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Web-based Systems Engineering
Application Profiles

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Overview of Talk

This talk will cover:

- Part 1 : MSSE/ENPM Program Overview
- Part 2 : MSSE/ENPM Curriculum
- Part 3 : Web-based Delivery of Systems Engineering Education
- Part 4 : Java Object Library Toolkit
- Part 5 : Conclusions and Future Work

Don't worry, I'll keep it short!

Part 1 : MSSE/ENPM Overview

ISR faculty

- 36 faculty at ISR with joint or affiliate appointments.
- Participating departments include Aerospace Engineering, Chemical Engineering, Civil Engineering, Electrical Engineering, Mechanical Engineering, Computer Science, and the Business School.
- 8 faculty at ISR involved with MSSE/ENPM program.

Typical research interests of ISR faculty

- Dynamics and control of smart structures
- Computer integrated manufacturing
- Satellite and hybrid communication systems

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Part 1 : MSSE/ENPM Program
Overview

MSSE/ENPM PROGRAM

Masters level systems engineering for both students and practicing engineers.

BACKGROUND

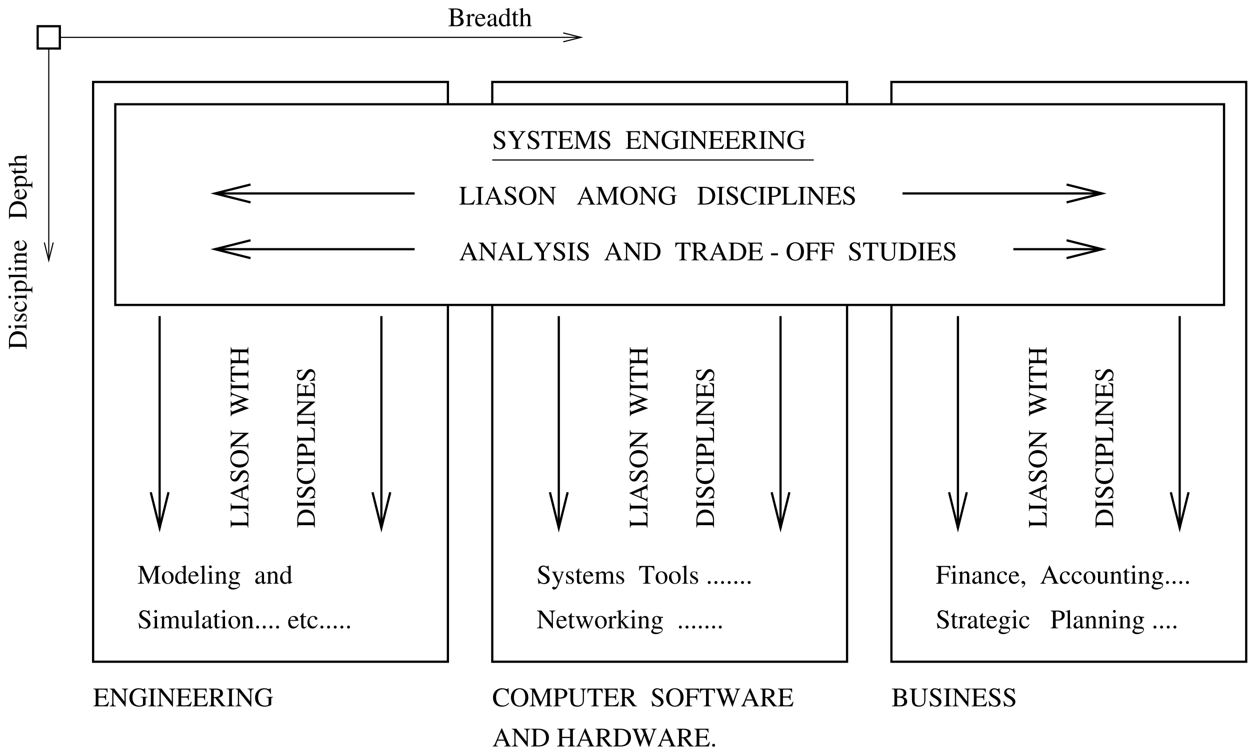
- Master of science in systems engineering (MSSE) : Fall 1987.
- Professional master of engineering (ENPM) : Mid 1990s.

STUDENT POPULATION

- MSSE (30) : Full-time study leading to first career position
- ENPM (18) : Mid-career professionals looking to balance professional experience with academic training – need for "industry relevance" at an all time high.

Part 1 : Traditional Engineering versus Systems Engineering

Systems engineering is a cross-disciplinary "team activity"



- WHAT TOOLS ARE NEEDED TO HELP ENGINEERS DO THIS ???

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Part 2 : MSSE Curriculum

ENSE 621 Systems Engineering Principles	ENSE 622 Systems Modeling and Analysis	ENSE 623 Systems Engineering Design Projects.

SYSTEMS ENGINEERING SCHOOL COMPONENTS

ENSE 625 Systems Financial and Contract Managment	ENSE 626 Systems Life Cycle Cost Estimation	ENSE 627 Quality Management in Systems.

BUSINESS SCHOOL COMPONENTS

ENSE 624 Human Factors in Systems Engineering		ENSE 799 Masters Thesis Research

DEPARTMENT OF COMPUTER SCIENCE | | MULTI-DISCIPLINARY RESEARCH

Part 2 : ENSE 621 : Systems Engineering Principles

ENSE 621 Curriculum (Austin/Frankpitt)

- Basic systems concepts (e.g., system structures, object-oriented notation)
- Introduction to systems engineering (systems engineering technical process; systems engineering management process)
- SE models and management practices (behavior models; structural models; business models)
- Assessment of systems information (requirements engineering)
- Synthesis and design
- Assessment and evaluation (cost, quality, risk, time-to-market)
- Optimization in analysis and design. Exercises with CPLEX (Linear, mixed-integer and quadratic programming problems) and Console (Nonlinear optimization problems).
- Introduction to computer-aided systems engineering (CASE) tools.

Part 2 : ENSE 622 : System Modeling and Analysis

ENSE 622 Curriculum (Frankpitt)

- Discrete event systems
- Critical path analysis; Project evaluation and review technique (PERT)
- Probability and statistics
- Markov chains
- Modeling and analysis projects with Simscript.

System Modeling and Analysis Projects (Spring 1998)

- Simulation and Statistical Analysis of a Restaurant System
- Gamma Ray Large Area Telescope (GLAST) Instrument Basic Simulation
- HP to LP Turbine Crossover Expansion Joint Manufacturing System Simulation Study

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Part 2 : ENSE 623 : System Engineering Design Projects

ENSE 623 Curriculum (Rubloff/Austin)

- Apply systems engineering approaches and tools to solve specific industry problems.
- Exercises with SLATE (System Level Automation Tool for Engineers). Represent project requirements, system designs, requirements traceability, budgets, simulation.
- Demonstrate pieces of solution.
- Presentations by systems engineering professionals.

Fall Semesters 1996 and 1997

- Student groups develop and present a “preliminary systems design” on the web.
- Student groups develop and a “systems engineering application profile” on the web.

Systems Engineering Application Profiles (SEAPs)

- A systems engineering application profile is a high-level description of how systems engineering concepts, procedures, processes, and technology can be used for problem solving within a specific industry or application domain.
- By assembling and presenting a suite of Applications Profiles in one place, we hope to identify "patterns in problem solving strategies and techniques" that are common to multiple application domains (INCOSE 95).

Uses of SEAPs

- To understand how systems engineering practices can be applied across domains.
- For systems engineering education
- Promoting is discipline of systems engineering as a whole

Part 2 : Profile Contents (modified version of INCOSE SEAPs)

Structure of SEAP is defined by a series of questions

Introduction

- What is the purpose and history of the application domain?
- How is the application domain affected by political, social, economic, and commercial forces?

Industry Functions and Processes

- What is the lifecycle of a typical product in the application domain?
- How is the domain (or industry) decomposed into individual functions and processes that represent its primary activities?
- How is a typical project designed, manufactured, distributed, and maintained ...etc?

Part 2 : Profile Contents (modified version of INCOSE SEAPs)

Organization and Management

- What are the business challenges faced by companies working in the application domain?
- Are formal systems engineering techniques used, either formally or informally, by companies within the application domain? If not, why not?
- How do people within an organization interact with other organizations, customers, and stakeholders?

Technology Profile

- What sections of the application domain lifecycle have been automated?
- What COTS tools are available for "understanding" system performance?
- To what extent is team development supported by automation?

Part 2 : Profile Contents (modified version of INCOSE SEAPs)

Online Systems Analysis

- The students were asked to demonstrate how analytical procedures they learned in the prerequisite courses – ENSE 621 and ENSE 622 - could be applied to a decision making scenario within their application domain.

Challenges

- What are the near- and long-term challenges facing the application domain?
- What technologies could the application domain benefit from – for example, simulation, optimization, decision analysis, generation of design alternatives.

Contacts and References

- Contact addresses for further information; links to online case studies (if they exist).

Part 3 : Web-based Delivery of Systems Engineering Education

Key observation

- System engineering projects will be better if students have freedom to work in a area of personal interest.

Standard Report Presentation of SEAPs

- Bounded linear presentation.

Web-based Presentation of SEAPs

- Dynamic real-time information presented in a multidimensional space of multimedia.
- Opportunity for creating SEAPs where students learn by becoming actively involved in problem solving.

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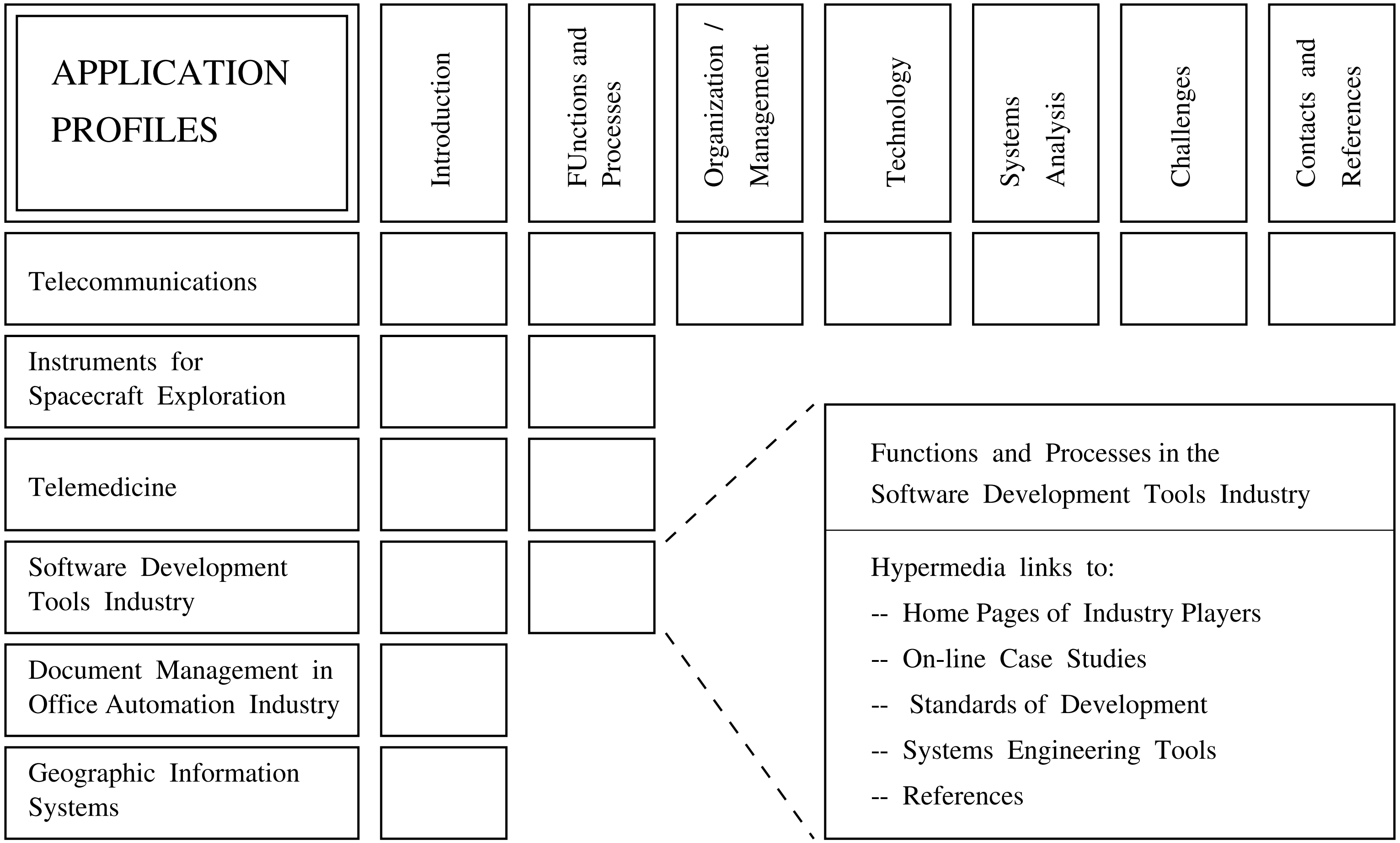
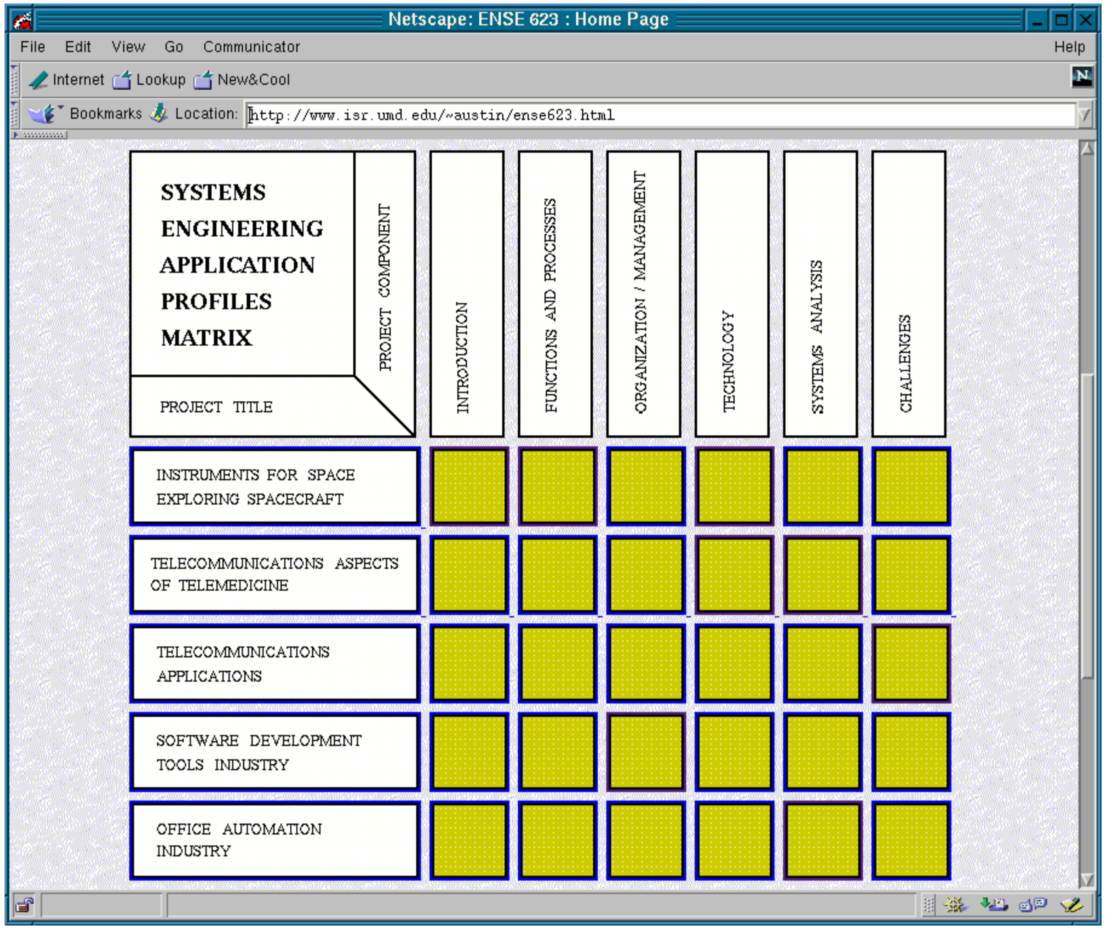
Part 3 : Web-based Delivery of Systems Engineering Education



Part 3 : Web-based Delivery of Systems Engineering Education



Part 3 : Web-based Delivery of Systems Engineering Education

What we already know ....

- Academics like to teach abstractions and general ideas that are context free – students need to make a connection to real world examples.
- The web is a great tool for information delivery – class web pages containing class notes, homework assignments, and faq, now scatter the Internet.
- Whether a student learns more because of the web is entirely another matter.

Results from Research in Education

- Information is only learned when it is transformed into knowledge. Transformations include looking at the information from several points of view, and constructing meaning from it in terms of what a student already knows.
- Students need to be active participants in the transformation process.

Part 4 : Java Object Library Toolkit

Java Object Library Toolkit (JOLT)

A collection of Java applets for the interactive presentation and manipulation of integrated scientific and engineering data/information. We are particularly interested in tools suitable for the interactive analysis and assessment of engineering systems in a networked environment.

Basic Questions

- To what extent can standard presentation tools such as spreadsheets/bar charts ...etc... be used for the I/O of large-scale system engineering analysis problems? Can these limitations be stated in quantitative terms?
- How to configure Java applets for interapplet communication?
- Understand the impact "web browser security restrictions" on applet communication?

Part 4 : Java Object Library Toolkit

Phases of JOLT Development

- **Standalone Presentation :** At this level we are mainly concerned with the development of a suite of standard, stand-alone, presentation applets (e.g., stand-alone bar charts, line charts, histograms etc ..).
- **Integrated Presentation :** At this level we are mainly concerned with the design and implementation of a communication protocol and language syntax for interapplet communication (e.g., how can an engineer tell a spreadsheet that output from a certain set of cells should be piped to a histogram).
- **Integrated Systems Engineering Analysis :** At this level we are concerned with the development of new applets for the solution of engineering analysis problems, and their integration with presentation applets at level 2. (e.g, a Java applet frontend to the linear optimization package CPLEX.)

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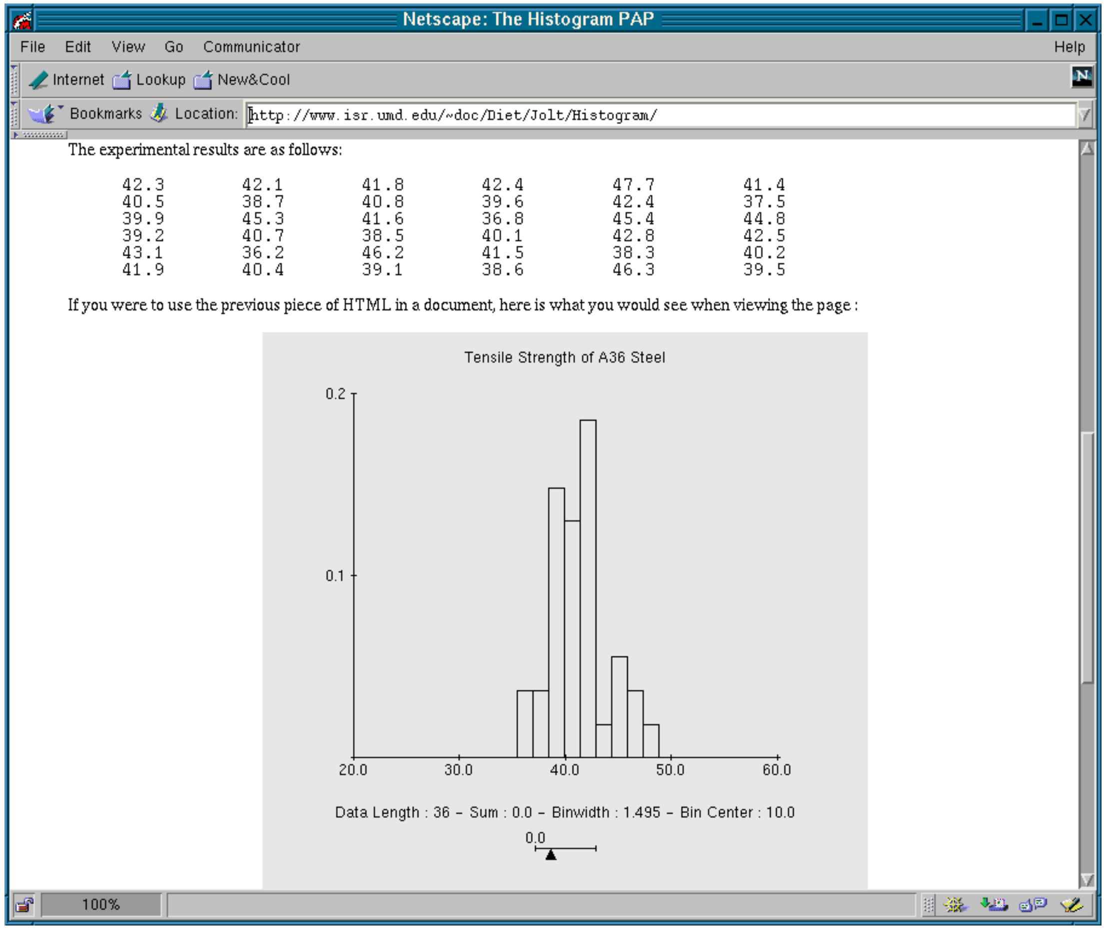
Part 4 : Java Object Library Toolkit



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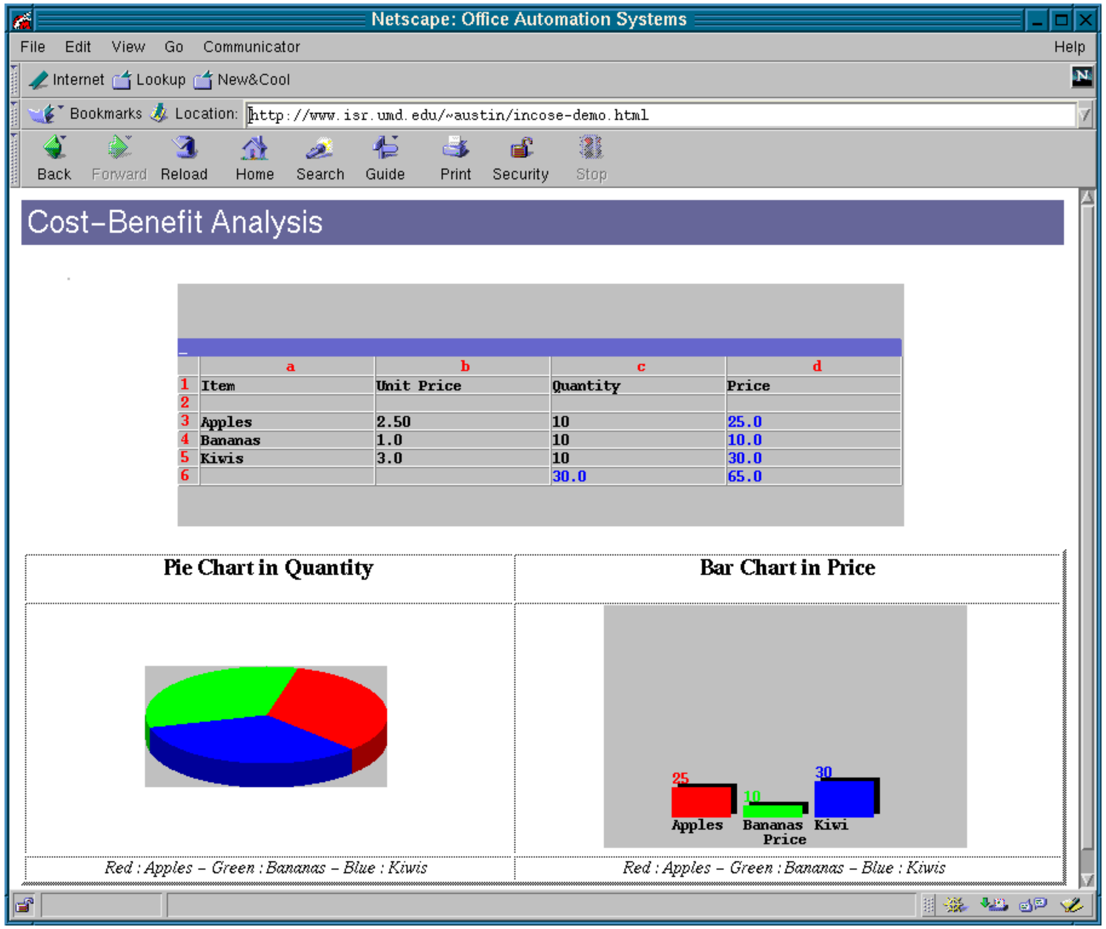


Part 5 : Conclusions and Future Work

Benefits of Web-based SEAPs to INCOSE

- Increased promotion and readership of INCOSE activities
- The web enables a team of geographically dispersed individuals to jointly participate in the writing of a new application profile

Benefits of Web-based SEAPs to Education

- SEAPs at Maryland should be viewed as a testbed for exploring ways of connecting "classroom material" to systems engineering practice.
- Considerable opportunity to strengthen connection between abstract system ideas and range of contexts in which knowledge can be applied across disciplines.
- Students can show potential employers what they did at Maryland!

Part 5 : Conclusions and Future Work

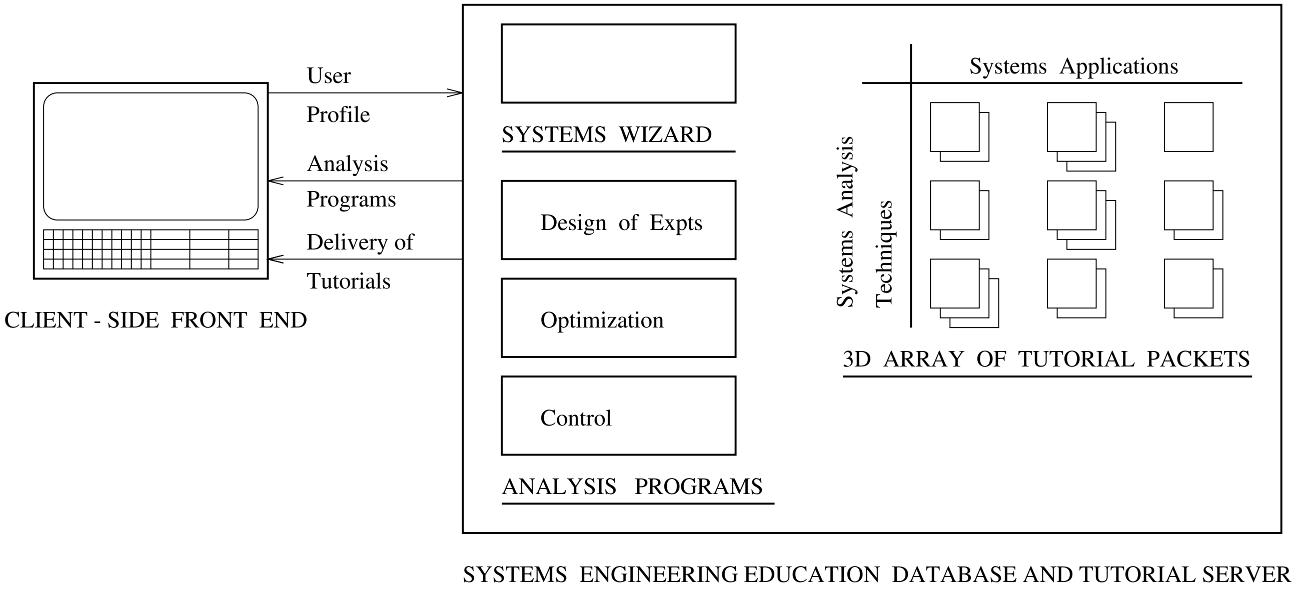
Future Work

- ISR must adapt to meet the educational needs of business/engineering professionals who are engaged in career-long learning.
- The Internet will be the foundation of next-generation systems engineering training (e.g., delivery of short courses).

  We are currently learning how to delivery of systems engineering courses via satellite instructional television (i.e., National Technological University (NTU)) and the Web
- One way that students learn about "cause and effect" relationships within a discipline is through the use of simulation programs. Future SEAPs will contain Java-based interactive web pages and downloadable simulation programs, perhaps demonstrating how systems analysis techniques can be applied to decision making across a number of disciplines.

Part 5 : Conclusions and Future Work

Tutorial Client/Server Architecture for Web-based Tutorials



From their desktops, engineers at all career levels access interactive systems analysis packages and array of dynamically configurable hypertext tutorial packages.

Part 5 : Conclusions and Future Work

Standalone Analysis Programs