as good as the data feeding it. If a visualization does not represent what should be happening as if it was running in reality, it will not be at all beneficial, no matter how great the graphics may be.
3. Describe how the visual system contributes to mission success in a flight simulator.
4. Provide students with a series of websites that use visual representations to assist in the understanding of a concept. Medical visual simulations are relatively abundant on the Internet.
5. Refer students to visual simulation packages on the web such as OpenSceneGraph (<http://www.openscenegraph.org/projects/osg>), an open source gaming and visualization engine.

6. Reinforce the concept of distributed simulation by reusing the distributed aspect of the "hello world" program, only this time, with the instructor's assistance, the students will be able to create a visual representation of the data they sent rather than simply text. Depending upon the fidelity of the visual program being used or created, students may be able to send hello's to other students in various colors and font sizes.
7. Provide some information about 3D graphic formats; the fact that such formats are in reality tree-structured databases that help with real-time rendering; a good example is OpenFlight or OpenInventor. In particular, OpenInventor can be an ASCII format that allows students to build 3D scenes by specifying shapes/objects in a text file. If time allows, Presages (from the developers of Vega Prime) provides a free API that allows reading/writing open flight databases.
8. Many companies use 3-D visual simulations in training their employees to perform a particular task (i.e. Northrop Grumman Shipbuilding). Find a local company and see if a visualization demonstration can be arranged. Many organizations will now use virtual reality.

References:

Delta3D Organization <http://delta3d.org>

FlightGear – a freely downloadable flight simulator <http://www.flightgear.org/>

Google SketchUp <http://sketchup.google.com/>

An Integrated Global GIS and Visualization System -- Paper
<http://smartech.gatech.edu/bitstream/1853/3527/1/97-07.pdf>

ISS Foresight Free Visualization Tool <http://3d-visual-simulation.qarchive.org/>

Open Flight - <http://www.multigen.com/products/standards/openflight/index.shtml>

Open Inventor - <http://oss.sgi.com/projects/inventor/>

Second Life 3-D virtual world <http://secondlife.com/>

Visual Simulation of Ice Crystal Growth <http://www.cs.unc.edu/~geom/ICE/>

Visual Simulation of Smoke
<http://physbam.stanford.edu/~fedkiw/papers/stanford2001-01.pdf>

Visual Simulation of Shockwaves <http://gamma.cs.unc.edu/SHOCK/>

Unit 3.4: Audio/Sound Simulation

Unit Length:

This unit will last approximately 10 days.

Goals:

Understand and explain audio and sound simulation.

Rationale:

Aural cueing is of primary importance in real-time virtual simulations in that it adds the realism necessary to transfer the simulation experience to the real platform should it be an airplane, automobile, tank, etc. In the case of airplane virtual simulators, various sounds generated include engine noises, voice communication, alerts and warnings, sensor information, wind noises, etc. The gaming industry embraces sound to accompany visualizations in various powerful scenarios. Sounds make games more exciting and stimulates the senses. Going back in history, movies in their infancy did not have sounds integrated with the projected visual scenes. There were captions written on the bottom of the screen for the words spoken and boring background music playing.. Today, the sounds including voices are broadcast in “surround sound” at a high volume (often at the threshold of pain) but offering the viewer the full benefits of visual and sound. New digital technologies have emerged to greatly improve the fidelity of the sounds and provide improved aural cueing and captivating experiences.

Objectives:

1. Incorporate audio assets into game/simulation engine.
2. Perform various job roles typical for an audio technician on a game/ simulation project
3. Understand the history of audio/sound effects in the entertainment industry.
4. Demonstrate basic audio production
5. Set-up and configure a computer for audio applications
6. Demonstrate application of MIDI in a game/simulation project.

Recommended Instructional Activities:

1. Define aural cueing in simulation.
2. As a group, list the sounds present in a commercial airliner that should be simulated to provide crew training.
3. Explain the uses of sound simulations in gaming.
4. Describe how the aural cueing system contributes to mission success in a flight simulator.
5. Provide students with a series of websites that use audio representations.
6. Refer students to visual simulation packages on the web. Have the students compare the performance of various commercial packages.
7. In a visit to a local simulator or gaming company, request a separate explanation of how sound is generated and integrated into the overall simulation or game.

Audio Production for Digital Media, Animation and Gaming:

Often the most effective way to enhance Visual Language is with the use of Sound. The sound can be in the form of a complex special effect using computers, synthesizers, and algorithms. It can also be produced by simple household items such as Pots, Pans, rubber bands and drinking glasses. But no matter how simple or complex the methodology it is important to know some simple rules of recording and in the case of digital applications and media how to import this sound information into a computer and add it to whatever visual media you are using it for.

This lab is designed to introduce the student to the basics of sound production, including audio production terminology, audio production tools and some examples of popular software used to pull it all together.

One of the first things that must be accomplished in recording or even editing already recorded sound is to create a quiet environment. To ensure that the audio you record has integrity, you should make sure the recording environment is free from ambient noises such as outdoor sounds from automobiles, airplanes and people talking. There are also interior noises that can contaminate your recording that are less obvious such as the fan from your computer, the ambient noise from a fluorescent light.

There are ways that these sounds can be isolated such creating a barrier use sound blankets (moving blankets are an excellent substitute), also foam found in boxes often used to cushion electronics.

Tools Needed:

- Computer
- Recording software
- Audio interface
- Audio mixer (optional)
- Studio monitors (Computer speakers) – consumer grade will do
- Headphones (Skype Headset will work)
- Microphones ()but a good mic such as a Snowball microphone by Blue or the Tascam TMSTI Condenser Microphone sold at Amazon.com for under \$30.00
- Pop filter (Optional)
- Digital Audio Recorder Zoom H2n that records directly to digital SD media cards.

Audio Software

Free Software PC:

Audacity

Waveosaur

Kristal Audio Engine

Free Software Mac:

Audio Toolbox

Audio Tools Pro 5.1

PlayerPro Freeware

Software (PC):

- Acid Music Studio Sony Media (Audio recording, loop sampling, composing original digital scores)
- Sound Forge
- Adobe Audition

Software (Mac)

- Garage Band
- Amadeus Pro
- WavePad

Lip Syncing Software:

Poser (3D)

Magpie Pro (3D/2D)

Adobe Flash (2D)

Lab Exercise Recording Audio for lipsyncing for Animation and Gaming - 6 Hours

How do I make my characters talk?

You can create talking characters by starting with a WAV sound file containing the speech, produce phoneme data from this sound file and animate the mouth of your characters head based on the phoneme data.

What is a Phoneme?

The smallest unit of speech that affects the meaning of a word (a sound unit). The 'c' in cat and the 'm' in mat are phonemes. A phoneme is the smallest contrastive unit of sound in a word. There are approximately 44 phonemes in English (the number varies depending on the accent). A phoneme may be represented by one, two, three or four letters. For the purposes of this technology, we are using one and two letter phoneme representations, and we are only using 10 phoneme variations for the mouth shapes. Game speech does not have to be accurate given the equal importance of overall performance, and 10 phoneme variants are plenty for modern games.

How do I animate the mouth of my own Characters?

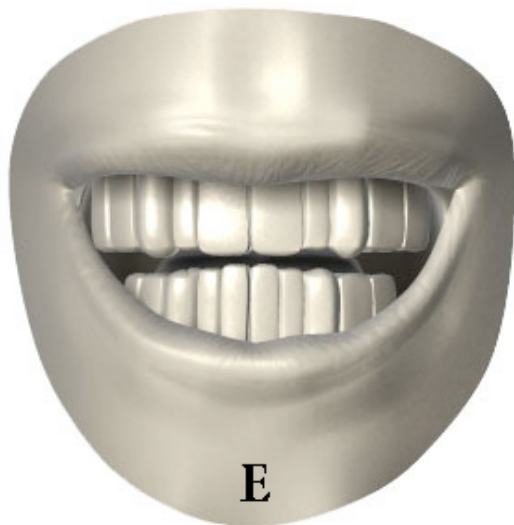
You can find video tutorials on The Game Creators web site showing how the Anna model was created in 3D Studio Max. We hope this will point you in the right direction for making your own talking 3D characters for your games or 2D Characters for Limited Animation and Digital Media projects. You can of course use Anna and modify her for your own creations.



A and I



**c_d_g_k_n_r_
s_th_y_z**



E



_f_v_d_th



l_d_th



m_b_p

Figure 1: The basic Phonemes

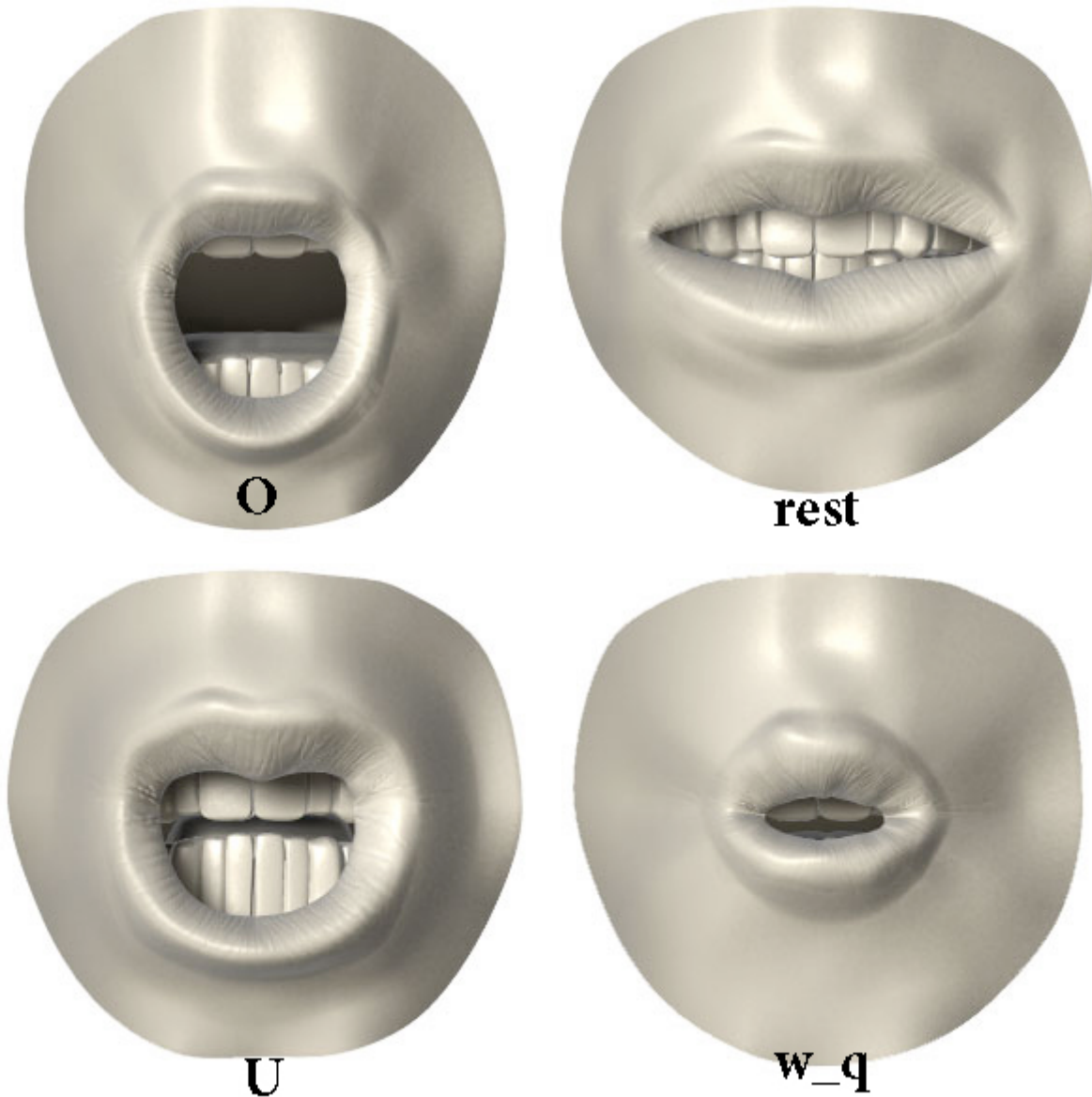
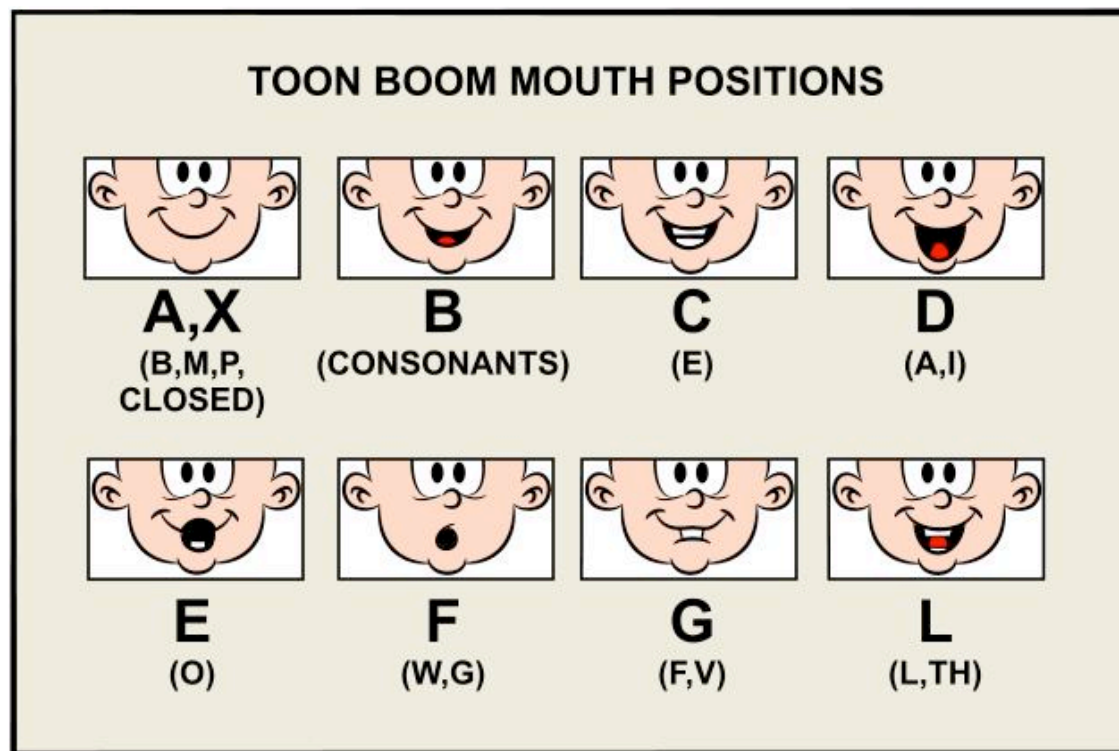


Figure 2



Figure

Animating speech can be one of the most difficult tasks in animation; the process of matching the mouth-movements of your animation to the phonemes of your audio track is most commonly known as **lip-synching**. For a quick fix, it's no problem to just animate the mouth opening and closing, and it's a simple shortcut, especially when animating for the web. But if you want to add actual expression and realistic mouth-movements, it helps to study how the shape of the mouth changes with each sound. There are dozens upon dozens of variations, but my sketches are renderings from the basic ten shapes of the *Preston Blair phoneme series*. (They're also an example of what happens when Adri dashes off ten-minute sketches from memory rather than detailed artwork.)

These ten basic phoneme shapes (click the image thumbnail in the right-hand column of this page, or [click here](#) for a full-size version) can match almost any sound of speech, in varying degrees of expression--and with the in-between frames moving from one to the other, are remarkably accurate. You may want to keep this for reference.

- **A and I:** For the A and I vowel sounds, the lips are generally pulled a bit wider, [teeth](#) open, tongue visible and flat against the floor of the mouth.
- **E:** The E phoneme is similar to the A and I, but the lips are stretched a bit wider, the corners uplifted more, and the mouth and teeth closed a bit more.
- **U:** For the U sound, the lips are pursed outwards, drawn into a pucker but still somewhat [open](#); the teeth open, and the tongue somewhat lifted.
- **O:** Again the mouth is drawn to a pucker, but the lips don't purse outwards, and the mouth is rounder, the tongue flat against the floor of the mouth.
- **C, D, G, K, N, R, S, Th, Y, and Z:** Long list, wasn't it? This configuration pretty much covers all the major hard consonants: lips mostly closed, stretched wide, teeth closed or nearly closed.

- **F and V:** Mouth at about standard width, but teeth pressed down into the lower lip. At times there can be variations closer to the D/Th configuration.
- **L:** The mouth is open and stretched apart much like the A/I configuration, but
- **M, B, and P:** These sounds are made with the lips pressed together; it's the duration that matters. "M" is a long hold, "mmm"; "B" is a shorter hold then part, almost a "buh" sound; P is a quick hold, puff of air.
- **W and Q:** These two sounds purse the mouth the most, almost closing it over the teeth, with just the bottoms of the upper teeth visible, sometimes not even that. Think of a "rosebud mouth".
- **Rest Position:** Think of this as the "slack" position, when the mouth is at rest--only with the thread of drool distinctly absent.

When you're drawing or modeling your animation, by listening to each word and the syllable combinations inherent you can usually break them down into a variation of these ten phoneme sets. Note that my drawings aren't perfectly symmetrical; that wasn't just shoddy sketching. No two people express themselves in an identical fashion, and each has individual facial quirks that make their speech and expressions asymmetrical.

The first lab:

(Students will learn to make a clean audio recording, then create a basic set of cartoon style phonemes for a simple self portrait character).

*This lab can also be accomplished by using a copy of the Phonemes in Figure 1 (3D) or Figure 2 (2D)

Equipment Required:

- PC Microphone – usb or 1/8" (Snowball, Logitech, Skype Headset)
- Relatively quiet location in the classroom
- Image Editing Program (Photoshop, Illustrator, Photoshop Elements, Firework's, Corel Draw, Flash, or Picasa)
- Timeline Editing Software that allows for both multiple layer and scrubbing of Audio
- Digital Camera or Cel Phone Camera

1. The first step is for the student to acquire a self-portrait with their mouth in the closed or (Rest) position.
2. They will then import the photo into any of the above-mentioned Image Editing programs and Convert the image to a vector (Cartoon Cel Shaded). (This can be accomplished by the use of a filter or by bitmap Tracing of the photo or simply tracing the image by hand and filling it with a single color so that the image has little or no detail other than its shape and basic features/
3. Next the students will need to separate Each Phoneme graphics above in Figure 1 or Figure 2 into individual files and name them appropriately.
4. After all the Graphic files have been created and named appropriately the student will need to Record the Audio file (My Name is Students Name Here) is all the audio they will need.

5. Now using one of the many Audio Recording Software Application recommended above (we will use Acid Music studio for the purpose of this demonstration) but any of the others will do the student will record their name.
6. Once the audio dialogue is recorded they will then use the Timeline Editing Program of choice to synchronize the Audio with the Phonemes.
7. Each sound should be labeled using a marker if allowed in the program, or by slowly scrubbing the audio file to carefully identify where the individual consonants and vowels exist.
8. In order to make this exercise look clean and accurate each picture show be placed in the same screen location so that referenced artwork does not jump around.
9. After this simple technique combining Lip-synced audio and facial animation is complete challenge your students to extend their dialogue and add facial expressions to their character.

There are numerous websites that show this technique and provide character models that can be used instead of the self-portrait method

(http://www.garycmartin.com/baggins_phonemes.html) but you will find the best animators in the business use the mirror as the center of reference for storytelling through facial animation.

References:

<http://www.flightsimulation.com/commercial/index.html>

<http://www.asti-usa.com/commercial/acuetech.html>

<http://www.dtic.mil/dtic/tr/fulltext/u2/a286046.pdf>

How to Make Animated Films: Tony White's Complete Masterclass on the Traditional Principles of Animation [Paperback and Kindle] by Tony White

Animation from Pencils to Pixels: Classical Techniques for the Digital Animator [Paperback and Kindle] by Tony White

The Animator's Workbook: Step-By-Step Techniques of Drawn Animation by Tony White

Animation from Script to screen by Shamus Culhane St. Martins Press

The Animator's Survival Kit--Revised Edition: A Manual of Methods, Principles and Formulas for Classical, Computer, Games, Stop Motion and Internet.

The Encyclopedia of Animation Techniques - Richard Taylor – Running Press

How to get Crystal Clear Recording - By braniac @ E-How
http://www.ehow.com/how_2297314_crystal-clear-vocals.html

Unit 3.5: Human Behavior Models

Unit Length:

This unit will last approximately 10 days.

Goals:

Explain human behavior models.

Rationale:

Integrating human behavior into models and simulations increases the reality of the simulation. By decreasing the required number of humans in the loop, the cost of running training exercises in various environments is decreased. The human model allows us to create both simulations and games that lead us closer to the reality of artificial intelligence.

Objectives:

- Define human behavior models.
- Explain importance of human behavior models
- Summarize the use of current research in human behavioral models.

Recommended Instructional Activities:

1. Define human behavioral models as it relates to psychology, emphasizing the need of interdisciplinary communication. Describe crowd behavior models.
2. Provide students with a few research papers on integrating human behavior into non human characters in games and simulation. Students will read the paper, summarize and present the material to the class. Students that do not present will need to submit discussion questions prior to the presentation.
3. Perform the Black Plague hands-on simulation which shows how this disease would have spread throughout Europe and Asia. Human behavior was key in the spread of the plague
http://www.bayarearenaissancefest.com/images/the_black_plague_classroom_simulation.pdf
4. Explore a few of the ethical questions regarding the use of human behavioral models in simulations. For example, explore the use of stereotypes when trying to simulate the activities of a particular group. Should we train with human representations of a particular group? What impact does the military have on these questions? What risks do we take when training medical professionals with “human” respondent simulators?
5. Explore the financial impacts of trying to simulate human behavior when purchasing stocks or other financial assets.

References:

Computational Models of Human Behavior

<http://www.isle.org/~langley/psych.html>

Crowd Simulation on Playstation 3

<http://www.research.scea.com/research/pdfs/GDC2006ReynoldsTemp.pdf>

Game Worlds Show Their Human Behavior

<http://news.bbc.co.uk/2/hi/technology/6917924.stm>

Human Behavioral Models for Agents in Simulators and

Games www.seas.upenn.edu/~barryg/PRESENCEpt2.doc

Human Behavior Models for Game-Theoretic Agents: Case of Crowd

Tipping http://works.bepress.com/barry_silverman/14/

Human behavior models for game-theoretic agents

<http://citeseerx.ist.psu.edu/viewdoc/summary?doi=10.1.1.25.3621>

Interoperable Human Behavior Models for Simulations

http://www.lsi.upc.edu/~npelechano/2006_BRIMS_paper.pdf

Leveraging Human Behavior Modeling Technologies to Strengthen Simulation-Based C2 System Acquisition

http://www.mitre.org/work/tech_papers/tech_papers_02/flournoy_leveraging/flournoy_leveraging.pdf

Positive Effects of VR Technology on Human Behavior

<http://www.idemployee.id.tue.nl/g.w.m.rauterberg/publications/ICAT2004paper.pdf>

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University of Wisconsin Crowd Simulation

<http://www.cs.wisc.edu/graphics/Gallery/Crowds/>

Unit 3.6: Intelligent Systems

Unit Length:

This unit will last approximately 10 days.

Goals:

Explain intelligent systems.

Rationale:

Although scientists have not yet built a truly artificially intelligent being as shown in television programs and movies, the progress continues. Due to the ever-increasing ability for processors to interpret instructions, the creation of an artificially intelligent system is getting closer. This is not to say that we do not use artificially intelligent systems in our day-to-day lives for uses such as scheduling, diagnostic behaviors, and data mining. An ever-growing aspect of artificially intelligent systems is the use of agents, which are small components that use instructions to make decisions. When agents combine their individual data together, the system can be considered “intelligent.” This concept is comparable to the cells in our body all working together thus making us one organism.

Objectives:

1. Define intelligent system.
2. Explain and examine structured logic and semantics.
3. Explain the use of intelligent systems.
4. Examine program using the elements of an intelligent system.

Recommended Instructional Activities:

1. Explain that intelligent systems are generally a specific area of study in the broader research area of artificial intelligence.
2. Explain concepts of predicate logic to include: *definition of first order logic, quantifiers (for every), symbols of first order logic, terms and formulas, inferences, provable identities*. Other concepts may be added as time permits to include automation and formation and natural languages, but these are generally presented at a higher level.
3. Review the concept of artificial intelligence and ensure students understand that no computer is truly intelligent at this point in time.
4. Have students perform research on the chess champion “Deep Blue” and write a summary including the computer’s specifications as well as why this was an important computer in history.

5. Explain the concept of search trees and have students create a binary search tree. Explain the use of search trees in projects like data mining for web sites.
6. Ask students to perform some research on the web and list sites that may have some artificial intelligent games. After the instructor approves the sites, students will go back and try and determine what makes the games “intelligent.”

References:

Artificial Intelligence in Games

<http://www.cs.rochester.edu/~brown/242/assts/termprojs/games.pdf>

Artificial Intelligence in Game Design <http://aidepot.com/GameAI/Design.html>

Artificially Intelligent Games

http://www.dmoz.org/Computers/Artificial_Intelligence/Games/

Binary Search Trees <http://www.cs.nyu.edu/alqvis/java/bst.html>

Britannica Online – Deep Blue

<http://www.britannica.com/EBchecked/topic/155485/Deep-Blue#tab=active~checked%2Citems~checked&title=Deep%20Blue%20--%20Britannica%20Online%20Encyclopedia>

First Order Logic

<http://pages.cs.wisc.edu/~dyer/cs540/notes/fopc.html>

First Order Logic Tutorial

<http://www.cs.ucsd.edu/groups/tatami/handdemos/doc/folidx.htm>

IBM Deep Blue

http://www.thocp.net/hardware/deep_blue.htm

Journal of Field Robotics - <http://journalfieldrobotics.org/Home.html>

Kasparov vs. Deep Blue

<http://www.cs.drexel.edu/~jpopyack/Kasparov.html>

Intelligent Systems at NASA Ames Research <http://ti.arc.nasa.gov/>

Intelligent Systems Group

<http://www.uu.nl/faculty/science/EN/organisation/depts/ics/research/is/Pages/default.aspx>

Planet Math – Logic

<http://planetmath.org/encyclopedia/FirstOrderLogic.html>

Search Trees

<http://www.brpreiss.com/books/opus5/html/page298.html>

Simple Binary Search Tree Applet

<http://www.ibr.cs.tu-bs.de/courses/ss98/audii/applets/BST/BST-Example.html>

Translating English to First Order Logic

<http://www.earlham.edu/~peters/courses/log/transtip.htm>

Unit 3.7: Environmental Models

Unit Length:

This unit will last approximately 10 days.

Goals:

Explain environmental models.

Rationale:

In initial experiments with simulations, weather factors were not integrated into the systems. As time progressed; it became apparent that weather, smoke, and other environmental factors are an important improvement needed in simulations in order to get closer to the real environment. It is important to understand the integration of environmental effects into a simulation and ensure that simulations you build can be affected appropriately. Consider the simulation of an aircraft; pilots must be trained to respond when encountering bad weather, wind, ice and snow. As modeling and simulation specialists, it is important to integrate both the creation of these effects as well as a simulation's response to the effects.

Objectives:

1. Explain the use of environmental modeling.
2. Discuss how to model environmental effects.
3. Discuss the effects of environmental simulations on related simulations.
4. Examine some environmental models on the web.

Recommended Instructional Activities:

1. Explain that there are really two aspects to environmental modeling: (1) The ability to incorporate wind, temperature, time of day etc. and have other models within the simulation be affected by these factors, and (2) The ability to study and model phenomenon of nature that will assist in the understanding of the phenomena or assist in the understanding of the mathematical principles of the phenomena.
2. Explain the impact of environmental effects on visualizations. For example, if a building is perhaps set on fire, how does the creation of smoke affect the overall simulation? Ask students to give other examples of environmental models in visualization.
3. Explain the impact of environmental effect on sensors. For example, if you are participating in a game that is being played in the ocean but waves are not factored in, then the simulation is not accurate.

4. Explain the connection between Geographic Information Science (GIS) and environmental models.
5. Explore how to design and implement something as simple as fog in a simulation. One might think its as easy as adding a layer on top of single picture, but ensure students consider that there are more factors than just the fog. How does the fog move? Why would we need to come up with a mathematical equation for the movement of fog? Ask students to explain some of the factors that would influence the movement of smoke. Allow students to explore the use of products and websites such as <http://io9.com/380777/light+in+fog-computer-simulation-is-ultra-realistic-and-cheap>. Emphasize to student that this is an actual company making money on the algorithms developed to represent, of all things, fog!
6. Using appropriate software or a game that was created in a previous unit, attempt to change some environmental issues. Because this is a game and not a simulation, one might consider changing the laws of gravity, for example. Make changes to the game as permitted by the software being used and allow other students to play both versions of the game. Write a paragraph that discusses the differences in the game keeping in mind that environmental factors should influence the game, not radically change the skill level necessary to play the game.

References:

3D Weather Data Visualization in Second Life

<http://www.secondlifeinsider.com/2006/10/28/3d-weather-data-visualization-in-second-life/>

Berkeley Environmental Simulation Laboratory

<http://www-laep.ced.berkeley.edu/research/simlab/>

Dynamic and Interactive Visualization of Weather Data with SVG

<http://www.svgopen.org/2005/papers/DynamicInteractiveWeatherData/index.html>

Environmental Curriculum Site

<http://www.shodor.org/master/environmental/>

Environmental Simulation Center

<http://www.simcenter.org/>

Georgia Tech 3D Weather Visualizations

<http://gtresearchnews.gatech.edu/reshor/rh-f01/weather.html>

GoldSim: Engineering and Environmental Simulation Software for the Mining Industry

<http://www.goldsim.com/Downloads/WhitePapers/MineEvaluation.pdf>

Integrated Land Use, Transportation, and Environmental Simulation:
UrbanSim Program

http://dgrc.org/dgo2004/disc/posters/tuesposters/ph_borning.pdf

A NextGen Target Generation Facility (TGF) Viewpoint of National Airspace System (NAS)
Weather Processing

http://www.faa.gov/about/office_org/headquarters_offices/ato/tc/about/campus/faa_host/labs/tgf/media/Weather3.pdf

Simulating Ocean Weather -- Video

<http://www.csiro.au/multimedia/pfid.html>

Shambles.net – variety of Simulations and games that include
environmental effects

<http://www.shambles.net/pages/students/simulation/>

Weather Channel Golf Game – simulates weather effects on a game of
golf

http://www.weather.com/activities/recreation/golf/golfgame/golf_game_nolocalwx.html

US Environmental Protection Agency

<http://www.epa.gov/epahome/models.htm>

Unit 3.8: Build A Scenario

Unit Length:

This unit will last approximately 15 days.

Goals:

Build a simple scenario for experimentation or training.

Rationale:

Whenever a few objectives are defined for a simulation training exercise, it is necessary to build a scenario to meet those objectives. Very often more than one scenario can generate the same outcome, but each should be carefully examined. Subject Matter Experts (SMEs) generally perform this activity, but as a modeling and simulation developer, it is important to know the process used in order to make the simulation meet the objectives. Additionally, the skills learned in this section of the M & S unit serve as a core for the development of today's video games.

Objectives:

1. Explain the use of scenarios as they relate to simulation.
2. Design a storyboard for a game.
3. Create a scenario containing a series of events
4. Build a game around the designed scenario.

Recommended Instructional Activities:

1. Display a first person computer game. As a group, discuss the underlying scenario. Discuss how the scenario influences the play of the game and motivates the players.
2. Explain the five major steps to develop scenarios. Steps from (http://life.eun.org/ww/en/pub/insight/school_innovation/leadership_and_change/scenario_building.htm).
3. Find videos of products on the internet that show scenario preparation. Most likely candidates include terrorist preparation and medical training.
4. Review storyboards and flowcharts. Ask students to provide you with an every day activity. Identify the goal, background, and create a storyboard for the activity.
5. Using the skills you have learned with programming, flowcharting etc. you are going to use the appropriate software to build a game of your choice. The first step is to come up with a basic concept. Answer the question: what type of game are you looking to create? Next, you will need to clearly and succinctly define the goal of the game. Next provide the background story for the game. Create a detailed storyboard or flowchart for the game. List all of the attributes, behaviors and interactions in the game. Design and build the game using the

provided software. Provide students with the rubric that will be used to grade their game.

References:

Advice for Game Design

<http://www.sloperama.com/advice.html>

The Anatomy of the Design Document

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The Art of Computer Game Design – Web Book

<http://www.vancouver.wsu.edu/fac/peabody/game-book/Coverpage.html>

Building Scenario Tutorial

<http://ag.arizona.edu/futures/tou/tut2-buildscenarios.html>

A Game Design Career Guide

http://www.gamecareerguide.com/features/260/game_design_career_preparation.php

Game Design Document PowerPoint

[http:// www.seat.utulsa.edu/cs4513/GameDesignDocs.ppt](http://www.seat.utulsa.edu/cs4513/GameDesignDocs.ppt)

Game Discovery – site of Downloadable 3D game tools

<http://www.gamediscovery.com/game-design/game-design-software.asp>

Game Maker Development Site – freely downloadable software to create 2D games <http://www.yoyogames.com/make>

An Introduction to Scenario Planning

<http://www.slideshare.net/mkconway/introduction-to-scenario-planning/>

Sample Outline For a Game Design

<http://www.sloperama.com/advice/specs.html>

Scenario Building to Plan an E-Learning Program

<http://tojde.anadolu.edu.tr/tojde6/articles/lisa.htm>

Serious Games Source

<http://www.seriousgamessource.com/>

Storyboarding: Just the Basics

<http://www.dcmp.org/guides/9428.pdf>

Storyboarding Information

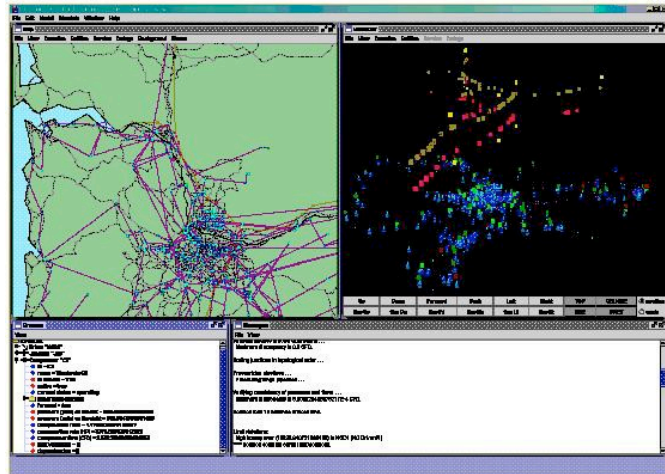
<http://www.usabilitynet.org/tools/storyboarding.htm>

Design Brief: Performing a Simulation Study

Creating a Discrete Event Simulation

Context

While there are many career opportunities falling within the field of modeling and simulation, it is important to understand that ultimately there is probably going to be some form of study being performed. It is important that regardless of a person's position in a project it is good to have a basic understanding of the work being performed. In this exercise, students will work in groups to perform a simulation study that can be translated into a discrete event simulation. Discrete event simulations are used in a variety of business areas including economics, manufacturing, shipping, and transportation.



Challenge

Students will work in groups to perform a simulation study. Students will observe a situation that could be easily represented as a discrete event simulation. One might recommend that students observe a fast food restaurant, pharmacy, cafeteria line, or a traffic pattern for a specified period time over several days. Using the fast food example, students could time how long it takes for each step in the process of serving the public, determine if bottleneck exits, and recommend changes to the system.

Objectives

Upon completion of the design brief, students will be able to do the following:

- Succinctly describe the goal of the simulation study.
- Produce a project schedule.
- Update a project schedule.
- Collect data using a scientific method.
- Examine data for irregularities and outliers.
- List any possible biases in the study.
- Design a simulation of the collected data.

- Flowchart the design of the simulation.
- Determine any bottlenecks for the collected data.
- Provide recommendations to reduce the bottlenecks.
- Test bottleneck recommendations.
- Perform analysis on the updated simulation.
- Write a report specifying the procedures for collecting and analyzing data.
- Summarize the conclusions derived from the use of the simulation.
- Present finding to the class in the form of a brief.

Materials

- Computer.
- Discrete event simulation software.
- Word processing software.
- Presentation software
- Flowcharting software

References

Bottleneck Definition

http://searchnetworking.techtarget.com/sDefinition/0,,sid7_gci540507,00.html

Design Document Overview from Cornell Computer Science

<http://www.cs.cornell.edu/courses/cs433/2001fa/Slides/DesignDocument.pdf>

Dependent and Independent Variables

<http://www.cool-science-projects.com/independent-and-dependent-variables.html>

Discrete Event Simulation: A First Course

www.cs.wm.edu/~esmirni/Teaching/cs526/DESAFC-1.1.ppt

How to perform a Simulation Study

<http://organizacija.fov.uni-mb.si/index.php/organizacija-si/article/viewFile/271/253>

How to Write a Design Document

http://www.ehow.com/how_6734245_write-software-design-document.html

Inside Discrete-Event Simulation Software: How It Works And Why It Matters

<http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=4117597>

Logic of Hypothesis Testing

http://davidmlane.com/hyperstat/logic_hypothesis.html

Methods for Summarizing Data

<http://www.uic.edu/sph/dataskills/publications/wrkbkpdfs/chap4.pdf>

Modeling and Simulation Resources

<http://home.ubalt.edu/ntsbarsh/Business-stat/RefSim.htm>

Observational Studies

<http://www.stat.wmich.edu/s160/book/node69.html>

Preparing a Simulation Study

<http://www.neirtec.org/evaluation/PDFs/PreparingtoCollect1.pdf>

Six Tips for Improving Your Design Documentation

http://www.boxesandarrows.com/view/six_tips_for_improving_your_design_documentation

Steps of the Scientific Method

http://www.sciencebuddies.org/mentoring/project_scientific_method.shtml

Summarizing Data Example

<http://www.mvps.org/dmccritchie/excel/sumdata.htm>

Writing Hypotheses

<http://www.accessexcellence.org/LC/TL/filson/writhypo.php>

An Urban Simulation Team

http://www.ust.ucla.edu/ustweb/about_us.html

Evaluation

1. All simulation assumptions are clearly identified.
2. Project plan was updated regularly and followed.
3. Data tables are clearly labeled and in column form. Column headings are accompanied by units.
4. Data is logical with inconsistent data (resulting from inaccurate measurement techniques), identified and removed.
5. The project and tested variables are elaborately summarized .
6. Discovered relationships are clearly identified, follow logically from gathered data,
7. Applied model of the world to explain findings.
8. Design document represents the implementation of the simulation and contains a detailed description and/or flowchart.
9. Simulation has no obvious errors.
10. Focused on the answer to the main question(s) identified in the project's purpose and are connected to the larger context of their topic of study.
11. Areas of bias are clearly identified.
12. Required functionality was provided.

13. Organization of simulation is logical.
14. Simulation has associated animation (if software permits).
15. Documentation of simulation is detailed and logical. Writing is clear and not overly technical.

Design Brief: Creating a Scenario for a K-8 STEM Puppet Show

Using 2D/3D Modeling to Develop an Engaging Scenario

Context

It is often stated that we have to improve our world position in STEM (Science, Technology, Engineering and Mathematics). Developing an interest in math and science early in the student's academic life seems to be the key to success. We know that early childhood students are captivated by theater, television, video games, etc. However, we also know that puppets can be used very effectively in capturing the attention of those students and setting an engaging learning environment. This rather low technology medium is used in the classroom to teach and to shape attitudes. For example, puppets are used in anti-bullying, domestic violence prevention and other living skills education programs. Educators using this level of abstraction find that students who might be shy and are reluctant to participate in the classroom often become more active and join in and become engaged in the scenario. As the various theme parks have learned, telling the story is key to success. Therefore, the scenarios and scripts require a good deal of thought and imagination while always keeping the goals in mind.

Challenge

Students will work in groups to create puppet characters and write scripts that will further engage the target population (K-8) of students. The students will develop the puppet characters in animation and they will follow the script developed earlier. The scenario will motivate the target student population to be aware of the careers available in science and engineering and to understand the importance of taking courses in science and mathematics to enter a career in those areas. The high school student must have a good grasp of the careers available and some awareness of how math and science are applied to engineering careers. The puppets to be simulated (using 2D/3D) will represent a cross section of society with emphasis on encouraging females and minorities to take an interest in pursuing careers in science and engineering.

Objectives

Upon completion of the design brief, students will be able to do the following:

1. Succinctly describe the goal of the design brief
2. Produce a project schedule
3. Collect data using the internet
4. Storyboard the scenario
5. Develop the cast of characters
6. Prepare scripts
7. Model the characters in the scenario
8. Assess the value of the scenario
9. Using hand puppets, recreate the animated version using the hand puppets
10. If possible, put on the show to K-8 students in both formats
11. Prepare a report of the procedures and findings
12. Present findings to the class in a brief

Materials

1. Computer
2. Hand (Sock) Puppets
3. Flowcharting software
4. Presentation software

Case Study: Airport Operations

Introduction

Air traffic is a critical component of the national transportation infrastructure. Virtually all passengers and cargo must utilize an airport as the place to board and deplane. On a daily basis, in excess of 100,000 air-traffic operations take place within the nation's airports. These include air-carrier, air-taxi, general aviation and military

operations. Worldwide air traffic is expected to double over the next 10 to 15 years.

At the same time, building new airports is extremely expensive, both in land and equipment cost but also because of environmental restrictions. Because of this, the capacity of existing airports is a significant bottleneck that ultimately limits national and world-wide air traffic expansion.

Increasing airport capacity will depend on technological measures that can address operational efficiency while maintaining current safety standards. In the short term, fielding new equipment and implementing new procedures is the only viable approach to ensuring airport capacity keeps up with demand. Due to the complexity of airport operations, modeling & simulation is critical to identifying potential benefits of new technology and procedures, and testing such procedures with little, if any safety issues.

Airport Operations Overview

Due to the stringent requirements for safety, various regulations and standard operating procedures dictate how air traffic can operate within the national and international air space. Virtually all passenger carrying aircraft are required to be in constant contact with air traffic control while enroute. Air traffic control consists

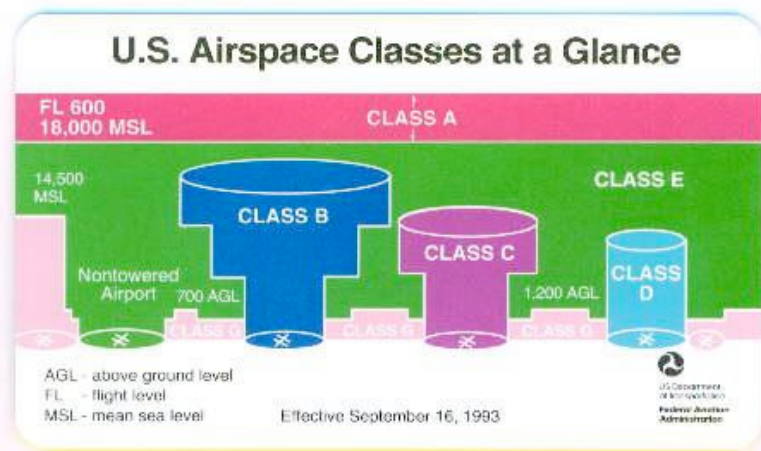


Figure 1: Airspace Classification (Federal Aviation Administration)

of specially trained individuals whose task is to manage air traffic flow by providing clearances to aircraft as such aircraft travel through the airspace. An air traffic controller can only handle a relatively small number of aircraft at any given time, so a given region may be serviced by numerous controllers, each focusing on a subset of the region. As aircraft travel between these regions, they are handed off from one controller to the other.

Air traffic controllers manage traffic according to an extensive set of procedures and regulations. These procedures can be loosely separated according to the portion of the airspace they control. Airport operations focus on class-B airspace, a portion of the airspace that surrounds the busiest airports in the nation, and extends from the ground to approximately 10000 feet of altitude. Figure 1 illustrates the various airspace classifications.

Airport operations are responsible for guiding aircraft while on the ground and while within the class B airspace.

Aircraft inbound to the airport are typically under the guidance of en-route controllers. When near the outer boundary of the class B airspace, control the aircraft is transferred to the approach controller. The approach controller receives incoming aircraft and routes them towards the desired landing runway. When near the runway, control is transferred to the tower controller. The tower controller is responsible for sequencing aircraft as they approach the runway for landing. Once an aircraft has touched down, they are then passed to ground control. The ground controller guides the aircraft through the taxiways to the desired gate.

An outbound flight begins way before the departure time. In busy airports, departure time slots are a precious commodity that are assigned several days in advance. Provided that departure slots are available, outbound aircraft begin their journey by requesting a clearance. In seeking a clearance, the aircraft provides a desired departure time, a destination and a desired route. A clearance, once issued, may not necessarily match the request. During busy times, it is not uncommon for an aircraft to be delayed from their desired departure time. It is also common to be issued a clearance with a route that is different than what was requested. Once a clearance is issued, the aircraft begins by pushing back from the gate, at which point they are under the control of the ground controller. The ground controller guides the aircraft to the assigned runway and hands off the aircraft to the tower. The tower controller gives the takeoff clearance and hands off the aircraft to the departure controller. The departure controller guides, or “vectors” the aircraft while within the class B airspace, and once near the boundary hands off the aircraft to the en-route controllers.

Problem Statements

There are numerous factors that affect airport capacity. One of the simpler ones to understand is spacing. Regulations dictate the minimum distance between aircraft while flying and landing. Safety is the primary concern when establishing

minimum spacing requirements. At the same time, spacing is directly related to the capacity of an airport, because the closer aircraft can be to each other, the faster they can take off and land.

Other factors that affect capacity include the availability and coupling of runways. Airports with multiple runways that can operate independently can drastically increase capacity. Also, the topology of the area surrounding an airport can have an impact on capacity. Airports near cities or major obstructions, such as monuments, towers, or uneven terrain, have limited corridors within which to manage aircraft movement. In such cases, technological improvements that improve space awareness can have a drastic effect on capacity.

Airport topology is important in facilitating traffic flow. The availability and layout of taxiways is another critical issue that effects airport operations. Once an aircraft has exited a runway, it must travel on taxiways to get to the gate. While on a taxiway, aircraft must contend with other aircraft that are taxing to and from their gates, as well as other ground vehicles such as utility vehicles, luggage transport carts etc. In some airports, taxing aircraft must cross active runways in which case they will have to wait for a gap in arriving or departing traffic before they can cross the runway.

The ability to time aircraft arrivals is critical in maintaining maximum aircraft flow through an airport. Aircraft arriving at the designated boundaries of the class B airspace must be routed to the runway by the approach controller. When aircraft arrive in regular intervals that match the required spacing, the controller's job is easier and efficiency is maximized. Uneven arrival intervals create problems because spacing requirements force aircraft behind a slower one to slow down, creating a ripple effect that can travel across the whole airspace. At the same time, predicting the time that an aircraft will arrive at the class B boundary depends heavily on accurate estimation of travel time, which in turn depends on the weather as well as en-route traffic.

Analysis Questions

- Describe the sequence of steps that an aircraft must go through while approaching its destination airport.
- Identify airport layout factors that can affect airport capacity.
- Develop a list of performance measures that can be used to assess the effect of a proposed improvement to arrival procedures.
- Identify technology improvements that if installed on-board all aircraft could improve airport capacity.

Serious Gaming Relevance

- Which elements of airport operations are best fitted for role-playing, adventure, or simulation games? How will these elements change if the game is a single-player vs. a multiplayer game?
- Describe how you would manage an airport simulation with various players in a massively multiplayer online game (MMO), i.e., aircraft

call sign, location and destination airport.

- What design elements will you program to ensure competition, challenge, fantasy, safety, and entertainment?
- How does your design incorporate player goals, rules, players, equipment, constraints, penalties, and choices? How would these elements change if the game is a single-player vs. a multiplayer game?
- What are the interface and scenarios for your game? How much realism will you include in the accuracy of the underlying model? How much fidelity will you require in the visualization?

Modeling & Simulation Relevance

- When considering continuous-time versus discrete-event simulation, which approach would be best suited for simulating airport operations, and why?
- Describe how linking an airport simulation with real-time traffic data, i.e., aircraft call sign, location and destination airport, can be used to assess the simulation fidelity.
- Describe how best to incorporate human errors (both pilots and controllers) in an airport simulation.

Unit 4: Demonstrating Visualization

Unit Length:

This unit will last approximately 110 days.

Goals:

- 4.1. Build a two dimensional visual model.
- 4.2. Build a three dimensional visual model.

Rationale:

Formerly, the output data from a computer simulation was sometimes presented in a table, or a matrix, showing how data were affected by changes in the simulation parameters. The use of simulation models were simply 'black boxes' - data going in and results coming out; however, psychologists noted that humans could quickly perceive trends by looking at graphs or even moving-images generated from the data, as displayed by computer-generated-imagery (CGI) animation. Using on-screen animations in a simulation model enables the status of the model to be viewed as it progresses. For example, a machine that breaks down may change its color to red. This enables visual cues to be passed back to the operator of the simulation model, so action could be taken.

Additionally, visualization is useful in convincing decision makers of the model's credibility. For example, in manufacturing if the directors can see a visualization of the production line with widgets traveling down a conveyor belt, it would do more to sell the concept of the model than a 'black box', churning out data.

Today visual simulation models are used in many disciplines. In geographical information systems (GIS) and meteorology, weather forecasting models balance the view of moving rain/snow clouds against maps that use numeric coordinates and timing of events. Similarly, computer simulations of CAT scans can simulate how a tumor might change, during an extended period of medical treatment, presenting the passage of time as a spinning view of the visible human head, as the tumor changes. Other applications of CGI computer simulations are being developed to graphically display large amounts of data, in motion, as changes occur during a simulation run.

Unit 4.1: Build a Two Dimensional Visual Model

Unit Length:

This unit will last approximately 30 days.

Goals:

Build a two-dimensional model

Rationale:

This unit will provide students with grounding in using computers and 2D modeling software to develop simple models. There are many applications for 2D models. 2D modeling sets the foundation for more complex 3D modeling to follow.

Objectives:

1. Understand the various job titles and responsibilities of a 2D artist as it relates to the modeling and simulation industry.
2. Determine and document the graphical and animation needs of a modeling and simulation using design documents including art direction and reference materials.
3. Understand the fundamentals of drawing and painting techniques.
4. Demonstrate a working knowledge of vector and paint programs used to make 2D graphics and animation.
5. Understand the principles of Sprite animation as it relates to 2D modeling and simulation graphics (walk, run, Jump, idle...etc.)

Recommended Instructional Activities:

1. Review standard primitives and write definition for each.
2. Read an article on parametric modeling. Select and define five parametric modeling terms. Share the terms and their meaning with classmates.
3. Speed Quiz (Modeling professionally requires **speed** - build your speed) - Model an object of simple scene in your school.
4. Create a Second Life Avatar and enter a community.
5. Design and model a flat bed truck with a hydraulic lift.
6. Design and model a deep draft Container Ship.
7. Model a shipping warehouse with conveyor belts.
8. Sketch and model a physical system, such as joints and muscles, a virtual operating room, virtual reality for rehabilitation, port shipping facilities, network railroad operations, or an airport baggage handling system etc.

References:

3dk.org – Excellent source of 3d model tutorials - <http://www.3dk.org/tutorials/date/15/1.html>
3ds max and its Applications by Eric K. Augspurger, Goodheart Wilcox Co, Inc., Tinley Park, Illinois

Autodesk games tools -
<http://usa.autodesk.com/adsk/servlet/index?id=10225745&siteID=123112>

Doron trucking simulators - <http://www.doronprecision.com/450truck.html>
Orange County Public Schools (Florida) University High School's Global Technologies Magnet Program -
<https://www.ocps.net/lc/east/hun/academics/programs/gt/Pages/default.aspx>

Full Sail University -
http://www.fullsail.edu/index.cfm?fa=landing.CA_1a&mnc=210&kw=3d%20graphic&utm_source=yahoo&utm_medium=cpc&utm_term=3d%20graphic&utm_content=CA_1a&utm_campaign=CA

Great 3d website source: [By Google](#)
Google SketchUp is software that you can use to create, modify and share 3D models -
<http://sketchup.google.com/>

Ignition Game Design Academy Curriculum: - <http://www.applied-ideas.com/products/ignition>

ProModel is a of simulation-based, decision making tool - <http://www.promodel.com/>

Second Life is a 3-D virtual world created by its residents- <http://secondlife.com/>

SEDRIS - Environmental Data Representation & Interchange - <http://www.sedris.org/>

STELLA tutorials and demos –
<http://www.iseesystems.com/community/downloads/tutorials/stella.aspx#>

Visualizations with the TU Dresden 3d traffic simulator
<http://www.vwi.tudresden.de/~treiber/movie3d/index.html>

Using 3d Models for Visualizing „The City as It Might Be" -
<http://www.isprs.org/proceedings/XXXVI/part2/pdf/cartwright.pdf>

Unit 4.2: Basic 3-D Models

Unit Length:

This unit will last approximately 80 days.

Goals:

Build a three dimensional model.

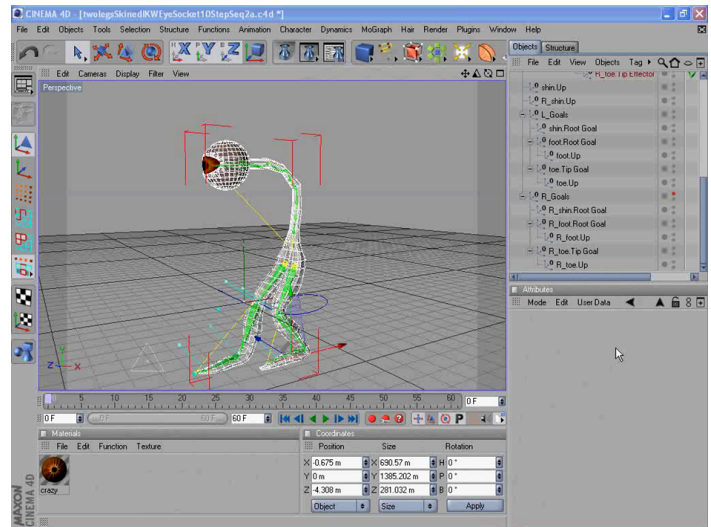
Rationale:

Rendering is applying color and shading to a model or scene giving it a more realistic look. Once the model has materials applied to them, the computer with powerful graphics software performs the rendering process.

During rendering, the computer “draws” the 3D objects to the screen and/or to a file, usually a bitmap. Real-time rendering occurs when viewing objects interactively in 3D view ports, or in a game or simulation application. Production level rendering draws a much higher quality image, at the expense of speed. A production render may take anywhere from a few seconds per frame to an indefinite period of time... sometimes hours or even days for a single frame.

Objectives:

1. Review the history of Animation
2. Understand the production process
3. Understand intellectual property rights, copyright laws and plagiarism as it applies to creative assets
4. Demonstrate knowledge of photo editing software
5. Demonstrate knowledge of production writing as it relates to 3D animation.
6. Demonstrate knowledge of storyboarding
7. Demonstrate knowledge of video editing software
8. Understand modeling in relation to the production process
9. Demonstrate knowledge of animation principles as it relates to modeling
10. Demonstrate knowledge of modeling principles
11. Demonstrate knowledge of 3D Animation Software
12. Demonstrate knowledge of 3D Animation software navigation
13. Demonstrate knowledge of NURBS modeling
14. Demonstrate knowledge of polygon modeling
15. Demonstrate knowledge of basic lighting
16. Demonstrate knowledge of basic materials and textures



17. Demonstrate knowledge of basic animation
18. Demonstrate knowledge of basic character setup
19. Demonstrate knowledge of basic 3D rendering
20. Understand the role of texture artist in relation to the production process
21. Demonstrate knowledge of rigging
22. Understand knowledge of motion capture systems

Recommended Instructional Activities:

1. Render the same scene at 3 different resolution sizes. Determine which level provides the most effective and efficient output.
2. Render and animate a flat bed truck with a hydraulic lift.
3. Render and animate a deep draft Container Ship.
4. Render and animate a shipping warehouse with conveyor belts.
5. Complete the Modeling of a planet. Setting up the scene and light - <http://www.3dm3.com/tutorials/planet/index.php>

Computer Imaging Labs:

- 1) Basic image processing utilizing MatLab, ScienceLab, or Octet as the prototype engine; 2 - 3 weeks

Learning content:

Image architecture -the understanding image architecture.

The following lab will allow the student to understand how image processing application like the Adobe and all modeling engines achieve their imaging effects...

(Vector Images and Raster images)

1. RGB images, Gray-scale images, and logical images.
2. Logic and semantics of the C and the specifics of the prototype engine
3. Building a simple render stream and processing image pixels and data
4. Labs:
 - a. Develop logic and code to implement a simple near real-time render stream.
 - b. Develop image processing code to convert RGB images to gray-scale images.
 - c. Develop image processing code to convert RGB images to inverted gray-scale images.

- 2) Advanced image processing (motion detection, tracking, and projection); 2 - 3 weeks

Learning content:

To understand how motion detection and tracking are accomplished and implemented in simulations and serious game system, and to develop the logic and coding background required to implement such applications.

(motion detection, tracking, and projection)

5. Parsing RGB images and determining motion intersections
6. Calculating motion area and registration point locations
7. Imprinting bounding box/meta data
8. Implementing a tracking stack
9. Predicting possible future movement

References:

3dk.org – Excellent source of 3d model tutorials - <http://www.3dk.org/tutorials/date/15/1.html>
3ds max and its Applications by Eric K. Augspurger, Goodheart Wilcox Co, Inc., Tinley Park, Illinois

Autodesk games tools -

<http://usa.autodesk.com/adsk/servlet/index?id=10225745&siteID=123112>

Great 3d website source: By Google

Google SketchUp is software that you can use to create, modify and share 3D models -

<http://sketchup.google.com/>

Ignition Game Design Academy Curriculum <file:///localhost/>- <http://www.applied-ideas.com/products/ignition>

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SEDRIS - Environmental Data Representation & Interchange - <http://www.sedris.org/>

STELLA tutorials and demos -

<http://www.iseesystems.com/community/downloads/tutorials/stella.aspx>

Visualizations with the TU

Dresden 3d traffic simulator - <http://www.vwi.tudresden.de/~treiber/movie3d/index.html>

Design Brief: Create and Model a Transportation Asset

Model a Transportation Asset

Context

Transportation planning simulations evaluate the impacts of regional urban development patterns on the performance of the transportation infrastructure. As input, these models generally accept census data on population, employment, and land use. On output, they estimate demand for travel (by origin and destination), the impact of that travel on the surface transportation infrastructure, and subsequent impacts of that travel on air quality. Early plans were not truly "simulations" (in that they did not incorporate some sense of time, or explicit interactions between model components.) These models were based on a sequential four-stage process including trip generation, trip distribution, mode split, and route assignment.

Challenge

Each student will demonstrate an understanding of creating a 3D model of a transportation asset such as a ship, truck, train, or forklift etc.

Objectives

Upon completion of the design brief, students will be able to do the following:

1. Utilize 3D modeling and other visualization tools.
2. Create a basic 3D model.
3. Apply several 3D viewing options.
4. View and control a model interactively in 3D space.
5. Generate a plan view of a 3D model.
6. Control the appearance of surface meshes.
7. Change the type and appearance of a surface mesh.
8. Place predefined 3D surface primitives in a scene.
9. Edit the placement and orientation of 3D surface primitives.
10. Create regions using Boolean operations.
11. Extrude a solid region to form a 3D model.
12. Create solid primitives, including a cylinder, torus, cone, wedge, box, and sphere.
13. Extrude a closed spline to produce a solid model.
14. Check for interference between adjacent objects in 3D space.
15. Set up a modeling session.
16. Explain different ways to select objects.
17. Define transforms and modifiers.
18. Apply modifiers.
19. Explain sub-object mode.
20. Hide and display objects.

Materials

1. Computer with appropriate graphical software
2. Pencil and paper

References

Institute of Transportation Studies: California Partners for Advanced Transit and Highways (PATH) (University of California, Berkeley) - <http://repositories.cdlib.org/cgi/viewcontent.cgi?article=1096&context=its/path>

Simulation-Based Operations Planning For Regional Transportation Systems - <http://dgrc.org/dgo2004/disc/presentations/transportation/fitzgibbons.pdf>

Universal Transportation Model Simulation Center - <http://www.utmsc.org/>

Vehicle Dynamic Simulation Laboratory - http://www.vss.psu.edu/VSRC/vsrc_simulation_lab.htm

Great 3d website source: [By Google](#)

ProModel is a of simulation-based, decision making tool - <http://www.promodel.com/>

Visualizations with the TU Dresden 3d traffic simulator - <http://www.vwi.tudresden.de/~treiber/movie3d/index.html>

3ds max and its Applications by Eric K. Augspurger, Goodheart Wilcox Co, Inc., Tinley Park, Illinois

Evaluation

1. Discuss the level of fidelity in the model.
2. Determine in the polygon count is within predetermined allowance.

Case Study: Seaport Container Terminal

Introduction

Containers have quickly become the universal means by which goods are transported in international and national trade. Containers are boxes with uniform width and height that can vary in length, from 20 to 53 feet. Containers remain sealed during their transfer from a point of origin to their destination. Cargo capacity is measured in Twenty-foot Equivalent Units (TEUs), the capacity of a 20 ft x 8 ft container. The size uniformity allows the development of standardized loading and unloading processes that can be customized for truck, rail, and sea transport. Today, the majority of cargo is transported in containers, and most new ship designs are optimized for container transport. Ships designed in the early 70's could carry approximately 1700 TEUs, but the latest generation "Super Post-Paramax" ship designs can carry in excess of 8600 TEUs. Figure 1 shows loaded container ships en route.¹



Figure 1: Loaded container ships en route

A seaport container terminal is the place where container ships dock to unload and load containers, so they can be delivered to the next mode of transportation. The seaport terminal is an extremely complex system that consists of a number of interrelated operations. Containers are first unloaded from the ship and transported to a buffer area. From there, containers are then transported to an inter-modal transfer center. Finally, they are loaded from the inter-modal transfer area to rails and or trucks, at which point they leave the terminal area. (Figure 2)²

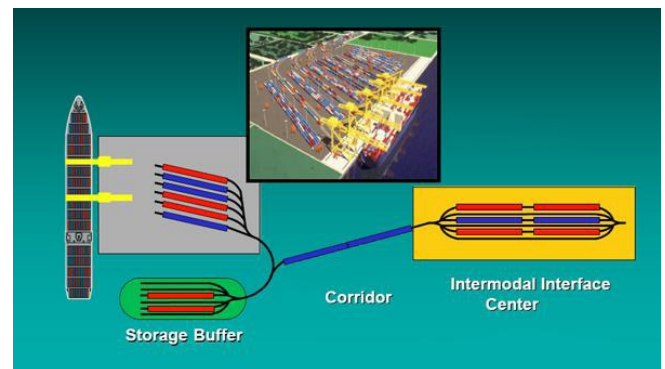


Figure 2: Container ship loading and unloading process

Typically, a container ship enters the port and docks on a specially constructed wharf. Specially designed cranes will transfer the containers from the ship onto land, from where they can be delivered to the buffer area in the terminal. These cranes, called gantry cranes are manually operated. The left side of Figure 3 is a ship docked at the wharf while a gantry Crane is loading and unloading containers. Note that trucks can drive under the crane in order to

¹ National Oceanic and Atmospheric Administration/Department of Commerce. (2009). NOAA Photo Library. Retrieved June 10, 2009, from America's Coastlines Collection: West Coast Web site: <http://www.photolib.noaa.gov/htmls/line0534.htm>. [Public domain and cannot be copyrighted.]

² From <http://www.transystems.com>. Copyright 2003 by TranSystems. Reprinted with permission.

receive containers for delivery to the buffer area. The right side of Figure 3 shows multiple gantry cranes that can deliver containers to the buffer area.³

The transfer from the gantry cranes to the buffer, or yard, takes place through use of special mobile vehicles that are operated by humans or in some cases operate autonomously. Some terminals perform this transfer by using large overhead crane installations. Once in the yard buffer, containers are stacked in groups. To facilitate identification of their location, the yard is organized in blocks, bays, rows, and tiers. The mobile vehicle and land cranes are designed to access containers by using such an address scheme. Figure 4 shows a diagram of the yard storage organization and the crane/vehicle operation.⁴



Figure 3: Multiple Gantry cranes loading a ship.

Once in the storage area within the terminal, containers await delivery to their next transportation medium. Separate areas in the terminal provide access to trucks and/or rail cars. When a truck arrives in the terminal, it gets assigned a pick-up point. The mobile vehicle or overhead crane

installation must then find the container in the buffer area and deliver it to the truck. The truck can then drive away. A similar process ensues for rail cars. Outgoing containers are treated in a similar manner. Upon arrival, the container is delivered to the buffer area where it waits for the ship to dock. At that point, the container must be transported from the yard buffer to the gantry crane which will then load it on the ship. Once the ship is fully loaded, it departs the wharf and the next ship can dock. The container movements to and from the wharf are collectively referred to as a waterside transshipment process (WTP). The movement of containers arriving by road or rail is collectively referred to as the landside transshipment process (LTP). Finally, the movement of containers within the terminal is collectively called the hinterland transportation process (HTP).

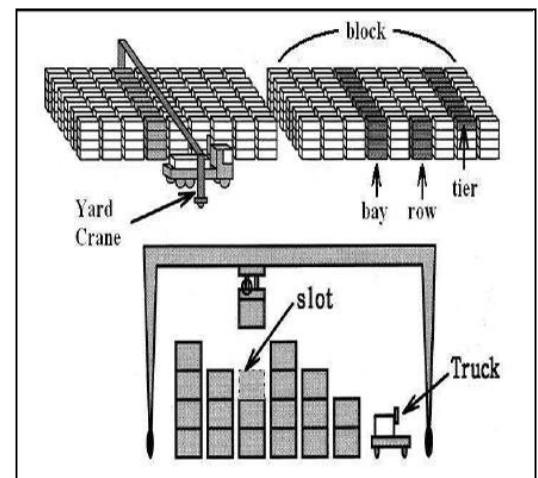


Figure 4: Terminal yard crane, vehicle and storage operation

Problem Statements

³ From Minderhoud, M. (n.d.). In *Wikipedia, the free encyclopedia*. Retrieved June 10, 2009, from [http://en.wikipedia.org/wiki/File:Portainer_\(gantry_crane\).jpg](http://en.wikipedia.org/wiki/File:Portainer_(gantry_crane).jpg). GNU Free Document.

⁴ From Vacca, I, Bierlaire, M., & Salani, M. (2007). Optimization of Container Terminal Operations [PowerPoint slides]. Retrieved from Ecole Polytechnique Federale de Lausanne web site: http://transpor2.epfl.ch/talks/CT_IBM_07.pdf

The goal of the terminal is to minimize the time it takes for a container to transfer from the incoming to the outgoing vessel. The amount of time a container spends in the terminal is called the dwell time, and can be from several hours to 6 to 8 days. Clearly, the best case scenario is for dwell time to be 0, as this would maximize terminal throughput. However, there are numerous factors that make the logistics

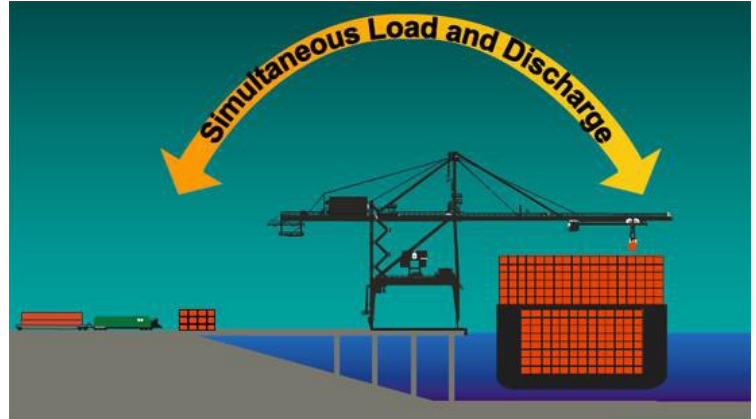


Figure 5: Modern terminal design

of seaport container terminals intractable. Each of the three processes, WTP, LTP and HTP, has numerous variables that can affect overall operation.

For example, the arrival of delivery and pickup vessels is subject to unpredictable delays that make precise planning impossible. Scheduling the transport of containers from the gantry crane to the yard buffer is also an intractable problem, as is the best way to store the containers in the yard to minimize unnecessary shuffling when trying to access a specific container.

Modern terminal designs attempt to improve throughput and minimize dwell time. Examples of such improvements include mobile trucks that can carry more than one container, gantry cranes can be scheduled to load and unload a ship at the same time (see Figure 5), thus minimizing turning time.⁵ Special queuing algorithms can be used to re-order how trucks arrive to minimize internal transport time. Containers can be stacked in ways that make loading rail cars easier.

There is a tremendous amount of research in algorithms technology that aims to improve the logistics of a seaport terminal; however, local optimizations do not necessarily lead to improvements if the remaining processes cannot take advantage of such improvements. Modeling and simulation is a unique, and often singular way to identify the effects of different policies and algorithms on dwell time and overall terminal efficiency. Numerous case studies can be constructed to demonstrate concepts, and if desirable, open-source simulation packages could be used to construct simulations of subsets of existing seaport terminals as a way to investigate their operation, as well as the effects of different operational policies.

Analysis Questions

1. Explain how the user of standardized containers has facilitated cargo shipping using ships, rails and trucks.
2. Describe the sequence of steps that a container arriving in a ship will go through during its transfer from the ship to a rail car.
3. Identify three factors that can affect the efficiency of the waterside transshipment process.

⁵ From <http://www.transsystems.com>. Copyright 2003 by TranSystems. Reprinted with permission.

4. Develop a list of pros and cons for the use of autonomous mobile vehicles in a terminal yard when compared to manually operated vehicles or cranes.
5. Develop a list of performance measures beyond dwell time that can be used to assess the efficiency of a seaport terminal.

Modeling & Simulation Relevance

1. When considering continuous-time versus discrete-event simulation, which approach would be best suited for simulating a seaport terminal, and why?
2. Consider a high quality visualization component as an add-on to a seaport simulation.
3. Assess the importance of this component with respect to the usefulness of the simulation for purposes of 1) dwell time, and 2) mobile vehicle travel time.
4. Identify a list of model inputs and outputs that would be needed in order to use a seaport simulation for testing and evaluation of alternative gantry crane operation schemes.

Unit 5: Understanding Problem Analysis

Unit Length:

This unit will last approximately 30 days.

Goals:

- 5.1 Demonstrate the experimental design process.
- 5.2 Explain discrete event simulation.
- 5.3 Apply numerical analysis techniques.
- 5.4 Select appropriate level of fidelity for a model

Rationale:

Mathematical models are powerful tools for conducting analyses and experiments. Further, exercising that model in a simulation allows the analyst to observe the consequences of multiple iterations over simulated time to gain tremendous insight into the behavior of that system. Experiments can be conducted using simulation alone with surprising results. In the world of simulation, variables can be considered to be either continuous or discrete event. The flow of oil through a pipeline can be considered to be continuous whereas Marine recruits processing- in , where they receive their uniforms, boots, etc., could be considered “discrete events”. Today, computer technology enables complex numerical analysis. For example, there are computer programs for complex analyses such as Finite Element Analysis (FEA). You may have heard the phrase: “garbage in – garbage out” before. One can only expect to get good results if the fidelity of the inputs are good. In training simulators, the level of fidelity of a flight simulator determines the acceptance by the Federal Aviation Administration (FAA) for that simulator to provide effective training and the transfer of that training to the actual aircraft.

Unit 5.1: Experimental Design

Unit Length:

This unit will last approximately 5 days but objectives will be reinforced throughout course.

Goals:

Demonstrate the experimental design process.

Rationale:

Experimental design (ED) is a very powerful problem solving technique that assists engineers and other problem solvers in tackling quality control problems effectively and economically. It involves a strategy of planning, conducting, analyzing and interpreting experiments so that sound and valid conclusions can be drawn efficiently, effectively and economically. ED has proven to be very effective for improving the process yield, capability, performance and reducing variability in many business, engineering and scientific functions.

In this unit students will understand that a sequential process must be followed for a task to be completed. Also, when charting similar familiar tasks, they will learn to be very explicit in their directions. This explicit recitation of steps will help the student develop the directional thinking patterns that are so necessary in problem solving and ED.

Additionally, they will understand the basic principles of analysis of problems by identifying major problems and the main causal relationships between them.

Objectives:

1. Use proper attributes to develop flowchart.
2. Compare various types of studies (i.e. survey, observation, experiment).
3. Identify an experimental design.
4. Set objectives of the experiment.
5. Select the response or output.
6. Select process variables or design parameters (control factors), noise factors and the interactions among the process variables of interest.
7. Perform experimental design execution.
8. Check that the data are consistent with the experimental assumptions
9. Interpret the results.
10. Present the results.

Recommended Instructional Activities:

1. Experimental Design Vocabulary activity
<http://mjkscteachingideas.com/pdf/ExpDesVocab.pdf>
1. Experimental Design Practice - <http://mjkscteachingideas.com/pdf/ExpDesPrac.pdf>
2. Provide a brief overview of the three types of *t*-tests (two-sample, paired, and one-sample *t*tests).
3. Write a 1-2 page paper that provides the following: Highlights of what you learned about experimental design; questions you might have; and ideas for how to design an experiment. Make specific recommendations for how you could improve on an experimental design format.
4. Play Computer Class. Assign groups of students to be INPUT DATA teams, OPERATIONS teams, DECISION teams, and OUTPUT teams. Each group has a set task to perform based on instructions given to them by another team. Watch how the transference of information is accomplished. Have students discuss the information processing involved.
5. Paper helicopter experiment - ED application for optimizing the time of flight of a paper helicopter which can be made from A4-size paper, scissors, ruler, paper clips and a measuring tape.*

Supporting Activities:

Students should eventually feel comfortable about designing flowcharts to complete tasks outside the realm of mathematics as they know it. Practice in the following activities will direct students to pay attention to the details and the order of events.

1. Use flowchart application program to develop and illustrate a flowchart identifying decision matrix to determine one of the following: what clothing to wear to school, what college to attend, what career field to pursue etc.
2. Write a flowchart to explain how one buys a can of soda from a soda machine.

References:

Teaching Experimental Design - <http://mjkscteachingideas.com/design.html>

Experimental Design Reference - <http://mjkscteachingideas.com/pdf/ExpDesRef.pdf>

Aspects of Experimental Design with Real Live Examples
<http://liutaiomottola.com/myth/expdesig.html>

A Library of Materials, most freely downloadable, created by classroom teachers and other educators, that addresses diverse curricular and organizational topics of interest to K-12 educators - <http://www.clexchange.org/>

Article - Scientific inquiry training for high school students: Experimental evaluation of a model program, By Kenneth D. Peterson, School of Education, University of California, Berkeley, California 94720

Alcock, Donald. Illustrating BASIC: A Simple Programming Language... Cambridge University Press, Cambridge, 1977. Simple explanations of programming in the BASIC language. Clear enough for the general reader.

Engineering Statistics Handbook -
<http://www.itl.nist.gov/div898/handbook/pri/section1/pri13.htm>

Florida University High School"s Global Technologies Magnet Program -
<https://www.ocps.net/lc/east/hun/academics/programs/gt/Pages/default.aspx>

Klienberg, Harry. How You Can Learn to Live With Computers. J.B..Lippincott Company, Philadelphia, 1977. An amusing book describing computer technology and its basic usages in laymen terms. Good for those who have no experience with computers.

Modeling using STELLA, a powerful tool to explore systems as well as to generate a deep understanding of interconnections (see sample models) -
<http://www.iseesystems.com/community/downloads/EducationDownloads.aspx>

Schneider, Ben Ross Jr.. Travels in Computerland. Addison-Wesley Publishing Company, Inc., Reading, Mass., 1974. A humanist's impression of the potential for good and evil of computers in our society based on the authors' experience. Fun reading.

The Military Operations Research Society (MORS) - <http://www.mors.org/>

Wiebe, James H. "BASIC Programming for Gifted Elementary Students." Arithmetic Teacher, Vol.28, No.7 (March 1981) Report on the study of a group of children introduced to programming in BASIC during a summer school session.

Unit 5.2: Discrete Event Simulation

Unit Length:

This unit will last approximately 10 days.

Goals:

Explain discrete event simulation.

Rationale:

Discrete event simulation is an important system analysis technique. A discrete event simulation (DES) manages events in time. Most computer, logic-test, and fault-tree simulations are of this type. In this type of simulation, the simulator maintains a queue of events sorted by the simulated time they should occur. The simulator reads the queue and triggers new events as each event is processed. In this unit you will be able to access data produced by a simulation, understand the event relationships and to discover logic defects in the design, or the sequence of events.

Objectives:

1. Identify discrete event simulations.
2. Use simulation as an analysis tool.
3. Describe the output distribution.
4. Use historical/empirical data.
5. Correctly interpret summary statistics.
6. Correctly interpret confidence and prediction (certainty) intervals.
7. Identify sources of error in simulations.
8. Describe relationships among variables.
9. Describe the effect of correlation on simulation results.

Recommended Instructional Activities:

1. Read, Pair and Share reading activity: Read and discuss the various uses of DES in article: The Multiple Roles of Discrete Event Simulation in the Workplace – [The Multiple Roles of Discrete Events](#)
2. Read, Pair and Share reading activity: Read and discuss the uses of DES in automotive manufacturing. Article: Automotive applications of discrete event simulation Automotive Manufacturing & Production, July, 1997 - http://findarticles.com/p/articles/mi_m0FWH/is_n7_v109/ai_19785139/pg_1

3. Invite guest speaker to class to discuss the utility of numerical analysis. National Security Agency Mathematics Speakers Bureau is an excellent resource.
http://www.nsa.gov/academia/early_opportunities/math_edu_partnership/index.shtml
4. List 5 samples of discrete event simulations and provide a paragraph synopsis of each one.
5. Develop basic discrete event simulation which provides summary percentile data statistics.
6. View video on queuing theory - <http://hsor.org/videos/index.cfm?videos=arm-and-a-leg>

References:

A philosophy of Modeling and Simulation (and more) - <http://www.thesimguy.com/pubs.htm>

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Discrete-Event Simulation: Modeling, Programming, and Analysis by G. Fishman, 2001, [Discrete-Event Simulation: A First Course](http://www.cs.wm.edu/~esmirni/Teaching/cs526/DESAFC-1.1.ppt) - <http://www.cs.wm.edu/~esmirni/Teaching/cs526/DESAFC-1.1.ppt>

High School Operations Research Mathematics for Decision Making in Industry and Government – [Welcome to HSOR.org \(High School Operation Research\): Home](http://www.hsor.org/)

Matt Rohrer, Bucky Strong. Article: Automotive applications of discrete event simulation Automotive Manufacturing & Production, July, 1997 -

Monte-Carlo *simulation*? Teach Discrete-Event simulation? [Teaching \(Monte-Carlo\) Spreadsheet Simulation](http://meetings.informs.org/TMSWorkshop/TMS04/presentations/Grinde.ppt) - <http://meetings.informs.org/TMSWorkshop/TMS04/presentations/Grinde.ppt>

Overview of Simulation - <http://www.systems-thinking.org/modsim/modsim.htm>

Peter J. Lawrence. Article: [The Multiple Roles of Discrete Event Simulation in the Workplace](http://www.promodel.com/)

ProModel is a of simulation-based, decision making tool - <http://www.promodel.com/>

Design Brief: Analyze Airport Operations

Context

Airport terminals have dramatically changed after September 11th, primarily due to the tightened security measures. These changes had a major impact on passenger arrival patterns, passenger flows, space allocation, processing times, and waiting times. In turn, it impacted terminals' performance, levels of service, and the overall passenger experience. Airport planners and decision makers required a decision support tool that can quickly evaluate the impact of the often changing security regulations and the decisions to counterpart these changes on the airport's level of service. Discrete event simulation is an important system analysis technique that can assist Airport planners and decision makers in improving the airport and passenger flow.



Challenge

Each student will demonstrate an understanding of creating a simple Discrete Event Simulation that represents the airport and should include the following modules:

- 1. Arriving and Departing Passenger Creation:** Creates the Enplanement Passengers (and accompanying well-wishers) from a time based arrival schedule. Assigns initial passenger attributes such as group size, international/domestic, number of bags and servicing airline. This module allows for modeling passenger behavior distribution (i.e. arrive time before flight).
- 2. Ticketing Areas and lobby (Manned ticketing, electronic, kiosks, and remote):** Contains logic of a generic ticket area (including common use) that might be composed of a combination of e-ticket machines with manned or unmanned stations and manned ticket counters. Passengers are smartly routed to respective facilities based on passenger characteristics (remote check in passengers bypass ticket counters, etc.). This module also provides the ability to model agent schedules.
- 3. Security Screening Checkpoints:** Generic representation of detailed security checkpoint composed of a combination of regular lanes and employee lanes. Include preceding queuing area, individual queues, bag drop off, scanning, and bag pick up. Each lane is modeled individually with unique characteristics such as schedules, failure probabilities and staffing.

4. **Baggage Claim:** Generic representation of baggage claim belt representing the process of passenger bag pick up.
5. **EDS (Explosives Detection System) Machines for baggage screening:** Generic representation of detailed EDS machine units and groups. Each EDS machine unit can be modeled individually or within a group with unique characteristics such as schedules, failure probabilities and staffing.
6. **Airport Access and flow:** Passengers are routed (based on their characteristics) throughout the airport to mimic real passenger behavior. Includes, entrances, exists, horizontal flow (Corridors, moving sidewalks), vertical flow (elevators, escalators, stairways), waiting areas and other services (car rental service desks, food court, restrooms, etc.)

Upon completion of this simulation model design brief, you will be able to access data produced by a simulation, understand the event relationships and to discover logic defects in the airport design, or the sequence of events. Suggested problems to simulate:

1. How passengers flow through the airport
2. Identify the passenger queues
3. How long passengers wait in each identified queue
4. Identify and list in ascending order the airport bottlenecks
5. Identify peak time over the course of a day
6. Identify processing resources utilization (e.g. ticketing agents, security screening, etc.)

Objectives

Upon completion of the example, students will be able to do the following:

1. Identify discrete event simulations.
2. Use simulation as an analysis tool.
3. Describe the output distribution.
4. Use historical/empirical data.
5. Correctly interpret summary statistics.
6. Correctly interpret confidence and prediction (certainty) intervals.
7. Identify sources of error in simulations.
8. Describe relationships among variables.
9. Describe the effect of correlation on simulation results.

Materials

1. Internet and appropriate airport and travel data
2. Computer
3. Appropriate simulation software
 - a. Arena
 - b. Simio
4. Pencil and paper

References

Fayez, Mollaghasemi, *et.al.* Managing Airport Operations using Simulation, Journal of Simulation (2008) 2, 41-52.

Evaluation

1. Present simulation to the class for peer critique
2. Was the simulation valid?
3. Did simulation produce desired analysis?

Unit 5.3: Numerical Analysis Techniques

Unit Length:

This unit will last approximately seven days.

Goals:

Apply numerical analysis techniques.

Rationale:

Numerical analysis and mathematical modeling are essential in many areas of modern life. Sophisticated numerical analysis software is commonly embedded in popular software packages (e.g., spreadsheet programs) and allows fairly detailed models to be evaluated, even when the user is unaware of the underlying mathematics. Numerical analysis and methods are applied to a very wide range of subject areas. Numerical analysis is an effective tool used by many researchers in many areas of engineering and science. For example, building modern structures makes major use of finite element methods for solving the partial differential equations associated with models of stress; and computational fluid mechanics is a fundamental tool in designing new airplanes, and so on.

Objectives:

1. Apply logical reasoning skills to solve real-world problems through the development of mathematical models.
2. Design a step-by-step plan (algorithm) to solve a given problem.
3. Write program specifications that define the constraints of a given problem.
4. Use a programmable calculator.
5. Write an algorithm to solve mathematical problems using formulas, equations, and functions.

Recommended Instructional Activities:

1. Invite guest speaker to class to discuss the utility of numerical analysis. National Security Agency Mathematics Speakers Bureau is an excellent resource.
http://www.nsa.gov/academia/early_opportunities/math_edu_partnership/index.shtml
2. Read, Pair, and Share Article: Review and discuss interview with a pioneer in Numerical Analysis -<http://history.siam.org/pdfs2/davis.pdf>
3. Collaborate with a Physics class in a study of velocity and acceleration; consider using Hooke's Law.
4. View video and discuss application: Apply a variety of algorithms to solve

a traveling salesman problem -

http://hsor.org/videos/index.cfm?videos=outel_semiconductor

5. Design a step-by-step plan (algorithm) to solve a given problem. The plan will be in the form of a program flowchart, pseudo code, hierarchy chart, and/or data-flow diagram.

6. Complete this online programmable calculator activity -Velocity and the Bouncing Ball -

http://education.ti.com/educationportal/activityexchange/activity_detail.do?cid=us&activityid=4084

References:

A [Library of Materials](#), most freely downloadable, created by classroom teachers and other educators, that addresses diverse curricular and organizational topics of interest to K-12 educators -

<http://www.clexchange.org/>

An interview with PHILIP J. DAVIS Conducted by William Kolata and Gail Corbett, 15 April, 2004, <http://history.siam.org/pdfs2/davis.pdf>

Floating-Point Number Tutorial - <http://www.cs.utah.edu/~zachary/isp/applets/FP/FP.html>

High School Operations Research Mathematics for Decision Making in Industry and Government – [Welcome to HSOR.org \(High School Operation Research\): Home](#)

Internet Resources for Numerical Analysis - <http://mathforum.org/advanced/numerical.html>

Kendall E. Atkinson, An Introduction to Numerical analysis -

http://www.math.uiowa.edu/~atkinson/NA_Overview.pdf

Kendall E. Atkinson, Elementary Numerical Analysis (Paperback)

Numerical analysis from Wikipedia - http://en.wikipedia.org/wiki/Numerical_analysis

Schery, Stephen, Topics in Numerical Analysis for High School Mathematics, Math Teacher, 63, 4, 313-317, 70 Apr

NSA Concepts Curriculum -

http://www.nsa.gov/academia/early_opportunities/math_edu_partnership/collected_learning/high_school/index.shtml

Steering Behaviors for Autonomous Characters - <http://www.red3d.com/cwr/steer/>

Unit 5.4: Select Model Fidelity

Unit Length:

This unit will last approximately 8 days.

Goals:

Select appropriate level of fidelity for a model

Rationale:

Fidelity in M&S is the degree to which a model or simulation reproduces the state and behavior of a real world object or the perception of a real world object, condition in a measurable manner. When developing a model simulation it is imperative to understand the importance of an efficient level of simulation fidelity, which will achieve acceptable output accuracy with minimum resources and thereby reduce model building effort and computation time. We have all heard the axiom that time is money and in the business world spending too much time on a simulation that only solves simple problems is not cost-effective.

Objectives:

1. Define fidelity.
2. Discuss the ramifications of model fidelity parameters variations.
3. Select the proper level of fidelity to solve a given problem.
4. Identify the rationale for selecting fidelity level.
5. Adjust model fidelity parameters to meet output requirements

Recommended Instructional Activities:

1. Research the definition of model fidelity. Identify and illustrate (5) fidelity related concepts e.g. Listening to a portable radio vs. listening to a Bose radio.
2. Discuss and demonstrate model simulation fidelity levels.
3. Design a spreadsheet cost/benefit analysis of different fidelity level models. In your cost, consider construction time, money, storage capacity, and bandwidth, etc.
4. Class discusses the relationship between fidelity of simulation with transfer of training in a flight simulator.

References:

A [Library of Materials](http://www.clexchange.org/), most freely downloadable, created by classroom teachers and other educators, that addresses diverse curricular and organizational topics of interest to K-12 educators -
<http://www.clexchange.org/>

Characterization of Model Fidelity Uncertainty for Robust Design Chandan Kumar Mozumder, D.Deg, 05, 63 pp

Fact Sheet dealing with military simulation fidelity level: What is a Model or Simulation hierarchy -
<http://www.imcva.com/simulation/Fact%20Sheet%205%20What%20is%20a%20model%20or%20simulation%20hierarchy%20-Final.doc>

Medical study on the level of fidelity used in training surgeons
<http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=1356416>

Understanding Simulation Fidelity: What is it and how much do we need? Deals with process simulation -
<http://www.mynah.com/pdf/Understanding%20Simulation%20Fidelity.pdf>

Design Brief: Create a Discrete Event Simulation (DES)

Context

The growth of container traffic in the shipping industry has brought a major challenge for marine and intermodal terminals: how to successfully handle the increase in demand? Current forecasts estimate worldwide container volume doubling over the next twenty years (1). One North American port forecasts a growth rate in container traffic of 249 percent (2). Terminals must find a way to manage this additional demand, or risk losing business to their competitors.



Discrete event simulation is an important system analysis technique that can assist shipping industry decision makers in predicting demands and developing solutions to problems.

A discrete event simulation (DES) manages events in time. Most computer, logic-test, and fault- tree simulations are of this type. In this type of simulation, the simulator maintains a queue of events sorted by the simulated time they should occur. The simulator reads the queue and triggers new events as each event is processed.

Challenge

Each student will demonstrate an understanding of creating a simple Discrete Event Simulation that provides summary data useful in making effective decisions. Upon completion of this Design brief, you will be able to access data produced by a simulation, understand the event relationships and to discover logic defects in the design, or the sequence of events. Suggested problems to simulate:

1. How containers are moved (percent by rail or by truck)
2. Most efficient technology used for handling containers (e.g., straddle carriers vs. crane/hostler)
3. Where containers are stored (on-site or remote, stacked or on chassis)
4. Expansion of terminals or creation of new storage yards
5. Inefficient gate operations resulting in long queues of idling trucks
6. Cost of encroachment on surrounding wetlands
7. Cost of Shifting tonnage from rail to truck
8. The result of increasing OTR (over-the-road) traffic
9. Determining unacceptable increase in harmful emissions

Objectives

Upon completion of the design brief, students will be able to do the following:

1. Identify discrete event simulations.
2. Use simulation as an analysis tool.
3. Describe the output distribution.
4. Use historical/empirical data.
5. Correctly interpret summary statistics.
6. Correctly interpret confidence and prediction (certainty) intervals.
7. Identify sources of error in simulations.
8. Describe relationships among variables.
9. Describe the effect of correlation on simulation results.

Materials

1. Internet and appropriate shipping industry data
2. Computer with appropriate simulation software
3. Pencil and paper
4. ePortfolio

References

[Military Sealift Command.\(GOVERNMENT NEWS\)\(Brief Article\)](#), February 01, 2005

[Baltimore Chapter.\(conferences\)\(Brief Article\)](#), February 01, 2005

[Arizona Frontier Chapter.\(donations\)\(Brief Article\)](#), February 01, 2005

[Gulf coast chapter.\(obituary\)\(Brief Article\)\(Obituary\)](#), February 01, 2005

[Sacramento chapter.\(join forces with NEWS10\)](#), February 01, 2005

Discrete-Event Simulation: Modeling, Programming, and Analysis by G. Fishman, 2001, [*Discrete-Event Simulation: A First Course*](#) - <http://www.cs.wm.edu/~esmirni/Teaching/cs526/DESAFC-1.1.ppt>

Monte-Carlo *simulation*? Teach Discrete-Event simulation? [*Teaching \(Monte-Carlo\) Spreadsheet Simulation*](#) - <http://meetings.informs.org/TMSWorkshop/TMS04/presentations/Grinde.ppt>

Overview of Simulation - <http://www.systems-thinking.org/modsim/modsim.htm>

Evaluation

- Present simulation to the class for peer critique
- Was the simulation valid?
- Did simulation produce desired analysis?

Unit 6: Exhibiting Mathematical Skills

Unit Length:

This unit will last approximately 75 days.

Goals:

- 6.1 Data Collection
- 6.2 Analyze graphs
- 6.3 Describe statistical patterns
- 6.4 Identify the relationship between events
- 6.5 Compute probabilities
- 6.6 Compute permutations and combinations
- 6.7 Conduct an experiment
- 6.8 Basic mathematical calculations

Rationale:

One aspect of modeling and simulation is the need to perform analysis on given or generated data sets. In order to effectively conduct analysis on data, basic probability and statistical analytical methodologies are required. Probability and statistics provide the foundation for simulations and cover methods used for incorporating randomness into models and estimating the unknown model parameters using observed data. The math review unit provides a review of the overall skills necessary to create and analyze simulation models.

Unit 6.1: Data Collection

Unit Length:

This unit will last approximately five days.

Goals:

Describe the methods of data collection in a census, sample survey, experiment, and observational study and identify an appropriate method of solution for a given problem setting.

Rationale:

Although it is very important to have two-dimensional and three dimensional visualizations for simulations, without realistic data, the visualizations have little value. Although many simulations may have unknown variables being studied, in order to make the simulation realistic, collected data is required as input. In this section, students will learn how to collect data via a variety of methods as well as begin to understand bias in data collection and statistics in general.

Objectives:

1. Define terminology associated with data collection.
2. Differentiate between the various methods of data collection.
3. Explain the uses of random number generators.
4. Recognize various sources of bias in data collection.
5. Prepare a sample data collection.

Recommended Instructional Activities:

1. Explain to students that roughly a day cannot go by without the bombardment of data and statistics. Ask students if they think they should always trust data? Come up with a few examples of when data might have been incorrectly presented and relate them to the students.
 - a. Define the following terms: *population*, *data*, *variables*, and *sampling*.
 - b. Define the following terms: *census*, *experiment*, and *observational study* (*Sample Survey*).
2. Discuss the use of data and statistics and bias in the use of data collection and statistics.
3. Define the following terms: *nonresponse bias*, *convenience samples*, *response bias*, and *undercoverage bias*.
4. Class Survey: What do you have in common with your classmates? Students create a survey of 5-10 questions. The questions can be anything from food likes and dislikes to political issues. Allow students to survey the class on their likes and dislikes. Ask students to write a paragraph summarizing their results, making sure to list any biases.

5. Students should also explain if they could make broad conclusions about their results and explain why or why not.
6. Provide students with a variety of scenarios and have them determine and explain whether the scenario was an observational study, experiment, or survey.

References:

Australian Bureau of Statistics --

<http://www.abs.gov.au/Websitedbs/cashome.nsf/51c9a3d36edfd0dfca256acb00118404/9bf24b731daf6144ca2572fe001e2ad7!OpenDocument>

Glossary of statistical terminology --

http://www.stats.gla.ac.uk/steps/glossary/basic_definitions.html

Moore, David S

Statistics: Concepts and Controversies –5th ed.

W.H Freeman and Company, New York, 2001.

Using observation to determine an understanding of the Milky Way galaxy --

<http://www.gb.nrao.edu/~glangsto/lessons/lessonHISTORY.html>

Unit 6.2: Analyze Graphs

Unit Length:

This unit will last approximately 5 days but objectives will be reinforced throughout course.

Goal:

Analyze graphical displays of data.

Rationale:

After designing your survey, experiment, or observational study, the next logical step is to analyze the data. Graphical displays are commonly used for to perform this activity.

Objectives:

1. Define graphical terminology.
2. Interpret tables of statistics.
3. Create bar charts and pie graphs with appropriate software.
4. Analyze the data to solve a presented problem

Recommended Instructional Activities:

1. Describe what makes a clear representation data and potentially what makes a misleading representation of data. Provide examples of good and bad histograms.
2. Explain the following terms: *frequency table, histogram, bar charts, shape, and outliers, labels, legends.* as they relate to graphical representations of data.
3. Students take the data from a completed survey place it in a table in a spreadsheet program and present a graphical representation of the data. (See Unit 3.1).
4. Form the graphical representation of the data, determine what conclusions could be formed. Ask students what was easier to understand, the table or the chart?
5. Provide students with a series of data in a spreadsheet. Students examine the data, and chart it using a graphical display of their choice. Type a paragraph summarizing the data, describing why they chose that particular type of chart and what conclusions they can make from the data and the associated chart.

References:

Exploratory Data Analysis -- This chapter presents the assumptions, principles, and techniques necessary to gain insight into data via EDA--exploratory data analysis.

<http://www.itl.nist.gov/div898/handbook/eda/eda.htm>

Gary Klass, *Just Plain Data Analysis: Finding, Presenting, and Interpreting Social Science Data* (New York: Rowman and Littlefield Publishers, 2008)
ISBN: 978-0-7425-6053-6

Just Plain Data Analysis Companion Website -- <http://lilt.ilstu.edu/jpda/>

Making Sense of the 2000 Census Lesson Plan --
http://www.create.cett.msstate.edu/create/classroom/lplan_view.asp?articleID=78

Statistics: Collecting and Organizing data lesson plan. --
<http://regentsprep.org/regents/biology/units/organization/index.cfm>

Types of statistical graphs. http://math.youngzones.org/stat_graph.html

Unit 6.3: Describe Statistical Patterns

Unit Length:

This unit will last approximately 10 days but objectives will be reinforced throughout course.

Goal:

Analyze numerical characteristics of univariate data sets to describe patterns and departure from patterns, using mean, median, and mode.

Rationale:

Every M&S professional is required to analyze the results of a simulation model to determine (1) if the simulation is operating correctly and (2) if the results of the simulation model with theoretical data are correct. Fortunately, statistics provides a variety of methods to describe patterns and variations in data.

In this section, we explore the several of the numerical characteristics of statistics.

Objectives:

1. Define statistical terminology.
2. Determine the numerical characteristics of a data set.

Recommended Instructional Activities:

1. Explain that *statistics* is the branch of mathematics that uses observations and measurements to analyze and summarize data gathered.
2. Identify the terms: *mean*, *median*, *mode*, *range*, and *standard deviation* and how they relate to the study of statistics.
3. Explain that variability is required to study data. For example, you might use an example of standard temperatures for the month of the year in which this section is being taught, measure the actual temperature and explain the idea that one can measure the variability from the average temperature.
4. Calculate the *mean*, *median*, *mode*, *range*, and *standard deviation* from a data set.
5. Using interactive software, students can compare and contrast properties of measures of central tendency, specifically the influence of changes in data values on the mean and median. For example, using the census database online (www.census.gov). Find information about the Income in the United States. Compare the behavior of mean and median.

References:

Exploring and Comparing Mean Median and Mode

<http://math.elon.edu/statistics112/exploring.html>

Mean and Median Applets : http://www.ruf.rice.edu/~lane/stat_sim/descriptive/index.html

Practical uses of mean, median, and mode:

<http://www.teachersnetwork.org/powertolearn/web/ludwig/outline.htm>

Research Methods Knowledge Base <http://www.socialresearchmethods.net/kb/statdesc.php>

Statistics, Concepts and Controversies Associated Web site:

<http://bcs.whfreeman.com/scc/default.asp?s=&n=&i=&v=&o=&ns=0&uid=0&rau=0>

Statistics Definition web site: <http://www.ltconline.net/greenl/courses/201/descstat/mean.htm>

Statistics Worksheets: <http://edhelper.com/statistics.htm>

Unit 6.4: Identify the Relationship Between Events

Unit Length:

This unit will last approximately 10 days but objectives will be reinforced throughout course.

Goal:

Identify and describe two or more events as complementary, dependent, independent, and/or mutually exclusive.

Rationale:

Probability requires understanding of the various types of events that can occur. Very often the occurrence of one event is dependent upon a sequence or the occurrence of the first event. In order to accurately simulate random events, it is necessary to understand the way probabilities can change based on order or dependence.

Objectives:

1. Define probability event terminology.
2. Identify events as complementary, dependent, or independent.
3. Identify events as mutually exclusive or not mutually exclusive.

Recommended Instructional Activities:

1. Define the terms: *complementary, dependent, and independent*.
2. Provide examples of dependent and independent events.
3. Define the terms: mutually exclusive, complementary, dependent, and independent.
4. Provide students with a series of examples that can be categorized as mutually exclusive, complementary, dependent, and independent.
5. Ask students to provide examples of events for each of the categories and explain why they meet criteria for each group.
6. Explain that the students will need to know how to identify these events because in the next section they will be calculating the probability for these types of events.

References:

Independent and Dependent Events:

http://www.learningwave.com/chapters/probability/dependent_independent.html

The Math Forum at Drexel: <http://mathforum.org/library/drmath/view/56494.html>

SparkNotes, Complementary Events and Odds:

<http://www.sparknotes.com/math/algebra1/probability/section2.rhtml>

Online Math Learning: <http://www.onlinemathlearning.com/complementary-events.html>

Mrs. Glossars Math Goodies:

http://www.mathgoodies.com/lessons/vol6/mutually_exclusive.html

Regents Prep: <http://www.regentsprep.org/>

Probability Lesson Plan: <http://www.cimt.plymouth.ac.uk/projects/mepres/book7/y7s21lp.pdf>

Probability Simulations:

http://www.mathsonline.co.uk/nonmembers/resource/plans/tree_plan.html

Unit 6.5: Compute Probabilities

Unit Length:

This unit will last approximately 10 days but objectives will be reinforced throughout course.

Goal:

Find probabilities (relative frequency and theoretical), including conditional probabilities for events that are either dependent or independent, by applying the “law of large numbers” concept, the addition rule, and the multiplication rule.

Rationale:

Most people are familiar with probability, or the mathematics of chance, from playing lotteries or gambling games such as slot machines. There are many more applications of probability in business, weather forecasting, and in our day to lives. In fact, an entire area of study called Operations Research uses probability to assist business to run more efficiently. Modeling and simulation experts use probability in designing models that will occur at relative frequencies or to add randomness into a simulation.

Objectives:

1. Define probability terminology.
2. Explain probability rules.
3. Analyze categorical data using two-way tables to describe patterns and departure from patterns and to find marginal frequency and relative frequencies.
4. Distinguish between empirical and theoretical probability.
5. Calculate probabilities.
6. Explain the law of large numbers.
7. Calculate probabilities using addition rules.
8. Calculate probabilities using the multiplications rules.

Recommended Instructional Activities:

1. Define the following terms: probability, probability experiment, outcome, trial, sample space, and classical probability.
2. Explain and give examples of sample spaces. For example, the samples space for a coin is heads or tails. Ask students what the sample space is for two coins?

3. Explain the probability rules:
 - The probability of any event will always be a number from zero to one.
 - When an event cannot occur the probability is zero (0)
 - When an event's certainty is 100%, the probability is 1
 - The sum of all probabilities of a sample space are 1;
 - The probability that an event will not occur is one minus the probability that the event will occur.
4. Provide students with an experimental probability exercise using dice or similar. For example, in a box, place pieces of paper to represent a \$1, \$5, \$10, and \$20 bills.
5. Determine the probability that the bill is \$10. Determine the probability n that the denomination of the bill selected is more than \$2. The bill selected is of an odd denomination.
6. Provide students with the formula to calculate theoretical probability.
7. Ensure that probability notation is explained. For example, the probability of event A occurring is written: $P(A)$.
8. Explain to students that providing more trials on a particular probability experiment will lead to an experimental probability that is closer to the theoretical probability. Ensure students understand that this idea is the Law of Large Numbers.
9. Review the concepts of mutually exclusive and non-mutually exclusive while explaining the Addition Rules.
10. Provide students with the two probability addition rules:
 - When two events are mutually exclusive: $P(A \text{ or } B) = P(A) + P(B)$
 - When two events are not mutually exclusive: $P(A \text{ or } B) = P(A) + P(B) - P(A \text{ and } B)$
11. Provide students with the two multiplication rules:
 - If two events are independent: $P(A \text{ and } B) = P(A) * P(B)$
 - If two events are dependent: $P(A \text{ and } B) = P(A) P(B|A)$
12. One of the most difficult aspects for students is to determine when the various rules should be used. During class, provide students with a worksheet or class problem. Ask the students to try the problem on their own and then review their answers. Ask students to explain why they chose the rule they chose, even if they did not choose the correct rule as this assists other students from falling into a similar trap.

References:

Introduction to Probability Lesson Plans:

<http://school.discoveryeducation.com/lessonplans/programs/probability/>

Mrs. Glossar's Math Goodies http://www.mathgoodies.com/lessons/vol6/intro_probability.html

Rules of Probability: <http://library.thinkquest.org/11506/prules.html>

Probability Tutorials: <http://www.probability.net/>

Probability Web, The <http://www.mathcs.carleton.edu/probweb/probweb.html>

Statistics Glossary: <http://mathforum.org/dr.math/faq/faq.prob.intro.html>

Unit 6.6: Compute Permutations and Combinations

Unit Length:

This unit will last approximately 10 days but objectives will be reinforced throughout course.

Goal:

Compute and distinguish between permutations and combinations and use technology for applications.

Rationale:

You probably thought that you already knew how to count, but counting for probabilities involves some different mathematic counting skills. In order to calculate some probabilities, it is necessary to know the total number of ways an event can occur. This unit will provide the mechanisms for counting the various ways that events can occur given various situations. You will learn three rules, The Fundamental Counting Rule, Permutations, and Combinations.

Objectives:

1. Define the *Fundamental Counting Rule*, *Permutation*, and *Combination*.
2. Perform calculations using the Fundamental Counting Rule, Permutation and Combination
3. Distinguish when one would use a permutation and when one would use a combination.

Recommended Instructional Activities:

1. Define the following terms: probability, probability experiment, outcome, trial, sample space, classical probability.
2. Explain and give examples of sample spaces. For example, the samples space for a coin is heads or tails. Ask students what the sample space is for two coins?
3. Explain the probability rules:
 - a. The probability of any event will always be a number from zero to one.
 - b. When an event cannot occur the probability is zero (0)
 - c. When an event's certainty is 100%, the probability is 1
 - d. The sum of all probabilities of a sample space are 1;
 - e. The probability that an event will not occur is one minus the probability that the event will occur.
4. Provide students with an experimental probability exercise using dice or similar. For example: In a box, place pieces of paper to represent a \$1, \$5, \$10, and \$20 bills. Determine the probability that the bill is \$10. Determine the probability n that the denomination of the bill selected is more than \$2. The bill selected is of an odd denomination.
5. Provide students with the formula to calculate the theoretical probability.
6. Ensure that probability notation is explained. For example, the probability of event A occurring is written $P(A)$.

7. Explain to students that providing more trials on a particular probability experiment will lead to an experimental probability that is closer to the theoretical probability. Ensure students understand that this idea is the Law of Large Numbers.
8. Review the concepts of mutually exclusive and non-mutually exclusive while explaining the Addition Rules.
9. Provide students with the two probability addition rules:
 1. When two events are mutually exclusive: $P(A \text{ or } B) = P(A) + P(B)$
 2. When two events are not mutually exclusive: $P(A \text{ or } B) = P(A) + P(B) - P(A \text{ and } B)$
10. Provide students with the two multiplication rules:
 - a. If two events are independent: $P(A \text{ and } B) = P(A) * P(B)$
 - b. If two events are dependent: $P(A \text{ and } B) = P(A) P(B|A)$
11. One of the most difficult aspects for students is to determine when the various rules should be used. During class, provide students with a worksheet or class problem. Ask the students to try the problem on their own and then review their answers. Ask students to explain why they chose the rule they chose, even if they did not choose the correct rule as this assists other students from falling into a similar trap.

References:

College Cram, Combinations: <http://www.college-cram.com/study/algebra/presentations/245>

Genius Maker Math Software for Permutations and Combinations:
<http://www.goldenstar.com/permutation-combination-software-school-mathematics.htm>

InfoPlease.com Combinations and Permutations:
<http://www.infoplease.com/ce6/sci/A0860531.html>

Introduction to Probability Lesson Plans:
<http://school.discoveryeducation.com/lessonplans/programs/probability/>

Probability, Combinations and Permutations:
<http://www.chem.qmul.ac.uk/software/download/qmc/ch5.pdf>

Regent Prep: <http://www.regentsprep.org/>

Unit 6.7: Conduct an Experiment

Unit Length:

This unit will last approximately 20 days but objectives will be reinforced throughout course.

Goal:

Plan and conduct an experiment that will address control, randomization, and measurement of experimental error.

Rationale:

Now that you are familiar with a variety of probability and statistics basics, it is useful to see how these are applied in the real world. To complete this activity, you will develop an experiment and explore the ideas of experimental error.

Objectives:

1. Define experimental terminology.
2. Explain potential reasons for experimental error.
3. Conduct an experiment within the classroom.

Recommended Instructional Activities:

1. Review the following terms: *hypothesis*, *statistical significance*, *bias*, *placebo effect*, and *sampling error*.
2. Provide students with a series of experiments and hold a class discussion to understand what might be reasons for experimental error. Explain to students the importance of examining any experiment with these concepts in mind.
3. Brainstorm with students' ideas for a measurable experiment that could be completed in the classroom. For example, you might measure everyone in the class to determine what the average height of a person in the modeling and simulation program. Another idea would be to perform some form of a class survey.
4. Split the class into groups to perform the same experiment. Students then compare their data to see how it may differ and should explain why there are differences in the data.

References:

Introduction to Probability Lesson Plans:

<http://school.discoveryeducation.com/lessonplans/programs/probability/>

Mrs. Glossar's Math Goodies http://www.mathgoodies.com/lessons/vol6/intro_probability.html

Rules of Probability: <http://library.thinkquest.org/11506/prules.html>

Probability Tutorials: <http://www.probability.net/>

Probability Web, The <http://www.mathcs.carleton.edu/probweb/probweb.html>

Statistics Primer: <http://mathforum.org/dr.math/faq/faq.prob.intro.html>

Unit 6.8: Basic Mathematical Calculations

Unit Length:

This unit will last approximately 15 days but objectives will be reinforced throughout course.

Goal: Perform basic mathematical calculations as needed in software applications.

Rationale:

It is important to understand probability distributions as these are commonly used in the models used in simulations. Probability distributions are critical to the study of discrete event simulations, which are used in manufacturing, business, and other industries.

Software-based random number generation depends on formulas that give a seed, return sequences of numbers that conform to a specific probability distribution. These are called pseudo-random numbers because the same seed will return the exact same sequence of numbers.

These sequences are finite in length, which can become a problem when needing more random numbers than exist in a sequence; in such a case the sequence repeats and the statistical properties are no longer valid. This is not a problem for small experiments.

Objectives:

1. Define various probability distributions.
2. Calculate the probability from a distribution.
3. Perform discrete event simulations using probability distributions.
4. Understand random number generation and its limitations.

Recommended Instructional Activities:

1. Define the following terms: probability distribution, discrete, continuous, binomial distribution, triangular distribution, and normal distribution.
2. Introduce the binomial distribution and identify what types of problems in which it is most likely to be used.
3. Have students describe the outcome for tossing three coins at the same time and then calculate the probability by grouping the number of heads in each.
4. Design and perform a binomial experiment as a class activity.
5. Calculate the mean and standard deviation for the binomial distribution.
6. Introduce the triangular distribution and identify what types of problems in which it is most likely to be used.
7. Design and perform a triangular distribution experiment as a class activity.
8. Calculate the mean and standard deviation for the triangular distribution.
9. Explain that the normal distribution is the most common type of distribution.
10. Describe the characteristics of the normal distribution.
11. Explain how to calculate the probability from a normal distribution curve.
12. Explain how the shape of the curve affects the probability.
13. Calculate the mean and standard deviation for the normal distribution and use z scores.
14. Show students how to calculate the z score on a scientific calculator.
15. Explain the concept and uses of discrete event simulation.

16. Using appropriate software, determine what type of activity (manufacturing for example) might follow the normal distribution and determine where the bottlenecks may exist.
17. Use the random number generator of a calculator to generate a series of random numbers and compare the actual distribution with the intended distribution.

References:

Discrete Probability Distributions:

http://www.dartmouth.edu/~chance/teaching_aids/books_articles/probability_book/Chapter1.pdf

Engineering and Statistics Handbook:

<http://www.itl.nist.gov/div898/handbook/eda/section3/eda36.htm>

Hyperstat Online, The Normal Distribution:

http://davidmlane.com/hyperstat/normal_distribution.html

Intervals and Probability Distributions: <http://ifsc.ualr.edu/jdberleant/intprob/>

Normal Distribution Calculator:

http://www.math.csusb.edu/faculty/stanton/m262/normal_distribution/normal_distribution.html

Rockwell Software, Arena Simulation Software: <http://www.arenasimulation.com/>

Probability distribution statistics tutorial:

<http://stattrek.com/Lesson2/ProbabilityDistribution.aspx>

Design Brief: Using Probability and Games

Simulation of a Forest Fire

Context

Wild fires are common in most ecosystems. Wildlife conservationists, local, state, and federal agencies work together to limit the negative effects of wildfires on resources and society. Most wildlife fires must be suppressed to meet resource and social objectives. While it has been shown that wildfires serve important ecosystem functions, human involvement has played a significant role in the destruction of wildlife resources. The most common human related causes of wildfires are due to arson, campfires, discarding lit cigarettes, and improperly burning debris. Fighting wildfires is a carefully planned and complex science. Many factors influence the method of fighting these fires. Activity participants can observe how properties like wind speed, wind direction, and forest density affect how the fire spreads.



Challenge

Each student will demonstrate an understanding of the application of probability and statistics as it relates to the spread of wildfires. Additionally, each student will identify the inputs and outputs of the simulation.

Objectives

Upon completion of the design brief, students will be able to do the following:

1. Explain some techniques used in fighting wildfires.
2. Understand experimental terminology.
3. Apply randomness.
4. Distinguish between empirical and theoretical probability.
5. Calculate probabilities.
6. Explain potential reasons for experimental error.
7. Graph using a line plot
8. Understand means
9. Describe variance.
10. Perform a hand simulation.

Materials

1. Computer with Internet access and a web browser that is Java enabled.
<http://www.shodor.org/interactivate/activities/DirectableFire/>
2. Pencil and paper
3. Dice
4. Graph paper

References

Fire and Aviation Management <http://www.fs.fed.us/fire/>

Forest Fire Lesson Plan

<http://school.discoveryeducation.com/lessonplans/programs/forestfires/>

Forest Fires and Percolation: Managing Wildfires and Tree Growth

<http://polymer.bu.edu/java/java/blaze/blaze.html>

Forest Fire In the American Southwest – Statistics <http://forestfire.nau.edu/statistics.htm>

Java Applet allows the user to see the results of a fire if a forest is densely planted in a rectangular grid when directional probabilities are set

<http://www.shodor.org/interactivate/activities/DirectableFire/>

Modeling Forest Fires using Probability Modeling Tools to compare Forest Management practices of today versus Forest Management practices of the Past.

<http://serendip.brynmawr.edu/local/cgi/lessons97/Abram.html>

Oregon Department of Forestry

<http://www.oregon.gov/ODF/FIRE/fire.shtml>

Plume rise model for Forest Fire Using ArcGIS Modeling Tool

<http://www.cwrw.utexas.edu/gis/gishydro03/Classroom/trmproj/Nopmongcol/report.htm>

Evaluation

1. Research the ecological benefits and dangers associated with wildfires. Provide a typed paragraph summarizing your finding.
2. Perform the *Fire! Exploration* questions worksheet
(<http://www.shodor.org/interactivate/media/worksheets/29.pdf>)
3. Describe the inputs and outputs to this simulation.
4. Describe the variables in the simulation.
5. Is this simulation realistic? Why or why not?
6. Any simulation can be updated to increase its fidelity. Define fidelity and explain what could be modified in the simulation to improve the fidelity.

Unit 7: Software Design and Development

Unit Length:

This unit will last approximately 95 days.

Goals:

- 7.1 Examine computer programming factors that influence design.
- 7.2 Explain object models.
- 7.3 Explain agent-based simulation.
- 7.4 Explore software evolution and lifecycle.
- 7.5 Apply simple gaming concepts.
- 7.6. Conduct software design

Rationale:

One aspect of Modeling and Simulation encountered by many professionals is the need to design or modify a simulation, create a visualization of a simulation model, or integrate two or more simulation models together. To achieve this task, it is critical that students have the ability to analyze and perform problem decomposition. Most real-time simulators integrate hardware and software to achieve a total system or sub-system. Computer programming knowledge and concepts provide the necessary skills to perform the required analysis and modify a simulation to meet the desired goal.

Unit 7.1: Programming Factors in Design

Unit Length:

This unit will last approximately 20 days but will be reinforced throughout course.

Goals:

Examine computer programming factors that influence design.

Rationale:

Understanding your computer is critical to being able to design and implement programs that will ultimately become simulations. In order to prevent unforeseen mistakes and buggy software, you will need to begin to learn about computers and programming. This unit will introduce you to basic computer hardware and introduce you to programming concepts.

Objectives:

1. Understand basic computer terminology.
2. Explain how a basic computer works.
3. Be able to decompose problems.
4. Apply problem analysis using flowcharts and the Unified Modeling Language (UML).
5. Understand basic programming constructs.
6. Examine programming styles and design.

Recommended Instructional Activities:

1. Define computer.
2. Explain the basic hardware of a computer to include: memory, hard drive, CPU
3. Explain how a computer works and the requirement of detailed instructions in order for a computer to operate correctly.
4. Explain the binary numbering system to students including how to perform conversions from binary to decimal and decimal to binary.
5. Explain how a computer uses the bin.
6. If time permits, gather students around a single workstation and remove the cover of a computer. Point out each of the various components and take a photo using a digital camera. Later on, part of an exam will be to identify the components of the computer.
7. Define algorithm and give examples of algorithms.
8. Allow students to provide the detailed steps for solving a problem using an every day scenario such as making a peanut butter and jelly

sandwich.

9. Explain that algorithms can be viewed pictorially using flowchart modules.
10. Define the modules of flowcharting to include: start/end, input/output, process, decision, and repetition modules
11. Apply the use of flowcharting modules using a variety of day to day activities.
12. Create an algorithm for a problem and draw it using flowchart modules.
13. Define a few of the UML modules.
14. Explain that the Unified Modeling Language is also commonly used to represent the physical flow and layout of computer programs.
15. By looking at flowcharts and UML diagrams, students can explain the flow of data and structure of a program.
16. Define programming language terminology
17. Understand that data types are used to define what can be stored in a memory location.
18. Use decision programming constructs.
19. Use repetition programming constructs.
20. Understand the organization and use of functions/methods and classes in object oriented programming.
21. Differentiate between functional design, event driven design, and object oriented design.
22. Apply functional design utilizing a programming language on simple problems.
23. Apply event driven design to the development of a simple game or program.

References:

Basic How To for a variety of computer issues:

http://www.ehow.com/information_1013-computer-hardware.html

Construx Software: Software Design Specification

Developer What is Software Design:

http://www.developerdotstar.com/mag/articles/reeves_design.html

Directory of Online Free Computer Related Books and Tutorials: <http://2020ok.com/5.htm>

Introduction to Object Oriented Programming:

http://en.wikipedia.org/wiki/Object-oriented_programming

IBM Introduction to UML:

<http://www.ibm.com/developerworks/rational/library/769.html> and http://www-128.ibm.com/developerworks/rational/library/content/03July/2500/2772/2772_uml.pdf

Introduction to Computers: <http://www.grassrootsdesign.com/intro/index.php>

Introduction to Functional Programming:

<http://www.cl.cam.ac.uk/teaching/Lectures/funprog-jrh-1996/>

Introduction to Programming Languages:

<http://burks.bton.ac.uk/burks/pcinfo/progdocs/plbook/index.htm>

Introduction to Programming Using Java – free online text: <http://math.hws.edu/javanotes/>

Introduction to UML PowerPoint:

<http://www.javapassion.com/javaprogramming/presentations/oopuml.pdf>

Java Tutorials, Introduction to Objected Oriented Programming:

<http://java.sun.com/docs/books/tutorial/java/concepts/>

Microsoft Windows Tutorial: <http://www.functionx.com/windows/Lesson01.htm>

Software Design Specification Template:

<http://www.cmcrossroads.com/bradapp/docs/sdd.html>

Unit 7.2: Object Models

Unit Length:

This unit will last approximately 10 days but objectives will be reinforced throughout course.

Goals: Explain object models.

Rationale:

This unit continues to explore programming principles with the focus on object-oriented programming which leads to the development of object models. While there are many approaches to programming, by far the most frequently used and accepted is that of object oriented design. In fact, several programming languages, including C++ and Java, are designed with object oriented programming and object models in mind.

Objectives:

1. Describe objects using object oriented design (OOD).
2. Distinguish between abstract and real objects.
3. Explain why object oriented design is an effective programming paradigm.
4. Implement classes and methods.
5. Describe the benefits of object oriented concepts.
6. Use UML to describe object oriented design.

Recommended Instructional Activities:

1. Define an object and explain that an object has attributes and behaviors. Ask students to describe basic day-to-day objects and describe what attributes and what behaviors each object would have.
2. Describe the concept of classes as techniques used to create objects. Provide an example using an appropriate object oriented programming language such as Java or C++ so students see the actual syntax.
3. Explain that classes implement attributes and behaviors via the use of methods and variables and is used as the container or template. Explain the idea of method names, arguments, and method bodies. Explain that the idea is very similar to when they were creating functional programs.
4. Allow students to create a basic class using object oriented design. At an introductory level, it is more important to be able to design the class than follow the exact syntax of a particular language. For example, students might create a class that describes a student.

5. Ask students to define the attributes and behaviors of a student. Students may come up with First name, Last name, student ID etc. Implement the attributes. Explain to students that without methods to display and modify the attribute variables, it is impossible to actually set or modify the attributes. Have students come up with names and implement the methods together. Finally, show students how to instantiate the object in the chosen programming language. Make sure to write the main program and show the students how it differs from a class.
6. Explain the difference between private and public functions and explain the benefits of using encapsulation.
7. The instructor may choose to explain the concept of encapsulation by asking students to identify something that they may be able to do, while others may not. The explanation should include an explanation that as a user of that ability, you don't care how they do it, you just care that it gets completed.
8. Explain the concept of polymorphism, why it is important and how it is use.
9. Explain the *is-a* and *has-a* relationships. A simple example that one might use includes the idea of people in a school. Schools have students, teachers, and principals who have different attributes and behaviors, but have the common attributes and behaviors of people.
10. Explain the concept of overriding a method and why this is useful.
11. Using UML or some other mechanism, allow students to describe the attributes and behaviors of the person, student, principal, and teacher classes. Ensure students identify and inherit the necessary events.
12. Provide students with a skeleton for implement the various classes for people in the school and allow them to fill in the details from their UML diagram.
13. Finally, explain that most games and simulations use object oriented design. Using some appropriate software such as GameMaker or Alice, reinforce the object oriented constructs.

References:

Basic C++ introduction to OOD: <http://gd.tuwien.ac.at/languages/c/c++oop-pmueller/>

Basic How To for a variety of computer issues:
http://www.ehow.com/information_1013-computer-hardware.html

Benefits of Object Oriented Design: <http://www.rtis.com/nat/user/jfullerton/BENEFIT.HTM>

Introduction to Object Oriented Programming:
http://en.wikipedia.org/wiki/Object-oriented_programming

Document Object Model: <http://www.w3.org/DOM/>

Just What is Object Oriented Programming: http://www.debreuil.com/docs/ch01_Intro.htm

Keogh, Jim and Giannini, Mario. OOP DeMystefied, McGraw Hill/IOsborne, 2004.

Object Oriented Programming Terminology: <http://www.startvbdotnet.com/oop/default.aspx>

JDO Object Model:

<http://www.odbms.org/download/038.02%20Jordan%20The%20JDO%20Object%20Model%20June%202001.PDF>

Object Oriented Programming Tutorial: <http://aonaware.com/OOP1.htm>

Unit 7.3: Agent-based Simulation

Unit Length:

This unit will last approximately 10 days but objectives will be reinforced throughout course.

Goals:

Explain agent-based simulation.

Rationale:

This unit continues to explore programming principles with the focus on agent based programming. Agent based programming is an approach to programming that is similar to object oriented programming but focuses on a distributed approach. It is this distributed approach that is used frequently in modeling and simulation.

Objectives

1. Understand the concept of a distributed environment.
2. Explain the architecture of agent based simulation.
3. Describe the uses of agent based modeling.

Recommended Instructional Activities:

1. Explain that agent based simulation uses the idea of autonomous decision making entities called agents. Each agent assesses its own situation and makes decisions based upon a set of rules.
2. Students should be able to define the following terms: agent, autonomous agent, distributed agent.
3. Demonstration: Tell students that they are going to work together to demonstrate the concept of agent based simulation.
 - a. Design a similar activity to the following: Tell students they are going to write a paragraph on a topic by each one of them writing an individual word on a paper. The rules for the sentences are that they must be grammatically correct and have meaning to the agreed upon topic.

It is up to each student to decide when a sentence should be completed and another one begins. Depending upon the number of students in the class, the instructor may want to pass the paper around the room more than once so each student has an opportunity to potentially make a decision on the structure of the paragraph.

Once the paragraph is complete, the instructor then reads the paragraph. Explain to students that they performed an example of an agent based simulation. The overall objective of writing a paragraph on a particular topic was met by each individual contributing to the activity and making decisions based upon the given rules. This is how agents work in an agent based simulation.

4. Define and introduce artificial intelligence as an area of study and give reasons for its usage.
5. Allow students to research uses of Agent based modeling and/or artificial intelligence to create a PowerPoint presentation on its particular use.
6. Discuss complex behaviors of agents and the notion that complexity often grows exponentially as the number of agents increase.

References:

Agent Based Simulation Tutorial Paper: <http://www.informs-sim.org/wsc06papers/008.pdf>

A Distributed Autonomous-Agent Network-Intrusion Detection and Response System:
<http://faculty.nps.edu/ncrowe/barruspap.html>

Book Results for Agent Based Programming:
<http://books.google.com/books?q=Introduction+to+agent+based+programming&source=citation>

IBM Agent Based Simulation Research:
http://www.research.ibm.com/trl/projects/optsim/mktsim/index_e.htm

Introduction to Agent Based Simulation of Social Processes:
<http://www.informs-sim.org/wsc06papers/008.pdf>

Is it an Agent or Just a Program?: <http://www.msci.memphis.edu/~franklin/AgentProg.html>

MaterialSim: An Agent-Based Simulation Toolkit for Learning Materials Science
<http://www.blikstein.com/paulo/documents/papers/BliksteinWilensky-MaterialSim-ICEE2004.pdf>

Multi-Agent-Based Simulation VI
International Workshop, MABS 2005, Utrecht, The Netherlands, July 25, 2005, Revised and Invited Papers
Series: [Lecture Notes in Computer Science](#) , Vol. 3891
Sublibrary: [Lecture Notes in Artificial Intelligence](#)
Sichman, Jaime S.; Antunes, Luis (Eds.) 2006, X, 191 p. With online files/update., Softcover
ISBN: 978-3-540-33380-7

Unit 7.4: Software Evolution and Lifecycle

Unit Length:

This unit will last approximately 20 days but will be reinforced throughout course.

Goals:

Explore software evolution and lifecycle.

Rationale:

Now that you have the background to create programs and design some basic software, it's time to examine the software development lifecycle models. Sometimes in the classroom, we fall into the habit of having each of you create your own programs, purely for the sake of grading purposes. What will be happening in this unit is that you will understand what it's like to work on a larger project and in groups. You will explore the concepts of project management while building a project.

Objectives:

1. Define software lifecycle
2. Identify the three primary lifecycle models.
3. Describe the steps in the lifecycle model.
4. Describe advantages and disadvantages of each type of model.
5. Understand project management principals.
6. Understand extreme programming.

Recommended Instructional Activities:

1. Introduce software lifecycle and project lifecycle concepts by reiterating that in the workplace, most software projects are performed via a large group of people, not individuals. Explain the necessity to be professional and the responsibility to meet the customer's needs on time and within the designated budget.
2. Define the primary software lifecycle models: Waterfall, Incremental, and Spiral.
3. Describe the steps of each of the lifecycle models and explain when it is appropriate to use each model. Although the Waterfall model has fallen out of common use, for historical purposes it is relevant to mention and there are still times when it is useful. Additionally, the incremental model is based upon the waterfall model.
4. Draw pictures to visually demonstrate the steps of the lifecycle model.
5. Identify the advantages and disadvantages of each type of lifecycle model.

6. Ask students to compare and contrast two of the models. Provide students with a sample project and ask them to write a paragraph describing what they would perform during each of the steps in the lifecycle model as well as describe **why** the model they chose fits their plan.
7. Describe the various positions within a project. Ensure students understand the concept of Project Manager, technical lead, developers, testers etc.
8. Provide students with an activity, preferably software oriented and divide them into groups. You may need to provide a skeleton program or extra classes to assist in the development. Ask students to acquire requirements, estimate a schedule, and design and implement a prototype.

References:

Barry W. Boehm, TRW Defense Systems Group, A Spiral Model of Software Development and Enhancement: <http://www.cs.umd.edu/class/spring2003/cmsc838p/Process/spiral.pdf>

Extreme Programming - <http://www.extremeprogramming.org/>

Freeman, Eric, Freeman, Elisabeth, Sierra, Kathy, Bates, Bert. **Head First Design Patterns**, O'Reilly, 2004. ISBN 0596007124, 9780596007126

Risk Management in a Software Development Life Cycle:
<http://www.brighthub.com/office/project-management/articles/72055.aspx>

Software Model Lecture: <http://www.ccs.neu.edu/home/matthias/670-s05/Lectures/2.html>

Spiral Model - A New Approach Towards Software Development:
<http://www.buzzle.com/editorials/1-13-2005-64082.asp>

Kary, Russel. "QuickStudy: System Development Life Cycle (SDLC)" -
http://www.computerworld.com/s/article/71151/System_Development_Life_Cycle

Waterfall Software Development Project: <http://www.buzzle.com/editorials/3-13-2005-67039.asp>

Unit 7.5: Simple Gaming Constructs

Unit Length:

This unit will last approximately 15 days but objectives will be reinforced throughout course.

Goals:

Apply simple gaming constructs.

Rationale:

Now that you've done the hard part, its time to apply the software design skills you've learned to create a few simple games.

Objectives:

1. Describe the history of gaming and evolution of video games.
2. Design games using programming techniques.
3. Implement a simple game using appropriate software.

Recommended Instructional Activities:

1. Review the history of game programming. The History channel has a few good videos on this.
2. Describe what makes a good game. Ask students to provide input to what they like in the games they play.
3. Project: Review decision statements. Students should then design and choose their own adventure story. The presentation should have at least 5 decisions with the key being that one bad decision does not lead to the player's demise. Students will then get to play **and** rate each other's games.
4. Using appropriate software, split the class into groups. Students will have to develop requirements, provide a schedule/plan, flowchart or storyboard. Students will need to update the schedule as needed. Provide salary rates for each group member based upon their role in the group and ask students to also prepare a budget. Students will then implement their project keeping a journal of their day-to-day activities. At the end students must "sell" their



- product to the class as a whole. The class will play and rate the game. The instructor may or may not choose to incorporate this as part of the grade.
5. The students will create their own board game from scratch or a template. There could be a working board game which they are asked to modify by adding new pieces, new rules, or new areas on the board. This is a good way to expose what is happening inside of a computer game or simulation.
 6. Use a game building program to create your own game. Perhaps something like Alice.org, Logo (or a modern version of it), Game Maker, Movie Maker, etc.
 7. Then turn the game into a simulator by applying it to some real problem and adding the basic logic of that real problem.

References:

Careers in Game Programming:

http://www.jobmonkey.com/videogamejobs/video_game_design_compensation.html

GameMaker Website: <http://www.yoyogames.com/make>

GameSpot: History of Video Games:

<http://www.gamespot.com/gamespot/features/video/hov/index.html>

Game Programming Lesson: <http://www.sloperama.com/advice/lesson15.html>

Rabin, Steve: Introduction to Game Development, Charles Rivever Media, 2008. ISBN: 1-58450-377-7

Habgood, Jacob and Overmars, Mark. The Game Maker's Apprentice: Game Development for Beginners. Apress, 2006
ISBN 1590596153, 9781590596159

Programmer's Corner, An Introduction to Game Programming:

<http://www.programmers-corner.com/article/32>

Introduction to Game Programming Course Outline: <http://itp.usc.edu/files/ITP%20380.pdf>

Links to Game Related Resources: <http://www.resourcium.com/>

Thorn, Alan. Introduction to Game Programming with C++. Worldwise Publishing Inc. 2007. ISBN: 1598220322, ISBN13: 9781598220322

ATM Object Oriented Design Example <http://www.cs.gordon.edu/courses/cs211/ATMExample/>

C and C++ Programming Tutorials <http://www.cprogramming.com/tutorial.html>

C++ Program Documentation Guidelines

<http://www.bgsu.edu/departments/compsci/docs/documentation.html>

C++ Language Tutorial <http://www.cplusplus.com/doc/tutorial/>

C++ Programming Language Tutorials <http://www.cs.wustl.edu/~schmidt/C++/>

Design Document Overview from Cornell Computer Science
<http://www.cs.cornell.edu/courses/cs433/2001fa/Slides/DesignDocument.pdf>

Free Downloadable Project software <http://www.smartdraw.com/specials/project-software.htm>

Gantt Chart in Excel http://www.hyperhot.com/pm_excel_gantt.htm

How to Write a Design Document
<http://blog.slickedit.com/2007/05/how-to-write-an-effective-design-document/>

In Program Documentation
http://www.cse.ucsc.edu/~karplus/185/w99/reader/7_In_program_Documentation.html

Java Documentation for the Core API <http://www.apl.jhu.edu/~hall/java/Documentation.html>

Java Tutorial <http://www.java2s.com/Tutorial/Java/CatalogJava.htm>

Java Tutorials from Java Web Site <http://java.sun.com/docs/books/tutorial/>

Microsoft Visual Basic Tutorials <http://www.tutorialized.com/tutorials/Visual-Basic/1>

Object Oriented Programming Techniques <http://www.mycplus.com/tutorials/object-oriented-programming/oop-techniques/>

Principles of Object Oriented Design <http://c2.com/cgi/wiki?PrinciplesOfObjectOrientedDesign>

Programming Tutorials <http://www.cprogramming.com/tutorial.html>

The Project Plan http://www.hyperhot.com/pm_plan.htm

Project Planning for Dummies <http://www.dummies.com/WileyCDA/DummiesArticle/PMP-Certification-Creating-the-Project-Plan.id-1821.html>

Six Tips for Improving Your Design Documentation
http://www.bboxesandarrows.com/view/six_tips_for_improving_your_design_documentation

Evaluation

1. Project plan was updated regularly and followed.
2. Program submitted correctly and directories correctly named.
3. Design document represents the implementation of the program and contains a detailed description and/or flowchart.
4. Program compiles and runs.
5. Program performs exactly as described in documentation.
6. Comments listed in program explain the program logic.
7. Code was organized according to programming standards.
8. Required functionality was provided.
9. Organization of code is logical.
10. Documentation of program is detailed and logical. Writing is clear and not overly technical.

Unit 7.6: Software Design

Unit Length:

This unit will last approximately 20 days.

Goals:

To conduct software design of real time and other simulations.

Rationale:

Computer software design requires discipline in following accepted processes and procedures. In the past, programmers had their own ways of doing programming and projects experienced disaster in many cases. Documenting the design approach and notes accompanying the design and coding were lacking. Consequently, when personnel changed or when the software was ready for integration, people were at a loss to understand the code and could not go back and analyze the design. The military developed standards for software development that required rigor and documentation throughout the design, development, integration, testing and support. A complete audit trail was achieved, enabling a smooth transition through the various phases of the project life cycle. Understanding these processes will give the student an advantage when he or she enters the work force.

Objectives (Standards):

1. Identify functions of information processing
2. Test software units, modules and programs
3. Plan program design
4. Code programs
5. Perform program maintenance
6. Create and maintain documentation
7. Implement enhanced program structures
8. Implement multimedia programming
9. Develop an understanding of programming techniques and concepts..

Recommended Instructional Activities:

Classroom activities will vary depending on course content and applications selected by the teacher. The following website provides a general approach to in-class activities:

<https://users.cs.jmu.edu/foxcj/Public/ISED/activities/activities.htm>

The in-class activities below are intended for teams of three to five students. Teams of only two students lack sufficient breadth of ideas to encourage good discussion, and

teams larger than five take too long to reach consensus and may leave some students out of the discussion and decision-making process. Dysfunctional teams should be changed as soon as possible; teams should probably be rearranged every few weeks in any case to maintain student interest and to keep students with strong personalities from becoming too dominant. Once the instructor gets to know the students, it may be a good idea to form teams whose members have a range of talents so that the weaker students can learn from the stronger ones.

Each activity requires at least a 50-minute class period. The earlier activities don't cover as much ground because it usually takes students a while to become accustomed to the activities and to their teams. Some of the activities are quite open-ended and can be easily be extended across two class periods or used as projects that are completed as homework. It is also not necessary to finish every activity—much learning occurs simply by working on the problems rather than by completing them. Students often become frustrated when their team is unable to finish an activity in class. The instructor can explain that the point is to learn and practice, not to produce a deliverable.

One behavior that exacerbates the problem of running out of time is failure of team members to read the resource material before class. Students understand after only one or two activities that this is a very bad practice, and peer pressure usually results in very high preparation rates. I encourage good preparation by posting the activity write-up on the class web page at least two days before the activity, and reminding students of the activity and the resource materials the class period preceding the activity. Scheduling activities on the same days (for example, on Wednesdays) also helps students remember to prepare.

Student deliverables may be graded, but the time pressures mentioned above and the vicissitudes of working on a team have convinced me that students should be graded only on participation in in-class activities. Although no homework assignments appear in the activity write-ups below, I generally assign homework to go with each in-class activity that is graded individually.

In principle, a course might be taught entirely using in-class activities, but this makes it difficult to cover the amount of material that must be included in a college-level course. Consequently, I generally have one in-class activity every week or two, for a total of between 7 and 12 activities during the semester. Besides the fact that in-class activities are a good teaching tool, using them this way helps vary the course so that it is not a monotonous series of lectures. My students generally like to have them almost every week, so I tend to use them often.

References:

Andrews, Paul. Documenting Software Architectures: Views and Beyond (SEI Series in Software Engineering Series) / Edition 2.2012

Boehm, Barry W. Software Engineering Economics. **Prentice-Hall, 1981**

Deitel, Paul and Harvey. **C++ How to Program**. Prentice Hall 2011

McConnell, Steve. *Software Project Survival Guide: How to Be Sure Your First Important Project Isn't Your Last*. Microsoft Press, 1997. ISBN: 1-57231-621-7.

Unit 8.0: Real Time Virtual Simulators

Unit Length:

This unit will last approximately 50 weeks.

Goals:

- 8.1 Understand the theory and major components of real-time virtual simulators.
- 8.2 Understand the applications of real time simulators
- 8.3 Become familiar and conduct the systems engineering the simulators

Rationale:

Real time virtual simulators are perhaps the most familiar to students. They have observed or experienced flight simulators used by the military, commercial airlines, nuclear power generation, space, entertainment, law enforcement, accident investigation, medical and other applications. Simulators are being used more frequently today for medical training by the military and for civilian applications. Simulators save time, money and lives. This unit delves into the theory, design and applications of simulators, demonstrating how science, technology and mathematics are integrated in producing simulators for multiple uses.

Recommended Instructional Activities:

1. Ask students to identify simulators they have experienced themselves or have seen on television, etc. Catalog the various applications: military, medical, transportation, commercial airlines, etc.
2. Have them defend the use of simulators for training to save time, money and lives.
3. Have them provide reasons why behaviors learned in the simulator are transferred to the real world (Example: flight training)
4. Ask them why some get sick in simulators at theme parks.
5. Have them draw a block diagram of a simulator, understanding what functions are performed in each of the blocks.
6. Break the class into groups and have them design (to the block diagram level) “fun” simulators such as a surfboard simulator or dressage competition. Ask them to brief the class on the approach and describe how the behaviors learned with the simulator can be transferred to the actual system.
7. Have them conceptualize a network of simulators of their choice and describe how the network works. Identify limitations.
8. For the *Design Brief* that follows, divide the class into two groups. Group 1 will identify the requirements for the Firefighting Simulator by researching operational and safety issues with firefighters. This includes active and volunteer firefighters.

At the conclusion of the research, the students of Group 1 will prepare a specification for a conceptual design. Group 2 will proceed with the design process and at the

conclusion of brainstorming and evaluating alternatives; Group 2 will make a presentation to Group 2 that outlines the proposed solution to the problem.

References:

Alfred T Lee, *Flight Simulation, Virtual Environments in Aviation* Ashgate Publishing Limited, 2005) ISBN0 7546 4287 9

J.M.Rolfe and K.J.Staples, *Flight Simulation* .Cambridge University Press, 1986 ISBN 0 521 30649 3

Early History of Flight Simulation—<http://www.simulationinformation.com>

Instrument Flight Training—<http://www.simulationinformation.com>

Electronic Flight Simulation—<http://www.simulationinformation.com>

HLA- High Level Architecture

<http://www.mak.com/resources/industry-standards/hla--high-level-architecture.html>

Web-based Surgical Videos- <http://www.websurg.org>

References provided by National Training Systems Association Modeling and Simulation Professional Certification Commission as follows:

Badler, N.I. et. al. *Simulating Humans: Computer Graphics Animation and Control*, 1993. [human behavior]

Banks, J., J.S., Carson, B.L., Nelson, and D.M. Nicole, *Discrete-Event System Simulation*, third edition. Prentice-Hall, 2000.

Carrie, A., *Simulation of Manufacturing Systems*, Chichester; New York: Wiley, c1988. [Manufacturing]

Cellier F.E., *Continuous System Modeling*. Springer-Verlag, 1991. [continuous, advanced, graduate]

Cloud, D. and L. Rainey, Editors, *Applied Modeling and Simulation: An Integrated Approach to Development and Operation*, Space Technology Series, McGraw Hill, 1998. [Decision Making]

Dutton, J.M. *Computer Simulation of Human Behavior*. New York, Wiley, 1971. [human behavior]

Fishwick, P., *Simulation Model Design and Execution: Building Digital Worlds*. Prentice Hall, 1995. [general, introduction, simulation techniques]

Fujimoto, R.M., Parallel and Distributed Simulation Systems, Wiley Series on Parallel and Distributed Computing, 1999. [parallel, distributed]

Gardner F.M. and J.D. Baker, Simulation Techniques Set, John Wiley & Sons, 1997. [simulation techniques]

Gentle, J.E., Random Number Generation and Monte Carlo Methods. Springer Verlag, 1998. [Monte Carlo, random numbers]

Gould, H. and J. Tobochnik, Introduction to Computer Simulation Methods: Applications To Physical Systems, second edition. Addison Wesley, 1996. [simulation methodology, physical]

Jain, R., The Art of Computer Systems Performance Analysis: Techniques for Experimental Design, Measurement, Simulation, and Modeling. John Wiley & Sons, 1991. [general, introduction, mathematics, statistics, simulation methodology, introduction, networks]

Klir, G.J., Architecture of Systems Problem Solving, New York: Plenum Press, c1985. [modeling]

Kuhl, F, R. Weatherly and J. Dahmann, Creating Computer Simulation Systems: An Introduction to High Level Architecture. Prentice Hall, 1999. [HLA, High Level Architecture]

Law, A.M., and W.D. Kelton, Simulation Modeling and Analysis, third edition. McGraw-Hill Series in Industrial Engineering and Management Science, 2000. [general, introduction, statistics, simulation methodology]

National Research Council, Virtual Reality: Scientific and Technological Challenges, National Academy Press, 1995. [virtual reality, policy]

National Research Council, Modeling Human and Organizational Behavior: Application to Military Simulations, 1999. [human behavior]

Neyland, David L. Virtual Combat: A Guide to Distributed Interactive Simulation, Stackpole Books, 1997. [warfare]

Zeigler, B.P., H. Praehofer and T.G. Kim, Theory of Modelling and Simulation, second edition, Academic Press, 2000. [modeling]

The Evolutionary Models in Social Science page,
http://www.cs.iastate.edu/~baojie/acad/reference/2003-01-27_emss.htm

Unit 8.1: Theory and Major Components

Unit Length:

This unit will take approximately 50 days.

Goals:

Understand the theory and major components of real time simulators

Rationale:

What is it that allows simulators to substitute for real world systems? The military and others have found that simulators save time, cost and lives. There have been many studies that validate that time in a simulator can substitute for training time in an aircraft, for example. There is a very strong case for the transfer of training from a simulator to the parent system. The issue of the fidelity (or amount of realism) of simulation as it affects the transfer of training must be addressed. Levels of fidelity must be considered for part task trainers, full mission simulators and simulators networked together for team mission training. Generally, there is a block diagram of components that are to be included in the overall design of a simulator regardless of application. This unit will identify those basic building blocks for a simulator.

Objectives:

1. Understand concepts of the transfer of training
2. Understand simulator computational systems (hardware and software)
3. Describe components of visual systems (image generation, data bases and displays)
4. Describe theory of motion/ control loading simulation and cue synchronization
5. Describe trainee station design, sensor simulation and instructor/operator station design

Recommended Instructional Activities:

1. Have students draw a block diagram of a simulator, understanding what functions are performed in each of the blocks.
2. Have them defend the use of simulators for training to save time, money and lives
3. Break the class into groups and have them design (to the block diagram level) “fun” simulators such as a surfboard simulator or dressage competition. Ask them to brief the class on the approach and describe how the behaviors learned with the simulator can be transferred to the actual system.
4. Have them provide reasons why behaviors learned in the simulator are transferred to the real world (Example: flight training)
5. Ask them why some get sick in simulators at theme parks.

Unit 8.2: Applications of Real Time Simulators

Unit Length:

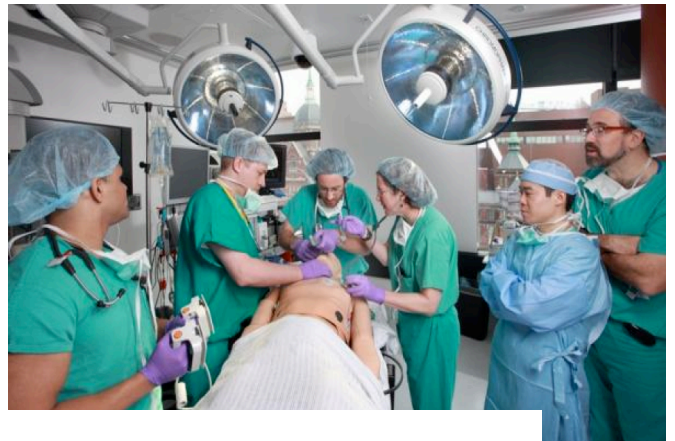
This unit will take approximately 15 days.

Goals:

To be able to identify the applications of real time virtual simulators

Rationale:

Real time simulators were first used by the military with Edwin Link, simulator pioneer, introducing his “Blue Box” to the Army Air Corps to train pilots in flying instruments. The commercial airlines recognized the effectiveness of simulators and began to use them for aircrew training. With the introduction of the digital computer, it became possible to design simulators in computer software in lieu of expensive, single-purpose hardware. This versatility, led others to develop simulators for a wide range of applications. The entertainment industry began to introduce video games and location-based



entertainment concerns such as theme parks took advantage of simulation technologies such as motion systems, visual displays, computer-generated imagery and even olfactory simulation to add realism to their rides. Homeland Security and law enforcement agencies seized the opportunity to use simulators in marksmanship and “shoot-don’t shoot” trainers. Of late, the medical and health care community adopted simulation technology for training of nurses, EMT’s, doctors, etc. The first such training device was the Human Patient Simulator: it breathes, has a heart beat, blood pressure, etc. Of course, the space program demanded and received high fidelity training simulators for individual and crew training. Putting a person on the moon would not have been possible without the use of simulators. It appears that the range of simulator applications is only limited by the imagination of the human.

Objectives:

1. Identify simulator applications
2. Identify where team simulators would be appropriate
3. Identify where individual simulators would be appropriate
4. Understand where and why networked simulators are used

Recommended Instructional Activities:

1. Ask students to identify simulators they have experienced themselves or have seen on television, etc. Catalog the various applications: military, medical, transportation, commercial airlines, etc. Then have them go to the internet and see how many applications they can find, categorize them as team or individual trainers.
2. Conduct a “brainstorming” session, preferably led by students, to think about future applications of simulation and how they might be effective in mission planning and training. Consider, for example, a simulation that includes networking with avatars in a space exploration mission. The avatars can be members of a space team with members of the team on Mars, spacecraft and on Earth. The simulators would be networked using High Level Architecture (HLA).

Unit 8.3: Systems Engineering the Simulator

Unit Length:

This unit will take approximately 20 days

Goals:

Understand the systems engineering processes used in the design of training simulators

Rationale:

Systems engineering is an interdisciplinary approach to manage the technical realization of a successful program. Systems engineering processes provide technical insight into the holistic status of the program. This is important for a number of reasons. First, there are many technical disciplines, which will address a portion of the product solution, and interact with other design areas. If the design requirements aren't fully understood by all designers, there can be problems resulting. For example, if the visual system engineers do not fully understand the requirement for weather, a student pilot in the training system may see with their "out-the-window" view a clear and calm day, but the aircraft is not responding because the environmental engineers are simulating thunderstorms and wind shear effects based by a scenario setting not used by the visual engineers.

Second, there may be a trade-off required among the technical designers in order to meet computational size, timing or network limitations.

Third, there may be cost considerations that drive the solution to tailor the technical approaches.

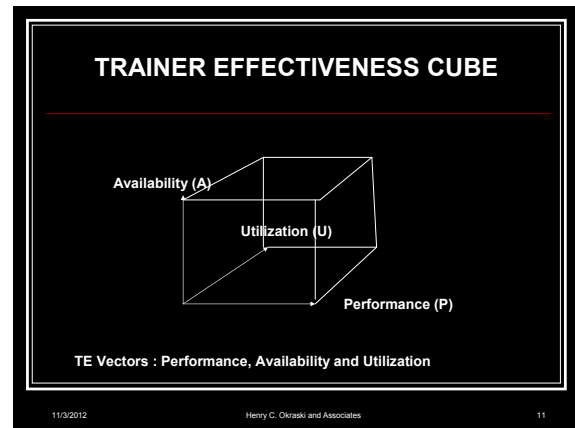
Fourth, there may be schedule considerations with drive the solution a particular way.

Fifth, the technical solution may require more personnel to run or maintain the system than are available. The cost to maintain the system may be higher than the original cost of the system.

Sixth, the architecture (software/hardware) may not be conducive to making changes required to reflect future customer needs.

Or, if it's a typical program, all of the above are impacting the technical approach.

So, how do you manage all this? The systems engineering process provides tools to allow the team to provide the right level of data and insight for the program team to make the right decision.



A few fundamentals of what's expected in systems engineering:

1. Know the requirements (what's needed?!)
2. These requirements are then further derived to better determine the technical design approach (Trace these in a Requirements Traceability Matrix (RTM))
3. The RTM allows changes in design to flow back to the base requirements (training objective and training requirements for training systems)
4. The RTM also flows to design documentation throughout the program, resulting in the basis for your test procedure.
5. Capture Program Risks and document with impact and mitigation strategies. Document and Brief this to a Risk Team on a planned schedule. (no surprises!)
6. Technical design reviews – these are held based on the progression of the design development to ensure to design is mature enough to go onto the next development stage.
7. Continually evaluate the teams' status, personnel requirements, schedule considerations, interim product item completion.
8. The amount of documentation and the extent of the review are based on the complexity and risk of the program.

Objectives:

1. Understand the Systems Engineering life cycle process and terminology
2. Understand Requirements Management
3. Understand Risk Management
4. Understand Technical Process Management (Technical Reviews)
5. Experience the breadth of items required to be tracked on a typical program and understand why plans can be in constant flux.

Recommended Instructional Activities

1. Assign everyone a role as part of a program team. Everyone will receive a motivation goal unknown to the rest of the team (Cost containment at all costs, Schedule shortfall, No need for SE Processes, volatile personality...) and a base set of requirements. At this point:
 - a. There will be a 30 minute discussion on the requirements and all will go and develop a schedule and requirements derivation based on their assignments (Program Manager, Logistician, Systems Engineer, Visual Engineer, Sensor Engineer, Software Engineer, Financial Manager, Test Engineer, Contracts Representative, etc). (Preferably requirements will be entered in Excel, Schedule in Project if possible.)
 - b. Bring team back together and discuss results, discuss the similarities and differences. Discuss items not covered, which could be catastrophic.
 - c. Organize an approach to work through the solution.
 - d. Break into groups for assignment of the now integrated schedule and requirements.
 - e. Prepare for a technical review (SRR, PDR, CDR for eg.)

Design Brief:

Design A Real-time Firefighting Simulaton

Courtesy of Engineering Computer Solutions & Henry C. Okraski Assoc.

The overall purpose of the design brief project is to design a firefighter trainer that will reduce the number of heart attacks and injuries experienced by civilian and military firefighters through better physical and mental conditioning achieved in a virtual environment. In addition to reducing the number of deaths and injuries, the following benefits are projected:

1. Improve the performance of firefighters through better screening and performance
2. Improve performance through familiarization with operating areas
3. Instill firefighter confidence through mission rehearsal and situational awareness training
4. Improve time-critical decision skills by introducing physical stressors into a controlled virtual environment
5. Identify operational and physical shortcomings leading to remediation.



Challenge

The challenge to the students is to combine creative thinking with the practicality of designing a simulator concept that will meet users' needs. There are several possible solutions to the problem and these should be evaluated and prioritized based on performance, initial and life-cycle costs and the probabilities of delivering a simulator to the user in a timely manner.

Objectives

Upon completion of the design brief, the student will be able to do the following:

1. Work in a team environment to identify feasible solutions to the users' needs
2. Evaluate alternative solutions
3. Identify the major components of a simulator
4. Use project management processes to lay out significant tasks and milestones
5. Put together a power point proposal briefing for the customer
6. Understand the implications of life cycle costing

Materials

1. Access to the internet
2. Computer support
3. Microsoft Project or other project management tools
4. Magic markers and large paper for brainstorming

References

Naval Air Warfare Center Training Systems Division (NAWCTSD) website (Resources-Acquisition) nawctsd.navair.navy.mil/

Unit 9: Demonstrating Innovation and Commercialization Techniques

Unit Length:

This unit will take approximately 20 weeks.

Goals:

- 9.1. Understand how ideas can become business opportunities
- 9.2. Understand how to protect intellectual property
- 9.3. Experience developing a Business Plan

Rationale:

In order to take an invention or new technology to market, students must learn the commercialization processes. To achieve these, students must learn both the legal and technical steps to finance, produce and market a technology solution they have created. This unit will explore these techniques and requirement using the” labs” included in this Unit.

Unit 9.1: Turning Ideas Into A Business

Unit Length:

This unit will last approximately 5 days.

Goals:

Understand the methods necessary to take a product or invention to the marketplace.

Rationale:

Teaching students the methods necessary to take a product/invention to the marketplace is fundamental to establishing a business and capitalizing on an invention. Many universities have incubators that can facilitate the transition of moving an invention to the marketplace. These organizations also provide advice in this process. The protection of the intellectual property is absolutely necessary throughout the transition process. Without patents, copyrights, trademarks, etc. anyone can take the product/invention as their own and begin to market it. We need to indoctrinate and help students to define the solution aspects of their invention and communicate those features of their product to potential investors-with proper legal advice.

Objectives:

1. Identify the technology application
2. Determine the design architecture
3. Formulate a proof of concept
4. Understand cost factors and ROI (Return on Investment)
5. Translate technology terminology to product descriptions that investors understand
6. Write the "Elevator Pitch" and the outline to the proformer document (Investment Proposal)

Recommended Instructional Activities

1. Students will create an idea Metaphor, or use a previously completed project.
2. Students will create Value statement for their product that results in improving or creating a new technology.
3. Students will create a written statement that describes the Technology Application.
4. Student will define and display the Design/Architecture using Power Point or similar presentation tool.
5. Students will describe the method with which they will demonstrate their Proof of Concept.

References:

Drucker, Peter F. Innovation and Entrepreneurship. 1985, New York. Harper and Roe

Sloane,Paul.The Innovative Leader: How to Inspire Your Team and Drive Creativity.2002.Penguin Group

Unit 9.2: Protecting Intellectual Property

Unit Length:

This unit will take approximately 15 days.

Goals:

Understand the methods and limitations of protecting Intellectual Property

Rationale:

It is imperative that students understand the methods of properly protecting Intellectual Property, and follow this process to its completions.

Objectives:

1. Understand the process of patent application filing, product trials, and communication techniques to describe their product.
2. Explore and examine the Intellectual Property Methods such as patents, copyrights, trademarks, and trade secrets.

Recommended Instructional Activities:

1. Research the cost and procedure involved in filing a Copyright, Trademark, Patent, and Trade Secret.
2. Students simulate filing the application through the Library of Congress and get financial quotes for any legal assistance required **using established coursewares both in text and online resources shown in References:**

References:

“So What Who Cares Why You” – Wendy Kennedy (Commercialization Workbook and online resouces)

“A Practical Guide to Business Incubator Marketing” by Corinne Colbert NBIA Publications, 2007

Online- The Growing Ventures.com Online Elevator pitch
<http://www.growingventures.com/elevator-pitch.1-1.shtml>

Unit 9.3: Develop a Business Plan

Unit Length:

This unit will last approximately 15 days

Goals:

Develop a comprehensive business plan that will expose students to the practical steps of developing a commercial business model.

Rationale:

To help students understand that entrepreneurship is an alternative career track. To secure loans or gain support for your enterprise, you must have a Business Plan.

This Unit will also give the students all the tools necessary to take a product from Lab to Market.

Objectives:

1. Develop a comprehensive business model.
2. Examine team building skills.
3. Understand the value of partnerships and sub-contracting of production and distribution of product.
4. Develop an understanding of the production process.
5. Understand return on investment (ROI) concepts.
6. Examine market analysis of product.
7. Develop and present a successful proposal for investors.

Recommended Instructional Activities:

1. Student will develop a written statement describing how their product solves a problem or services a market demand. (The statement must be written in a way that a non-technical investor can understand.) Students demonstrate how their ideas fit into industry, as well as solve business problems, improve life, science or technology.
2. Students will be divided into teams/production companies.
3. Each Team will then develop a comprehensive business plan.
4. Students will outline steps necessary to take their product to market.
5. Students will now build a prototype of the product to include in their demonstration of the products features.
6. Students will conduct a market analysis and define the products Return on Investment.
7. Students will distill their proposal into a pitch between 30 seconds and one minute designed to gain them an opportunity to make a proposal for financing.

8. Students refine their proposal through peer review, with each group acting as investors to each opposing groups' pitch.
9. Final proposal is made to instructor who represents investors.

References:

Business Plans and Florida Virtual Entrepreneur Center . www.flvec.com

User Guide, SCANS 2000: Developing a Business Plan: Virtual Workplace Simulation / Edition 1 by Arnold Packer, Johns Hopkins University
Cengage Learning, 2001

Unit 10: Project Management

Unit Length:

This unit will take approximately 40 days.

Goals:

- 10.1 Understand the Project Management body of knowledge
- 10.2 Understand Scope Management.
- 10.3 Understand Cost and Risk Management.
- 10.4 Understand quality and procurement management
- 10.5 Understand communications and human resources management.

Rationale:

Whether they realize it or not, students are immersed in the discipline of project management each time they plan a school play, plan their graduation, or enter a robotics competition.

Exposing high school students to the formal Project Management body of knowledge will better prepare them for their future endeavors, whether that is in College or the workforce.

Project Management is a skill that is in great demand across a wide spectrum of industries and organizations.

Unit 10.1: Project Management Body of Knowledge

Unit Length:

This unit will take approximately 10 days.

Goals:

Understand the process groups and knowledge areas that comprise the Project Management body of knowledge, including terminology..

Rationale:

The management of projects requires a skill set that can be applied to projects of various sizes, commodities and services. The processes for managing projects include new and unique terms requiring definition and understanding. To be able to function in any aspect of business, government or academia one has to be familiar with project management. From a career perspective, students entering industry will have a definite advantage by understanding the role and functions of project managers and project teams. Very frequently, teams are interdisciplinary, such as Integrated Product Teams (IPTs) requiring an understanding of how teams function and how the needs of the team members are met.

Objectives:

1. Define a Project.
2. Define Project Management.
3. Define the role of a Project Manager.
4. Define the role(s) of Project Stakeholders.
5. Discuss the Project life cycle.
6. Define the five Project Management Process groups.
7. Define the Project Management Plan & subsidiary plans.
8. Define the Project Charter
9. Define Project Scope

Recommended Instructional Activities:

During this module, the students should be asked to brain-storm about what their specific M&S project is going to be. A project Charter template should be handed out and used to record the general concept and scope of the project. The project charter should be used to guide class discussions on the project objectives, requirements, estimated cost and schedule, constraints, assumptions and stakeholder approval.

The instructor will then proceed to explain why it is important to define a clear, precise scope statement. This will include going over the components that make up the scope statement which are (a) the description (b), objectives, (c) deliverables, and (d) assumptions. Each student will draft a preliminary scope statement that can be “finalized” as a homework assignment.

References:

A Guide to the Project Management Body of Knowledge (PMBOK® Guide) 4th Edition, Project Management Institute, Newtown Square, PA, 2008.

Unit 10.2: Scope and Time Management

Unit Length:

This unit will take approximately 10 days.

Goals:

Demonstrate an understanding of Scope Management and be capable of constructing a project schedule

Rationale:

Project Managers are responsible for the cost, schedule and performance of the deliverable product and services required under the terms of the contract. The contract normally includes a specification or statement of work that describes what the customer intends to be delivered. To estimate how long the project will take, who will do the work and what resources are needed to complete the job, the Project Manager has to break down the project into its component parts and do the estimating. This analysis, given certain project management software tools, enables the manager to develop reasonable estimates for doing the work to the customer's satisfaction.

Objectives:

This module will build upon the work that the students had previously started in module one. Each student will be expected to:

1. Elaborate the scope of the M&S project identified in module one.
2. Detail the work to be done by creating a Work Breakdown Structure (WBS).
3. Develop a project schedule by:
 - a. Properly sequencing the work to be done (as noted in the WBS).
 - b. Making estimates of the duration required to do the work.
 - c. Assigning resource to the work to be done.

Recommended Instructional Activities:

Class will begin by reviewing the concepts discussed in the preceding class. The initial scope statement / project charter should have been finished as a "homework assignment. The instructor should begin the class by asking the student to define scope in the context of their M&S project(s).

Students should now begin the work of decomposing the work identified in the scope statement work into smaller tasks, work packages, and activities. Note: Ideally, this would be accomplished in a scheduling tool such as Microsoft Project. If that is not available, Microsoft Excel could be used to display a basic Gantt chart view.

The instructor should cover the various aspect of the Work Breakdown Structure (WBS) (phases, activities, and tasks) and the definition of a milestone. In concert with developing the WBS, the instructor should also discuss the responsibilities of project participants, how to create a responsibility assignment matrix and what an organizational breakdown structure is and how it is used.

References:

A Guide to the Project Management Body of Knowledge (PMBOK® Guide) 4th Edition, Project Management Institute, Newtown Square, PA, 2008.

Purna Duggirala. (2009). Gantt Charts – Project Management Using Excel. *Retrieved from* <http://chandoo.org/wp/2009/06/16/gantt-charts-project-management/>

Unit 10.3: Cost and Risk Management

Unit Length:

This unit will take approximately 10 days.

Goals:

Gain an understanding of the processes involved in Cost and Risk Management.

Rationale:

Every project has some risk in design, development or delivery and support. Risks can be in performance, schedule and/or cost. The Project Manager must assess that risk in order to develop reasonable cost and schedule estimates. Very often, customers wish to know where those risks are so that they can be involved in risk mitigation.(Working around those risks.) The Project Manager, with his or her team, must identify those risks and determine the impacts anticipated. From that activity, risk mitigation measures are identified to help lessen the effects of the risk areas identified.

Objectives:

This module will build upon the work that the students had previously started in module two. Each student will be expected to:

1. Create a Performance Measurement Baseline (PMB) for the Project.
2. Create a performance report that displays performance to plan for cost and schedule.
3. Develop an outline for a risk management plan for the M&S project.
4. Brainstorm potential project risks.
5. Create a risk register for the M&S project

Recommended Instructional Activities:

The instructor should begin the class with an overview of cost management. Using the PMBOK® framework, the instructor should facilitate the development of a PMB by using the time phased schedule developed in the previous class. Students should “plot” the accumulated (planned) project costs as a function of time in excel. Excel’s graphing functions can then be used to generate the “S” curve that is characteristic of the PMB. The instructor should then explain how the PMB will be used to measure performance to plan and suggest formats for performance reports.

The remainder of the class will be spent reviewing the six risk management process steps: risk management planning, risk identification, qualitative risk analysis, quantitative risk analysis, risk response planning, risk monitoring and control. Students will then be required to create a risk register for their M&S project. The instructor will facilitate a brainstorming session on potential risks for each of the student’s projects. The results of the brainstorming session will be recorded on the project risk register.

References:

A Guide to the Project Management Body of Knowledge (PMBOK® Guide) 4th Edition, Project Management Institute, Newtown Square, PA, 2008.

Unit 10.4: Quality and Procurement Management

Unit Length:

This unit will take approximately 5 days.

Goals:

Understand how quality policies, objectives, and responsibilities help ensure that the project satisfies the needs for which it was undertaken and define procurement and how it relates to project management.

Rationale:

Years ago, a company had the advertising slogan, “The quality goes in before the name goes on.”

Quality assurance is vital and can be managed under the umbrella of a Quality Plan. Companies have quality standards that everyone in the organization must follow. This is important because the customer is expecting a quality product and by using acceptable processes, the probability of delivering a quality product is much greater. In addition, a close interface must be established between the Project Manager and the contracts or procurement department.

Objectives:

This module will build upon the work that the students had previously started. Each student will be expected to:

1. Develop an outline for a quality management plan for the M&S project.
2. Define Procurement and how it relates to project management.
3. Describe the types of contracts and how contract type is used to manage risk.

Recommended Instructional Activities:

The instructor should review the project quality management and procurement management knowledge areas within the PMBOK with the students.

1. Quality planning
2. Quality assurance
3. Quality control
4. Procurement
5. Plan Purchases and Acquisitions
6. Plan Contracting
7. Request Seller Responses
8. Select Sellers
9. Contract Administration
10. Contract Closure

References:

A Guide to the Project Management Body of Knowledge (PMBOK® Guide) 4th Edition, Project Management Institute, Newtown Square, PA, 2008.

Unit 10.5: Communications and Human Resources Management

Unit Length:

This unit will take approximately 5 days.

Goals:

Demonstrate an understanding of the processes involved with project communications and human resources management.

Rationale:

The free flow of information within a project is vital to performance. Project teams can include members representing different disciplines and it is necessary for those team members to communicate. Today, most communications take place electronically. However, face-to-face meetings are very important. Integrated Product Teams (IPTs) are used throughout the government and processes are available on the internet. Also, team members can participate in collaborative design through electronic means. The objective is to have information shared among all team members, including Human Resources.

Objectives:

1. Develop a Communications plan for the M&S Project.
2. Develop performance reports for the M&S project. Reports should provide status and progress information, at the level required by the stakeholders, as documented in the communications plan.
3. Develop an outline of a Human Resources plan for the M&S Project.

Recommended Instructional Activities:

The instructor will discuss why different stakeholders require different type of communications during the course of the project. Students will be asked to brain storm about their project sponsors and determine what types information they need, how often that information should be provided, and in what medium/format. This information will be captured in the student's communication plan for each specific project. Specific emphasis should be place on what performance reports would be needed by the sponsors.

The instructor will then lead a discussion on the functions that comprise project human resources management (organizing, leading and managing project teams). Roles of the various project members and how they might be "hired" to assist with the project will be discussed. The discussion will culminate with the students developing a responsibility assignment matrix (RAM) for their specific project.

References: *A Guide to the Project Management Body of Knowledge (PMBOK® Guide) 4th Edition*, Project Management Institute, Newtown Square, PA, 2008.

Unit 11: Logistics Engineering and Management

Unit Length:

This unit will take approximately 20 days.

Goals:

- 11.1. Incorporating logistics features in the design of systems.
- 11.2. Understand the concepts of Integrated Logistics Support (ILS).

Rationale:

Training and other systems to be effective over the life cycle must have reliability and maintainability features incorporated in design. Further, the logistics elements to accompany the system must be planned for early in design and they should be managed in accordance with accepted ILS procedures. Reliability and maintainability will be predicted and measured. The adequacy of the logistics elements will be validated and verified during the program and completed as part of the acceptance procedures. At times, incentives and penalties are incorporated into the contract for performance in those areas.

Unit 11.1: Designing- in Logistics Features

Unit Length:

This unit will take approximately 15 days.

Goals:

Understand the principles and methodology of incorporating logistics features in the design of systems.

Rationale:

Reliability and maintainability must be designed-in the system to reduce life cycle costs and offer the user a pre-determined level of operational availability. Further, there are qualitative and quantitative measures of both parameters that must be achieved to yield an acceptable level of operational availability.

Objectives:

1. Understand how to perform predictions for system Mean-Time-Between-Failures (MTBF)
2. Understand how to perform predictions for Mean-Time-To-Repair (MTTR)
3. Understand how to perform predictions for Inherent Availability (Ai)
4. Understand how to perform predictions for Operational Availability (Ao)
5. Describe a systems block diagram showing allocated values for MTBF and MTTR
6. Understand qualitative maintainability design features
7. Understand how MTBF and MTTR are tested, validated and verified.

Recommended Instructional Activities:

1. Draw a block diagram of a training simulator
2. Allocate MTBF and MTTR values to the various sub-systems of the block diagram
3. Calculate overall MTBF and MTTR based on predicted values taken from reference material
4. Calculate Ai and Ao
5. Replace one or more subsystems with a different MTBF and MTTR and observe the change in Ai and Ao

References: Benjamin S. Blanchard, *Logistics Engineering and Management* (Prentice – Hall of India Private Limited 2008 ISBN-978-81-203-2763-4

Unit 11.2: Integrated Logistic Support

Unit Length:

This unit will take approximately 5 days.

Goals:

Understand the concepts of Integrated Logistics Support (ILS) and life cycle support planning and costs.

Rationale:

Product support is often overlooked in systems acquisition and becomes an after-the-fact undertaking. This is very costly and results in system downtime, adversely affecting system utilization. The most effective way to ensure that proper support is provided on time is through effective planning and management of the logistics elements.

Objectives:

1. Define Integrated Logistic Support and identify the elements of support
2. Understand how the elements of support affect system utilization and availability
3. Understand the process of logistic support analysis
4. Understand the role of the Logistic Support Manager
5. Understand Integrated Project Teams
6. Understand Logistic Support Plans
7. Understand the life cycle costing process
8. Understand the concept of logistic support validation and verification

Recommended Instructional Activities:

1. Students take a conceptual design of a simulator and identify the logistics elements necessary for its programmed life cycle support.
2. Students form an Integrated Project Team with appropriate team members and conduct an IPT Program Review for the design developed above.
3. Students identify cost driver for the above design.
4. Students develop a Logistic Support Plan for the above system.
5. Students develop a cost model for the design above.

References: Benjamin S. Blanchard, *Logistics Engineering and Management* (Prentice – Hall of India Private Limited 2008 ISBN-978-81-203-2763-4

Unit 12: Dealing With Ethical Issues

Unit Length:

This unit will take approximately 15 days but objectives will be reinforced throughout the course.

Goals:

To become familiar with and analyze ethical issues.

Rationale:

Ethical integrity and character development are grounded in high expectations and fostering relationships, these must embody all that we as teachers, leaders, and role models do every day. As a professional with access to company and government confidential information, you must understand and respond appropriately to the ethical, legal and limitation issues they might be confronted with as students and later as career professionals.

Objectives:

1. Apply ethical and legal issues (including copyright) with technology.
2. Develop understanding of professional and ethical responsibilities.
3. Perform ethical behavior.
4. Use accepted Netiquette
5. Describe polite and civil communication.
6. Discuss individual integrity and honesty.
7. Explain the purposes of copyrights, trademarks, and patents.
8. Practice ethical behaviors regarding copyright, citation, and plagiarism.

Recommended Instructional Activities:

1. Complete the Design brief “Dealing with Ethical Issues”
2. Read, Pair, and Share activity – Read the code of ethics for simulationists and share your thoughts with your partner.
3. Post words such as these around the classroom as a constant reminder of ethics: Support, encourage, fair treatment, thorough, unbiased, trustworthiness, honesty, honor, truthfulness, integrity etc.
4. Take the work ethic inventory to determine your work ethic ability – http://www.coe.uga.edu/cgi-bin/cgiwrap/%7Erhill/new_owe/owe.pl

References:

Critiquing Acceptable Use Policies – Elzas, M.S. 2000. “Why Should We Consider Ethical Issues To Be Relevant to Modeling and Simulation?” Special Issue of Transactions of the SCS on Ethical Issues in Modeling and Simulation. 17:4 (Dec.), 164.

E-mail netiquette guidelines – <http://eleccomm.ieee.org/email-netiquette.shtml>

Ethical issues online quiz –
http://www.catawba.k12.nc.us/pages/sites/edwebsites/computerskills/quizzes/ethics_integrity.htm

Exploring Ethical Issues lesson plan –
http://www.highschooljournalism.org/Teachers/Lesson_Plans/Detail.cfm?lessonplanid=197

IEEE Code of Ethics – http://www.ieee.org/portal/cms_docs/about/CoE_poster.pdf

Kettenis, D.L. (ed.) 2000. Special Issue of Transactions of the SCS on Ethical Issues in Modeling and Simulation 17:4 (Dec.).

Lesson plans for teaching Ethical Computer issues –
<http://www.cyberspacers.com/learn/learn2.html>

Netiquette definition from Wikipedia – <http://en.wikipedia.org/wiki/Netiquette>
Ören, T.I. 2000a. “Responsibility, Ethics, and Simulation.” Special Issue of Transactions of the SCS on Ethical Issues in Modeling and Simulation 17:4 (Dec.), 165-170.

Ören, T.I. 2000b. “[Educating the Simulationists](#).” In Conception of Curriculum for Simulation Education, (H. Szczerbicka, ed.) <http://www.informs-cs.org/wsc00papers/225.PDF> Proceedings of the 2000 Winter Simulation Conference (Orlando, FL., Dec. 10-13), 1635-1644.

Ören, T.I. 2002. “[Rationale for a Code of Professional Ethics for Simulationists](#).” In Proceedings of the 2002 Summer Computer Simulation Conference (San Diego, CA, July 13-18).

The impact of plagiarism –
<http://www.gananda.org/webpages/hslibrary/index.cfm?subpage=303665>

Whiteside, Thomas. Computer Capers. Thomas Y. Crowell Company, New York, 1978. Tales of electronic thievery, and white collar crime.

Design Brief: Dealing with Ethical Issues

Context

Ethical standards are what it means to be a good person, the social rules that govern our behavior. Ethics in business is essentially the study of what constitutes the right and wrong behavior in the workplace environment. A business is an organization whose objective is to provide goods or services for profit. The organization has a group of people that work together to achieve a common purpose. The moral challenges that these men and women face each day along with a whole range of problems that could occur, are why ethics plays such an important role in business. Most large businesses have a written code of ethics, sometimes called a code of conduct to set the standards that employees are to follow. In summary a good M&S professional should refrain from engaging in or supporting any activity that would discredit the profession.

Challenge

Each student will demonstrate an understanding of dealing correctly with ethical issues in the workplace. Read and answer the following questions as an individual, then as a team, and lastly, as a team come to a consensus and present your answers to the class.

Workplace Integrity Situations

Read the following situations carefully and give your answers and explanations as directed by your teacher. Be prepared to discuss your explanation.

1. Your boss is working up a bank deposit. He drops a \$20 bill on the floor. He goes off to the bank. Do you keep the \$20?
2. You're reviewing your payroll records and you find out that you've shorted one of your employees \$20 in pay. He hasn't noticed it yet. Do you pay him the money?
3. Your company is giving an aptitude test for its employees that are going to be considered for promotion. A former employee offers to sell you the answers to the test for \$20. Do you buy them?
4. Your boss finds a terrible mistake you've made. Do you lie and tell him that the employee that he fired last week was the one who made the mistake?
5. You accidentally give back too little change to a customer. He gave you a \$50 and needed \$30 in change. You gave him only \$20. He didn't notice that he's been shorted. Do you keep the money?

6. A customer leaves his wallet on the counter one night. It has \$100 in it. When he comes back the next day do you keep the \$100 and tell him you found the wallet without the money in it?
7. Your boss asks you to carefully inspect the bottles you are packing for defects. You've got a date tonight and you know that if you do your job right you may have to work an extra half hour. Do you rush through the work and claim that the bottles were inspected?
8. You catch a shoplifter with \$10 of merchandise. He offers you \$20 to ignore it. Do you take the money?
9. You know your friend and fellow employee is stealing from the cash drawer. After a year the owner makes you a manager. Do you fire your friend?
10. After another year the owner offers to make you a partner in the company. Now do you fire your friend?
11. Your boss is considering someone for a promotion. You know he is well qualified, but you dislike him strongly. Do you lie to your boss and say he won't do a good job?
12. Your company desperately needs a loan. If you fill out the loan application honestly you won't get the loan. Do you lie on the form?
13. Your boss asks you for a date. You don't like him/her, but she/he hints that it could help your career. Do you go?
14. No one knows that it was you who accidentally erased another department's computer disc. The employee in charge might be fired. Do you admit it and risk your job?
15. You've been buying paper bags from the same excellent salesman for the last ten years. A competitor offers you a 20% price break. Do you switch suppliers?

16. Other businesses are boycotting a supplier because the company refuses to give up its racist hiring policies. He offers you a substantial discount. Do you join the boycott?
17. Explain “loss-leader sale.” Your lumber store is having a big two-week loss-leader sale on plywood sheets. After two days a hurricane is forecast. At the current rate your supply will run out in two days. Do you cancel the sale and raise your price?
18. Your friend helped get you a job at a stereo store. After three months you find out that he’s been stealing from the cash drawer. Do you report him?
19. You’re a plumber. You guarantee your work for thirty days. A client springs a leak in a pipe you fixed thirty-one days ago. Do you fix it for free?
20. A key employee has taken two weeks off due to the death of his mother. A crucial project in your department is overdue. Do you call him and ask him to come back three days early?
21. You are doing some research for your company and you find exactly what you are looking for on the internet. Should you copy the information, put your name on it and submit it to your supervisor as though it is your original work?

Objectives

Upon completion of the design brief, students will be able to do the following:

1. Apply ethical and legal issues (including copyright) with technology.
2. Develop the understanding of professional and ethical responsibilities.
3. Perform ethical behavior.
4. Use accepted Netiquette
5. Describe polite and civil communication.
6. Discuss individual integrity and honesty.
7. Practice ethical behaviors regarding copyright, citation, and plagiarism.

Materials

1. Internet and researched information
2. Computer with appropriate software
3. Pencil and paper

4. ePortfolio

References

Elzas, M.S. 2000. "Why Should We Consider Ethical Issues To Be Relevant to Modeling and Simulation?" Special Issue of Transactions of the SCS on Ethical Issues in Modeling and Simulation. 17:4 (Dec.), 164.

E-mail netiquette guidelines – <http://eleccomm.ieee.org/email-netiquette.shtml>

Exploring Ethical Issues lesson plan –
http://www.highschooljournalism.org/Teachers/Lesson_Plans/Detail.cfm?lessonplanid=197

Kettenis, D.L. (ed.) 2000. Special Issue of Transactions of the SCS on Ethical Issues in Modeling and Simulation 17:4 (Dec.).

APPENDIX A: Florida Workplace Readiness Skills

Student Performance: The student will be able to:	Key Concepts	Academic Goals	Activity/Resources
1.0 Self Critique – constructive criticism	Activities that encourage nonviolence	Create teams based on available resources	Learning preliminary object creation and production work flow
2.0 Problem solve-effective communicate and learn from each others specialty	Communication, written and oral, accuracy and function	Manipulation of figures	Building characters from photo in Flash, create simple facial and animation
3.0 Demonstrate positive communication skills	Know the types of simulations	Brainstorm	Create 3D objects by modeling with points and polygons
4.0 Advance in all skills associated with Math, engineering and Science	Make the first year fun to hook kids into upper level courses	Student leadership	Use industry as a content resources for students and teachers
5.0 Express themselves creatively	Queuing theory	Create a solution to a problem, replicate a scenario	DOE curriculum frameworks, activities and projects determined by skills
6.0 Know the M/S industry related to job industry	Cortesine coordinate system	Career opportunities that industry needs	Derive general concepts by using s/w modeling tools, agree on key concepts by peer interactions
7.0 Hands on projects modeling robots, games and concepts	Templates and layering	Soft skills professional development	West Point bridge building
8.0 Communication, creativity, critical thinking skills	Fundamentals of design	Ability to work on and facilitate teamwork	More team projects, problem solving, coordinate with industry so students see when/where they will use math
9.0 Foster curiosity	Understanding math concepts on a high level	Make something work	Industry professionals willing to train teachers
10.0 Problem solver, teamwork	Teach how to work as a team with each member being productive	Manipulation of scenarios using logic	3D Max, Maya and Blender tutorials
11.0 Critical thinking skills	Break a complex problem into small pieces	Use a computer, imaging software, Photoshop, AutoCAD and illustrator	Robotics Challenge – competition
12.0 A math based course that connect M&S software environment with legitimate math skill	Unit concisions, motion, problem solving	use a basic programming language to model a real world application	Blender 3D, Game maker, Adobe Flash

Student Performance: The student will be able to:	Key Concepts	Academic Goals	Activity/Resources
13.0 Empowerment exercise with Flash	Scientific method	Communicate in a variety of modes, visual, written and verbal	Externship for teachers
14.0 Create 2D animation in flash that students build from self portrait photo	Project based learning	Academic goals should reinforce language arts, algebra, geometry and trigonometry	FTC/FRC robotics programs
15.0 Articulate questions that they do not know the answer to	Logic design, basic number systems, basic modeling concepts and principles	Technical writing, applied algebra and geometry, presentation skills	Alice
16.0 Explain how 6 STEM concepts are of interest to then now and explain why	Team building skills	Risk assessment and mitigation	UUA team selection program
17.0 Create a simple science based model and execute that model	Link projects to real world problems and issues	(Fail fast –fail cheap)	SECME
18.0 Apply science math and technology concept	Coordinate systems, Map projections	Team goals and project to solve a problem	Industry presentations
19.0 Be able to understand the significance of historical and cultural heritage of art and artistic styles as it relates to 2D and 3D graphics and models	How does modeling help create jobs, and help people with physiologic issues and learn?	Technical writing vs. social writing and communication	Industry internships
20.0 See or vision desired project and have ability to sequence steps to product	Algebra and geometry in the real world	9 th grade biology- cell models, ecosystem simulations, human body modes, homeostasis simulations, genetics simulations and evolution simulations	Share projects with other programs/schools
21.0 Use active scripts for required skill sets at entry level	Structures, dimension , 3D geometry, discrete event and time simulation	Learn basic action script and associated math concepts	Industry tours

Student Performance: The student will be able to:	Key Concepts	Academic Goals	Activity/Resources
23.0 Have a basic understanding and solid foundation about programming and simulations	Introduce students to all possible applications to modeling and simulation	Understand software GUI parallel to math skills appropriate to grade level and software interface	Project lead the way
24.0 Use geometry for spatial thinking	How can it be applied to gaming, medical training and virtual scenarios	Understand the concept of a vector and how to manipulate them	Leadership buy in and support
25.0 Outline the tenets of experimental design and develop hypotheses	Provide solid foundation of the process	To understand how algebra and geometry can be used in the real world, especially in modeling and simulation, to retain what they learn and to see a purpose for it	Collaborations with content area teachers
26.0 Document through technical writing	Applied mathematics	Demonstrate language arts knowledge and skills, mathematics knowledge and skills, Science knowledge and skills, Using oral and written communications skills in creating expressing information	Teacher training (needs to be ongoing)
27.0 Problem solve	Plane geometry & algebra demonstrated by software		
28.0 Application of math skills		Leave high school with an area to focus on in a post secondary facility	Industry partnerships
29.0 Team work and teambuilding skills	Action script introduction to object oriented projects	Need to have applications of higher level of math	Brainstorming procedures and exercises
30.0 Convert units, create simple moving model		Principles of simulation	Computer skills
30.0 Break a complex problem into components	Understanding spatial time concepts and preliminary motion (Lip syncing) time based editing	Visualize 3D cross sections	Guest speakers, field trips, teacher training

Student Performance: The student will be able to:	Key Concepts	Academic Goals	Activity/Resources
31.0 Identify the roles of a team, their responsibilities and functions of each	See Models - graphically, numerically, verbally, analytically	Problem solving skills	Field trips - Otronicon, IITSEC conference
32.0 Career applications	Scientific concepts	Basic programming, basic engineering, modeling and simulation design, math skills	
33.0 Break down a problem into sub steps, identifying the order of solution	Working in team environments	Applied physical science and bio engineering	
34.0 Determine project cost to include time, hardware and software costs	Successful group collaboration	Principle of modeling	
35.0 Create a project for a business and respond to the need not self interest	History of M&S development	Give students a broad overview of modeling	
	Engineering design process		
36.0 Presentations to industry partners explaining and defending projects	Learn to fail		
37.0 Create 2D or 3D models paper based prior to the computer	Create not use a engine		
38.0 Establish benefits and limitations of models and simulations	Object oriented programming		
39.0 Apply knowledge of modeling techniques to a math/science concept	Make a movie then teach the rules that they used or didn't use start point		
40.0 Law of physics	Boolean logic		
41.0 Logic truth tables and understanding algorithms	Fundamentals of design and principles of design		

Student Performance: The student will be able to:	Key Concepts	Academic Goals	Activity/Resources
43.0 Photonics temperature at it relates to centers and how it effects change	Understanding of basic graphics and tools used		
44.0 Convert units			
45.0 Use "d=rt" with multiple combinations of variables			
46.0 Counting			
47.0 Basic drafting and drawing			
48.0 Geometric figures and angles			
49.0 Basic algebra, English and science			
50.0 Strong foundation of scientific method			

APPENDIX B: Florida Essential Skills

Florida Essential Skills

The essential skills listed in this document are being integrated into the standards and benchmarks of the secondary and post secondary Career and Technical Education programs maintained by the Florida Department of Education, Division of Career and Adult Education. They are the knowledge and skills essential to success for careers in all career clusters. Students preparing for careers at any level should be able to demonstrate this knowledge and these skills in the context of their chosen cluster and career path.

ACADEMIC FOUNDATIONS (AF)

01.0	Demonstrate language arts knowledge and skills The student will be able to:	AF 2.0
01.01	Locate, comprehend and evaluate key elements of oral and written documents using correct grammar, punctuation and vocabulary.	AF2.5
01.03	Present information formally and informally for specific purposes and audiences.	AF2.9
02.0	Demonstrate mathematics knowledge and skills. The student will be able to:	AF3.0
02.01	Demonstrate knowledge of arithmetic operations.	AF3.2
02.02	Analyze and apply data and measurements to solve problems and interpret documents	AF3.4
02.03	Construct charts/tables/graph using functions and data	AF3.5
03.0	Demonstrate science knowledge and skills. The student will be able to:	AF4.0
03.01	Discuss the role of creativity in constructing scientific questions, methods and explanations.	AF4.1
3.02	Formulate scientifically investigable questions, construct investigations, collect and evaluate data, and develop scientific recommendations based on findings.	AF4.3

COMMUNICATIONS (CM)

01.0	Use oral and written communications skills in creating, expressing and interpreting information and ideas. The student will be able to:	
01.01	Select and employ appropriate communication concepts and strategies to enhance oral and written communication in the workplace.	CM 1.0
01.02	Locate, organize and reference written information from various sources.	CM 3.0
01.03	Design, develop and deliver formal and informal presentations using appropriate media to engage and inform diverse audiences.	CM 5.0
01.04	Interpret verbal and nonverbal cues/behaviors that enhance communication.	CM 6.0
01.05	Apply active listening skills to obtain and clarify information.	CM 7.0
01.06	Develop and interpret tables and charts to support written and oral communications.	CM 8.0
01.07	Exhibit public relations skills that aid in achieving customer satisfaction.	CM 10.0

EMPLOYABILITY AND CAREER DEVELOPMENT (ECD)

01.0	Explain the importance of employability skill and entrepreneurship skills. The student will be able to:	
01.01	Identify and demonstrate positive work behaviors needed to be employable.	ECD 1.0
01.02	Develop personal career plan that includes goals, objectives, and strategies.	ECD 2.0
01.03	Examine licensing, certification, and industry credentialing requirements.	ECD 3.0
01.04	Maintain a career portfolio to document knowledge, skills, and experience.	ECD 5.0
01.05	Evaluate and compare employment opportunities that match career goals.	ECD 6.0
01.06	Identify and exhibit traits for retaining employment.	ECD 7.0
01.07	Identify opportunities and research requirements for career advancement.	ECD 8.0
01.08	Research the benefits of ongoing professional development.	ECD 9.0
01.09	Examine and describe entrepreneurship opportunities as a career planning option.	ECD 10.0

ETHICS AND LEGAL RESPONSIBILITIES (ELR)

01.0	Describe the importance of professional ethics and legal responsibilities. The student will be able to:	
01.01	Evaluate and justify decisions based on ethical reasoning.	ELR 1.0
01.02	Evaluate alternative responses to workplace situations based on personal, professional, ethical, legal responsibilities, and employer policies.	ELR 1.1
01.03	Identify and explain personal and long-term consequences of unethical or illegal behaviors in the workplace.	ELR 1.2
01.04	Interpret and explain written organizational policies and procedures.	ELR 2.0

FINANCIAL LITERACY (FL)

01.0	Demonstrate personal money-management concepts. The student will be able to:	
01.01	Identify and describe the services and legal responsibilities of financial institutions.	FL 2.0
01.02	Describe the effect of money management on personal and career goals.	FL 3.0
01.03	Develop a personal budget and financial goals.	FL 3.1
01.04	Complete financial instruments for making deposits and withdrawals.	FL 3.2
01.05	Maintain financial records.	FL 3.3
01.06	Read and reconcile financial statements.	FL 3.4
01.07	Research, compare and contrast investment opportunities	

INFORMATION TECHNOLOGY APPLICATIONS (IT)

01.0	Use information technology tools. The student will be able to:	
01.01	Use personal information management (PIM) applications to increase workplace efficiency.	IT 1.0
01.02	Employ technological tools to expedite workflow including word processing, databases, reports, spreadsheets, multimedia presentations, electronic calendar, contacts, email, and internet applications.	IT 2.0
01.03	Employ computer operations applications to access, create, manage, integrate, and store information.	IT 3.0
01.04	Employ collaborative/groupware applications to facilitate group work.	IT 4.0

LEADERSHIP AND TEAMWORK (LT)

01.0	Demonstrate leadership and teamwork skills needed to accomplish team goals and objectives. The student will be able to:	
01.01	Employ leadership skills to accomplish organizational goals and objectives.	LT 1.0
01.02	Establish and maintain effective working relationships with others in order to accomplish objectives and tasks.	LT 3.0
01.03	Conduct and participate in meetings to accomplish work tasks.	LT 4.0
01.04	Employ mentoring skills to inspire and teach others.	LT 5.0

PROBLEM-SOLVING AND CRITICAL THINKING (PS)

01.0	Solve problems using thinking skills, creativity and innovation. The student will be able to:	
01.01	Employ critical thinking skills independently and in teams to solve problems and make decisions.	PS 1.0
01.02	Employ critical thinking and interpersonal skills to resolve conflicts.	PS 2.0
01.03	Identify and document workplace performance goals and monitor progress toward those goals.	PS 3.0
01.04	Conduct technical research to gather information necessary for decision-making.	PS 4.0

SAFETY, HEALTH AND ENVIRONMENTAL (SHE)

01.0	Demonstrate the importance of health, safety, and environmental management systems in organizations and their importance to organizational performance and regulatory compliance. The student will be able to:	
01.01	Describe personal and jobsite safety rules and regulations that maintain safe and healthy work environments.	SHE 1.0
01.02	Explain emergency procedures to follow in response to workplace accidents.	
01.03	Create a disaster and/or emergency response plan.	SHE 2.0

SYSTEMS (SY)

01.0	Describe the roles within teams, work units, departments, organizations, inter-organizational systems, and the larger environment. The student will be able to:	
01.01	Describe the nature and types of business organizations.	SY 1.0
01.02	Explain the effect of key organizational systems on performance and quality.	
01.03	List and describe quality control systems and/or practices common to the workplace.	SY 2.0
01.04	Explain the impact of the global economy on business organizations.	

2011-12 Science, Technology, Engineering & Math (STEM) Curriculum Frameworks

Florida is taking a systematic approach to identifying “STEM” career and technical education programs based on STEM occupations. The following programs lead directly to STEM occupations or are included in a career path that leads to a STEM occupation identified through national and state research and labor market information. As further research is completed, this list will continue to evolve. Programs that meet the Race to the Top criteria for STEM programs are included on this list and are annotated as such.

Secondary/PSAV Programs/Courses

Agriculture, Food & Natural Resources STEM Programs - Supervisor: [Amy McAllister](#), (850) 245-9017

- [Agricultural Biotechnology \(8106600\)](#) (RTF, 421KB) * RTTT
- [Agritechnology \(8106800\)](#) (RTF, 526KB)
- [Animal Biotechnology \(8106100\)](#) (RTF, 423KB) * RTTT
- [Environmental Resources \(8113000\)](#) (RTF, 461KB) * RTTT
- [Environmental Water Technology \(8007100\)](#) (RTF, 516KB)
- [Food Science Applications \(8129200\)](#) (RTF, 467KB)
- [Forestry \(8118300\)](#) (RTF, 563KB)
- [Land Resources Technology \(8913000\)](#) (RTF, 514KB)
- [Plant Biotechnology \(8106500\)](#) (RTF, 452KB) * RTTT

Architecture & Construction STEM Programs - Supervisor: [Kathryn Frederick](#), (850) 245-9016

- [Architectural Drafting \(8725400 / I480112\)](#) (RTF, 664KB) * RTTT
- [Building Construction Technologies \(8720300 / I460401\)](#) (RTF, 624KB) * RTTT
- [Civil Engineering Aide \(Secondary - 8915000\)](#) (RTF, 399KB)
- [Drafting \(8725000\)](#) (RTF, 422KB) * RTTT
- [Drafting PSAV \(PSAV - C100200\)](#) (RTF, 449KB)
- [Electrical Drafting \(8725200 / I480114\)](#) (RTF, 611KB) * RTTT
- [Electronic Drafting \(8725100 / I480115\)](#) (RTF, 594KB) * RTTT
- [Mechanical Drafting \(8725300 / I480116\)](#) (RTF, 702KB) * RTTT
- [Structural Drafting \(8725500 / I480113\)](#) (RTF, 673KB) * RTTT

Energy STEM Programs - Supervisor: [Kathryn Frederick](#), (850) 245-9016

- [Energy Generation Technician \(9700200 / X600200\)](#) (RTF, 652KB)
- [Energy Technician \(9700300 / X600600\)](#) (RTF, 742KB)
- [Solar Energy Technology \(8006100 / A600200\)](#) (RTF, 696KB)

Engineering & Technology Education STEM Programs - Supervisor: [Duane Hume](#), (850) 245-9003

- [Aerospace Technologies \(8600080\)](#) (RTF, 561KB) * RTTT
- [Drafting/ Illustrative Design Technology \(8600800\)](#) (RTF, 427KB) * RTTT
- [Electronics Technology \(8600900\)](#) (RTF, 445KB)
- [Engineering Technology \(8607000\)](#) (RTF, 547KB) * RTTT
- [Materials and Processes Technology \(8601100\)](#) (RTF, 474KB)
- [Pathways To Engineering \(9400300\) \(PLTW\)](#) (RTF, 656KB) * RTTT
- [Power & Energy Technology \(8601300\)](#) (RTF, 446KB) * RTTT
- [Production Technology \(8604000\)](#) (RTF, 492KB)

Health Science STEM Programs - Supervisor: [Narcissus Willis](#), (850) 245-9018

- [Biomedical Sciences - PLTW \(8708100\)](#) (RTF, 517KB) * RTTT

Information Technology STEM Programs - Supervisor: [Duane Hume](#), (850) 245-9003

- [Applied Cybersecurity \(9001300 / Y100300\)](#) (RTF, 1MB)
- [Business Computer Programming \(8206500 / B070320\)](#) (RTF, 1MB)
- [Computer Systems Technology \(8732100 / I470104\)](#) (RTF, 581KB)
- [Computer Systems Technology 1 \(PSAV - J500100\)](#) (RTF, 368KB)
- [Computer Systems Technology 2 \(PSAV - J500200\)](#) (RTF, 267KB)
- [Database and Programming Essentials \(8206400 / Y300100\)](#) (RTF, 1MB)
- [Game/Simulation/Animation Programming \(8208300 / B082300\)](#) (RTF, 803KB)
- [Geospatial/Geographic Information Systems Technology \(8600200 / T860020\)](#) (RTF, 548KB)
- [Information Technology \(8207300 / Y300300\)](#) (RTF, 840KB)
- [Network Support Services \(8208000 / B078000\)](#) (RTF, 1MB)
- [Network Systems Administration \(8207440 / B079300\)](#) (RTF, 1MB)
- [PC Support Services \(8207340 / B070400\)](#) (RTF, 913KB)

Manufacturing STEM Programs - Supervisor: [Eric Owens](#) , (850) 245-9020

- [Automation and Production Technology \(9200100 / J100100\)](#) (RTF, 726KB) * RTTT
- [Engineering Assisting \(Secondary - 8743000\)](#) (RTF, 474KB)
- [Electronic Technology \(8730000 / I150303\)](#) (RTF, 577KB)
- [Industrial Biotechnology \(Secondary - 8736000\)](#) (RTF, 515KB) * RTTT

Degree & Certificate Programs

Architecture & Construction STEM Programs - Supervisor: [Kathryn Frederick](#), (850) 245-9016

- [Civil Engineering Technology \(AAS/AS - 0715020101\)](#) (RTF, 239KB)

Information Technology STEM Programs - Supervisor: [Duane Hume](#), (850) 245-9003

- [Computer Engineering Technology \(AS/AAS - 0615040200\)](#) (RTF, 218KB)

- [Cisco Certified Network Associate Certificate \(CCC - 0615040201\)](#) (RTF, 73KB)
- [Computer Specialist \(CCC - 0615040203\)](#) (RTF, 88KB)
- [Microcomputer Repairer/Installer \(CCC - 0615040202\)](#) (RTF, 70KB)
- [Network Systems Developer \(CCC - 0615040204\)](#) (RTF, 107KB)
- [Wireless and IP Communications Technician \(CCC - 0615040205\)](#) (RTF, 119KB)
- [Computer Information Technology \(AS/AAS - 0507030600\)](#) (RTF, 240KB)
 - [Information Technology Analysis \(CCC - 0507030607\)](#) (RTF, 103KB)
 - [Information Technology Support Specialist \(CCC - 0507030606\)](#) (RTF, 93KB)
- [Computer Programming and Analysis \(AS/AAS - 0507030500\)](#) (RTF, 215KB)
 - [Computer Programmer \(CCC - 0507030100\)](#) (RTF, 82KB)
 - [Computer Programming Specialist \(CCC - 0507030503\)](#) (RTF, 76KB)
- [Database Technology \(AS/AAS - 0507030601\)](#) (RTF, 114KB)
 - [Microsoft Certified Database Administrator Certificate \(CCC - 0507030604\)](#) (RTF, 144KB)
 - [Microsoft Certified Systems Developer \(CCC - 0507030605\)](#) (RTF, 83KB)
 - [Oracle Certified Database Administrator \(CCC - 0507030602\)](#) (RTF, 75KB)
 - [Oracle Certified Database Developer \(CCC - 0507030603\)](#) (RTF, 79KB)
 - [Oracle Software Engineering \(CCC - 0507030611\)](#) (RTF, 78KB)
 - [Oracle Certified Administrator \(CCC - 0507030612\)](#) (RTF, 74KB)
- [Enterprise Resource Planning \(ERP\) Software Specialist \(AS/AAS - 0506120108\)](#) (RTF, 131KB)
- [Information Technology Administration \(CCC - 0507039904\)](#) (RTF, 96KB)
- [Networking Services Technology \(AS/AAS - 0507030401\)](#) (RTF, 149KB)
 - [Unix/Linux System Administrator \(CCC - 0507030406\)](#) (RTF, 102KB)

Manufacturing STEM Programs - Supervisor: [Eric Owens](#), (850) 245-9020

1. [Aerospace Technology \(AAS/AS - 0615080100\)](#) (RTF, 280KB)
2. [Biomedical Engineering Technology \(AAS/AS - 0615040101\)](#) (RTF, 225KB)
3. [Biotechnology \(AAS/AS - 0626061600\)](#) (RTF, 203KB)
 - a. [Biotechnology Specialist \(CCC - 0626061602\)](#) (RTF, 163KB)
4. [Electronics Engineering Technology \(AAS/AS - 0615030301\)](#) (RTF, 376KB)
 - a. [Basic Electronics Technician \(CCC - 0615030310\)](#) (RTF, 178KB)
 - b. [Electronics Technician \(CCC - 0615030309\)](#) (RTF, 195KB)
 - c. [Laser and Photonics Technician \(CCC - 0615030311\)](#) (RTF, 214KB)
 - d. [Robotics and Simulation Technician \(CCC - 0615030314\)](#) (RTF, 190KB)
5. [Engineering Technology \(AAS/AS - 0615000001\)](#) (RTF, 628KB)
 - a. [Biomedical Systems Specialization](#) (RTF, 628KB)
 - i. [Medical Quality Systems \(CCC - 0615000005\)](#) (RTF, 179KB)
6. [Manufacturing Technology \(AAS/AS - 0615060302\)](#) (RTF, 234KB)
7. [Microelectronics Manufacturing Technology \(AAS/AS - 0615030303\)](#) (RTF, 231KB)

APPENDIX D-M&S HIGH SCHOOL COURSE LABORATORY SOFTWARE SUITE

Adobe Master	MathCad
ALICE	MATLAB (Matrix Laboratory)
Auto Desk (3D Max), (Maya)	Maxon Cinema 4D
Blender	Mudbox
Deep Creator	Ogre
Encore	Photo Shop
Experiment Creator	Real Games
FLASH	Rhino
Game Maker	Torque
Games Factory	UDK
Google Sketch	Unity
Illustrator	Vegas Pro HD
JMP - http://www.jmp.com/academic/	Z-Brush
Luxology (Moto)	Stella
Maple	

NOTE: All of the above software is not required to conduct the curriculum. Teachers may tailor the laboratory to include available software

APPENDIX E: Sample Capstone Project Guidelines

Fossil Ridge High School STEM Academy Definition and Criteria for the Capstone Project

The STEM Capstone Project is a student initiated culminating project to be developed over the students' high school careers. The students will be enrolled in a seminar course for 3 years (30 credits). The course is designed to offer instruction, support, and time to develop the project. The project must meet certain parameters and requirements. These parameters are primarily developed from 21st century skills as defined by the Colorado Department of Education.

Projects will focus on the content of the particular strand the student is enrolled. The focus of the project can be in one or more of the following fields; science, technology, engineering, business or social studies.

A project must have three elements:

1. **Action:** Students must “do” something: build a prototype, perform a community service, create a scaled model, write a business plan, etc.
2. **Research:** Every student must become an expert in the content area associated with their project and demonstrate proper research skills.
3. **Education/Outreach:** Students must keep detailed records of every step of the project for the purpose of assessment and education and/or outreach.
4. Each team will determine how the project will educate the community (website, video, public presentation, detailed power point, etc.) and how the project will be presented to the Advisory Board for assessment.

A student must demonstrate either directly within the project or provide documentation of the following criteria:

1. Creativity and Innovation

- a. Think Creatively
 - i. Use a wide range of idea creation techniques (such as brainstorming)
 - ii. Create new and worthwhile ideas (both incremental and radical concepts)
 - iii. Elaborate, refine, analyze and evaluate their own ideas in order to improve and maximize creative efforts
- b. Work Creatively with Others
 - i. Develop, implement and communicate new ideas to others effectively
 - ii. Be open and responsive to new and diverse perspectives; incorporate group input and feedback into the work
 - iii. Demonstrate originality and inventiveness in work and understand the real world limits to adopting new ideas
 - iv. View failure as an opportunity to learn; understand that creativity and innovation is a long-term, cyclical process of small successes and frequent mistakes.

- c. Implement Innovations
 - i. Act on creative ideas to make a tangible and useful contribution to the field in which the innovation will occur

2. Critical Thinking and Problem Solving

- a. Reason Effectively
 - i. Use various types of reasoning (inductive, deductive, etc.) as appropriate to the situation
- b. Use Systems Thinking
 - i. Analyze how parts of a whole interact with each other to produce overall outcomes in complex systems
- c. Make Judgments and Decisions
 - i. Effectively analyze and evaluate evidence, arguments, claims and beliefs
 - ii. Analyze and evaluate major alternative points of view
 - iii. Synthesize and make connections between information and arguments
 - iv. Interpret information and draw conclusions based on the best analysis
 - v. Reflect critically on learning experiences and processes
- d. Solve Problems
 - i. Solve different kinds of non-familiar problems in both conventional and innovative ways
 - ii. Identify and ask significant questions that clarify various points of view and lead to better solutions

3. Communication and Collaboration

- a. Communicate Clearly
 - i. Articulate thoughts and ideas effectively using oral, written and nonverbal communication skills in a variety of forms and contexts
 - ii. Listen effectively to decipher meaning, including knowledge, values, attitudes and intentions
 - iii. Use communication for a range of purposes (e.g. to inform, instruct, motivate and persuade)
 - iv. Utilize multiple media and technologies, and know how to judge their effectiveness a priori as well as assess their impact
 - v. Communicate effectively in diverse environments (including multi-lingual)
- b. Collaborate with Others
 - i. Demonstrate ability to work effectively and respectfully with diverse teams
 - ii. Exercise flexibility and willingness to be helpful in making necessary compromises to accomplish a common goal
 - iii. Assume shared responsibility for collaborative work, and value the individual contributions made by each team member

4. Information Literacy

- a. Access and Evaluate Information
 - i. Access information efficiently (time) and effectively (sources)
 - ii. Evaluate information critically and competently
- b. Use and Manage Information
- c. Use information accurately and creatively for the issue or problem at hand
- d. Manage the flow of information from a wide variety of sources
- e. Apply a fundamental understanding of the ethical/legal issues surrounding the access and use of information

5. Media Literacy

- a. Analyze Media
 - i. Analyze both how and why media messages are constructed, and for what purposes
 - ii. Examine how individuals interpret messages differently, how values and points of view are included or excluded, and how media can influence beliefs and behaviors
 - iii. Apply a fundamental understanding of the ethical/legal issues surrounding the access and use of media
- b. Create Media Products
- c. Utilize the most appropriate media creation tools, characteristics and conventions
- d. Effectively utilize the most appropriate expressions and interpretations in diverse, multi-cultural environments

6. ICT Literacy

- a. Apply Technology Effectively
 - i. Use technology as a tool to research, organize, evaluate and communication information
 - ii. Use digital technologies (computers, PDAs, media players, GPS, etc.), communication/networking tools and social networks appropriately to access, manage, integrate, evaluate and create information to successfully function in a knowledge economy
 - iii. Apply a fundamental understanding of the ethical/legal issues surrounding the access and use of information technologies

7. Life and Career Skills

Today's life and work environments require far more than thinking skills and content knowledge. The ability to navigate the complex life and work environments in the globally competitive information age requires students to pay rigorous attention to developing adequate life and career skills.

a. Flexibility and Adaptability

- i. Adapt to Change
 - 1. Adapt to varied roles, jobs responsibilities, schedules and context
 - 2. Work effectively in a climate of ambiguity and changing priorities
 - 3. Be Flexible
 - 4. Incorporate feedback effectively
 - 5. Deal positively with praise, setbacks and criticism
- ii. Understand, negotiate and balance diverse views and beliefs to reach workable solutions, particularly in multi-cultural environments

b. Initiative and Self-Direction

- i. Manage Goals and Time
 - 1. Set goals with tangible and intangible success criteria
 - 2. Balance tactical (short-term) and strategic (long-term) goals
 - 3. Utilize time and manage workload efficiently
- ii. Work Independently
 - 1. Monitor, define, prioritize and complete tasks without direct oversight
- iii. Be Self-directed Learners

1. Go beyond basic mastery of skills and/or curriculum to explore and expand one's own learning and opportunities to gain expertise
 2. Demonstrate initiative to advance skill levels towards a professional level
 3. Demonstrate commitment to learning as a lifelong process
 4. Reflect critically on past experiences in order to inform future progress
- c. Social and Cross-Cultural Skills**
- i. Interact Effectively with Others
 1. Know when it is appropriate to listen and when to speak
 2. Conduct themselves in a respectable, professional manner
 - ii. Work Effectively in Diverse Teams
 1. Respect cultural differences and work effectively with people from a range of social and cultural backgrounds
 2. Respond open-mindedly to different ideas and values
 3. Leverage social and cultural differences to create new ideas and increase both innovation and quality of work
- d. Productivity and Accountability**
- i. Manage Projects
 1. Set and meet goals, even in the face of obstacles and competing pressure
 2. Prioritize, plan and manage work to achieve the intended result
 - ii. Scale of Project
 1. Scale and scope of project should reflect 3.5 years of development and production.
 - iii. Produce Results
 - iv. Demonstrate additional attributes associated with producing high quality products including the abilities to:
 1. Work positively and ethically
 2. Manage time and projects effectively
 3. Multi-task
 4. Participate actively, as well as be reliable and punctual
 5. Present oneself professionally and with proper etiquette
 6. Collaborate and cooperate effectively with teams
 7. Respect and appreciate team diversity
 8. Be accountable for results
- e. Leadership and Responsibility**
- i. Guide and Lead Others
 1. Use interpersonal and problem-solving skills to influence and guide others toward a goal
 2. Leverage strengths of others to accomplish a common goal
 3. Inspire others to reach their very best via example and selflessness
 4. Demonstrate integrity and ethical behavior in using influence and power
 - ii. Be Responsible to Others
 1. Act responsibly with the interests of the larger community in mind
- f. Financial Literacy**
- i. Create and use a financial plan & budget

1. Design, analyze, and apply a financial plan based upon short and long term financial needs of the project.
2. Analyze various funding sources, including Academy seed funds, community support, and granting sources, and apply for necessary funds.
3. Recognize and evaluate ways to manage financial risks and choices
4. Design and use a budget to track all expenses and income

g. Content Accuracy & Reliability

- i. Information is current
 1. Research and/or conclusions are up to date at time of project completion
- ii. Facts and methods are accepted by the scientific community
 1. Facts and methods are either accepted or considered plausible by the greater scientific community
- iii. Resources used are reliable and credible
 1. Sources are cited accurately and appropriately
 2. Sources are effectively evaluated and used appropriately.