eSyst Implementation Webinar Series Part Three: Digital Fundamentals

Maricopa Advanced Technology Education Center

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A presentation of eSyst.org

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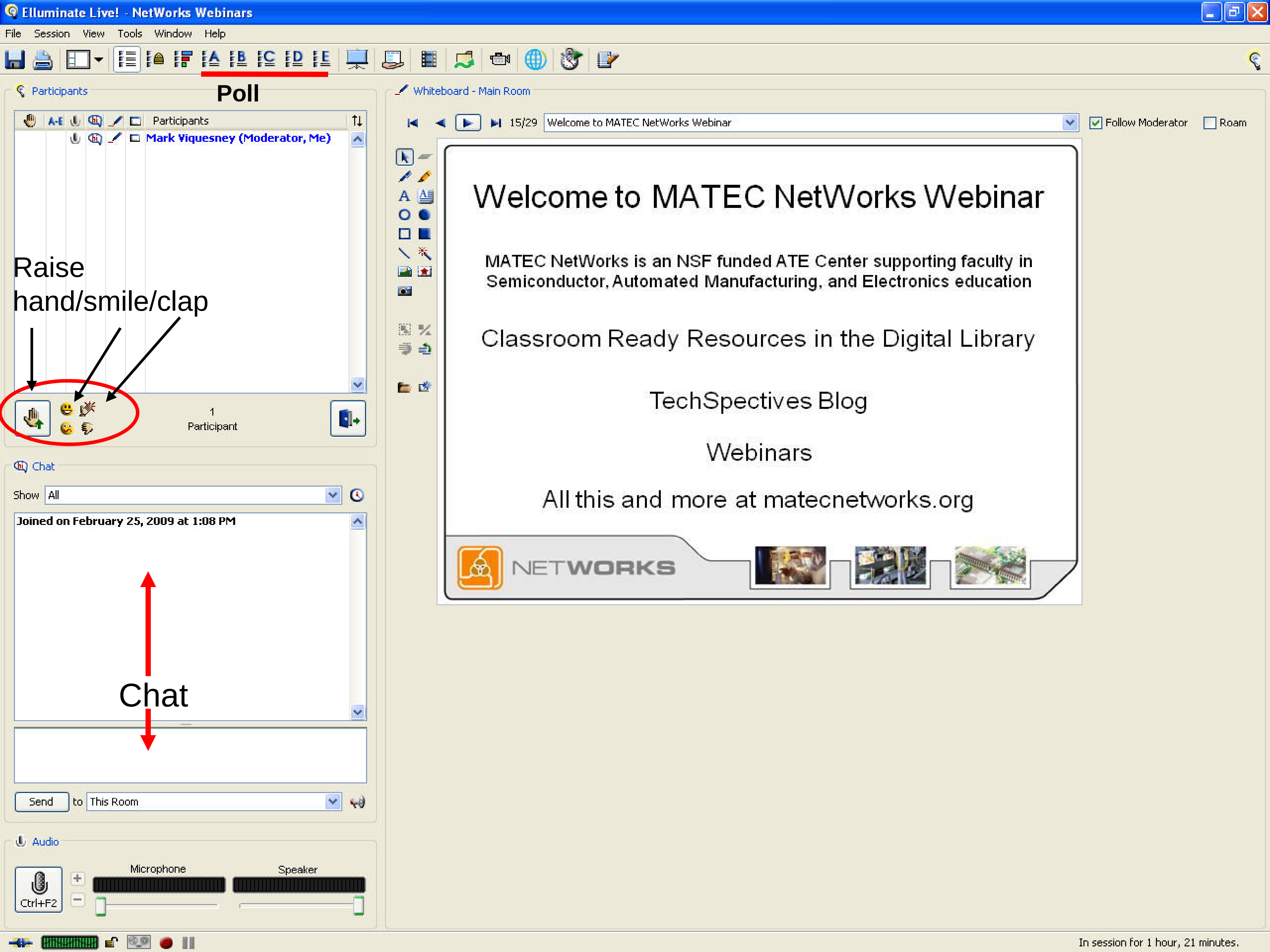
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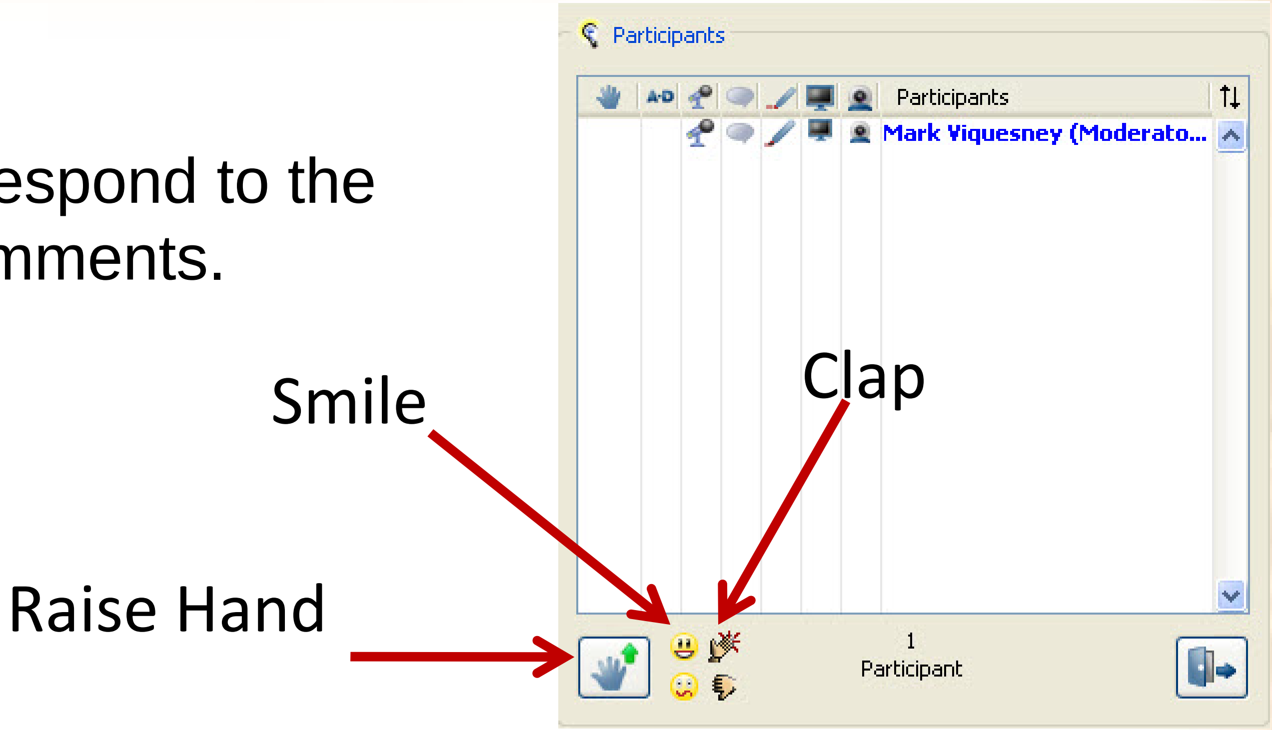
In session for 1 hour, 21 minutes.

Chat Box

- If you have questions during the presentation, please submit them in the Chat Window and Send to "All" so that others can follow along.
- Throughout the presentation and at the end of the session we will answer as many questions as we can.

Participants Box

Allows you to respond to the presenter's comments.



eSyst Webinar Presenters

Tom McGlew:
eSyst Project Manager

eSyst Webinar Agenda

- Overview of the eSyst Project
- Review of the eSyst Implementation Guide
- Demonstration of the Microprocessor Animation
- Review of eSyst Digital Fundamental Resources
- Where to Find Resources? Web site tour
- Survey and Final Questions from Participants

Project Development Team Members

Mike Lesiecki – Principal Investigator

Lou Frenzel - Project Lead Subject Matter Expert

Roy Brixen – Project Developer

Wayne Phillips – Project Developer

Jesus Casas – Project Developer

Ui Luu – Project Developer

Bassam Matar – Project Developer

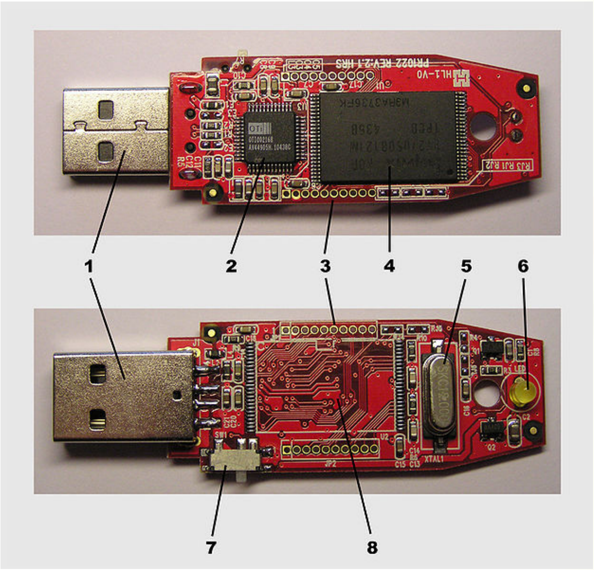
James Hardison – M.I.T. Project Developer

Tom McGlew – Project Development Manager

eSyst Project Overview

So what has changed and what is a System?

Then to Now



Now to the future

A presentation of eSyst.org

eSyst Home Media Animation

http://www.esyst.org/Courses/Entertainment_System/animation900.html

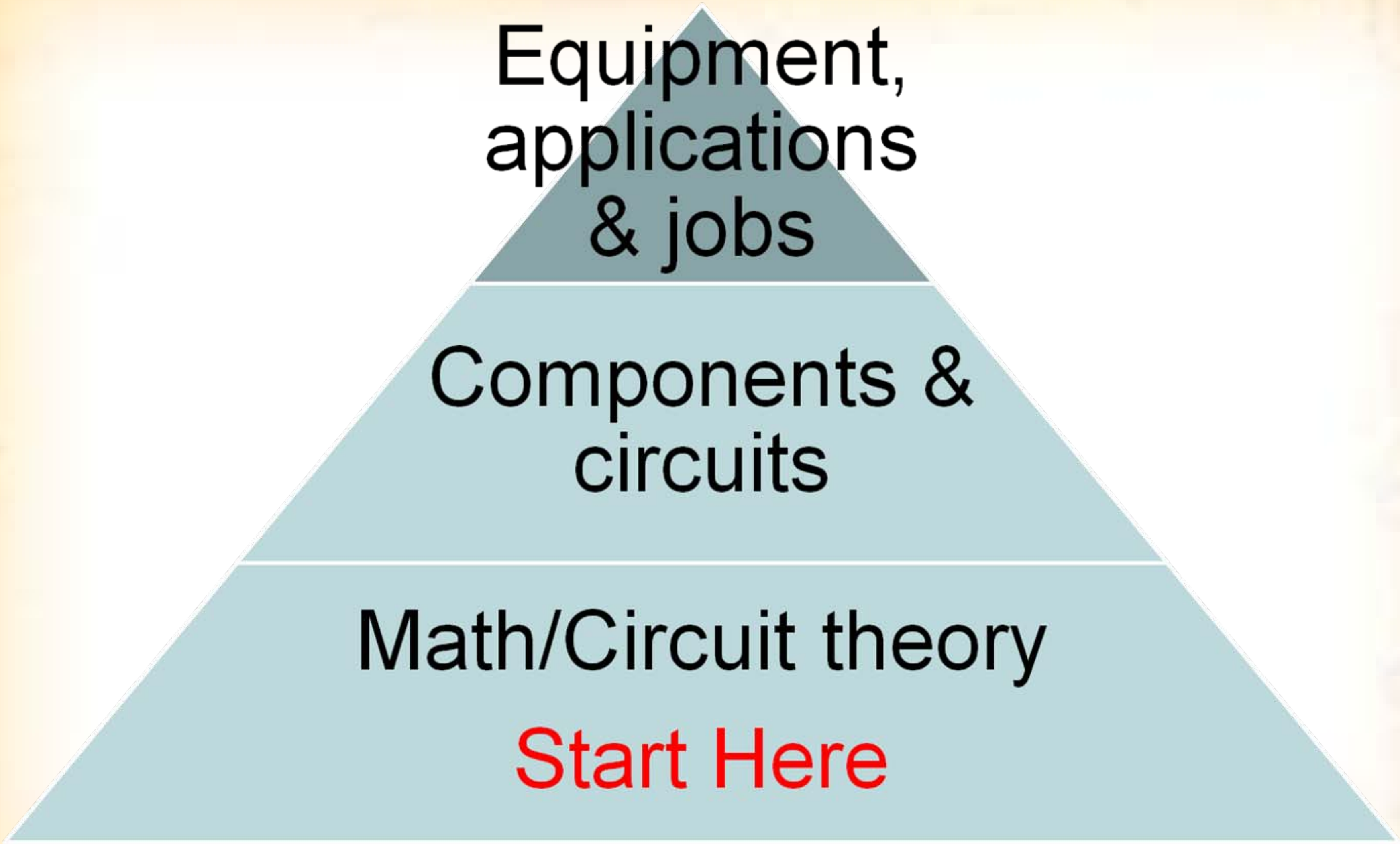
Impact to Graduate Technicians

- Major implications for technicians.
  - Few if any engineering technician jobs.
  - Less troubleshooting to the component level.
  - More system troubleshooting, measurement, and test.

Results in:

- Legacy programs being out of touch with reality.

The Legacy Bottom Up Approach



The Top-Down Approach

Applications/Equipment

Jobs and duties.

Start Here

Circuits/Components (as needed)

Math/Circuit theory (as needed)

A Solution: eSyst

- A project conceived to address the systems view of electronics to meet industry's current needs
- Develop new systems resources
- Create a guide to help facilitate the changes
- Encourage colleges to update programs

Electronics Courses Identified by eSyst Project Team

- DC and AC Circuits Analysis
- Solid State Devices and Circuits
- Digital Fundamentals
- Microprocessor Applications Inc. microcontrollers
- Data Acquisition and Measurement
- Communications

Project Status

- Project has resources for the following on eSyst.org:
  - Implementation Guide
  - DC/AC Circuits
  - Solid State Devices
  - Digital Logic
  - iLabs Application Phase Two now available online
  - Microprocessors
  - Data Acquisition – under development
  - eCommunications – under development

Implementation Guide: Project Information

- eSyst Drive for Revision and Project Goals
- eSyst Approach to Electronics Systems
- Definition of an Electronics System
- Technicians and Systems Applications
- eSyst Program recommendations
- eSyst Course recommendations
- M.I.T. iLabs eSyst Project description

Implementation Guide: Course Information

- Traditional View versus Systems View
- General Course Recommendation
  - De-emphasized Topics
  - New Systems Topics
  - General Lab Recommendations
  - Textbook Recommendations
- Student Learning Outcomes
- Systems Course Outlines
- Systems Instructional materials

Traditional View versus Systems View

Traditional View

- Every AAS degree program in electronics technology has a Digital fundamentals course. This course contains valuable concepts that students will use in later courses and on their jobs. These courses teach the binary number system and coding, logic gates and flip flops, and basic combinational and sequential logic circuits. Some courses also include an introduction to A/D and D/A conversion. Others provide an introduction to microcontrollers. Usually the Digital course is the prerequisite for a more comprehensive microcontrollers course.
- Typically such Digital courses and the texts that support them take a very detailed approach to digital logic, which includes extensive coverage of Boolean algebra, truth tables, logic minimization with Boolean algebra, Karnaugh maps, and basic digital circuit design from state tables, truth tables, etc. Implementation focuses on TTL, or in some cases CMOS, logic gates, flip-flops and functional logic circuits like decoders, registers, counters and others.
- Looking at this approach today reveals that it is less appropriate to modern equipment and jobs. First, many of the methods taught address how to design circuits. Since technicians rarely design circuits there is less need to spend time on methods of design.

Traditional View versus Systems View

Traditional View continued:

- Second, modern equipment is not implemented with discrete TTL or CMOS logic. Instead, virtually all-digital circuits are made with a microcontroller or a programmable logic device (PLD) like an FPGA.
- Third, most technician work is at a higher systems level working with computers, boards, equipment, modules and in some cases ICs. The work is more related to testing and troubleshooting than to design. Techs trace signals and make measurements to insure compliance to some specification or standard. They use oscilloscopes, pulse generators, and logic analyzers to perform these jobs. Much of the work involves buses and interfaces between boards, modules and equipment. Typically most courses do not include coverage of these critical connections

Traditional View versus Systems View

New Systems View

- While the basic content of most Digital courses is sound, some of it can be eliminated to make room for new material on PLDs and microcontrollers as well as buses and interfaces. The emphasis can shift from a design approach to one more related to how circuits operate and how to test and troubleshoot them. It is still essential that the fundamentals of binary numbers and codes, logic circuit types and operation, and key combinational and sequential logic functions be taught. However, the approach should shift from a design orientation and more to a systems approach emphasizing test and troubleshooting.

General Course Recommendation

The course should begin with a systems introduction. Some suggested topics are:

- Distinguish between analog and digital signals and give examples of each.
- Teach the binary/hex/decimal number systems, codes, and representation.
- Introduce the idea of the input/process/output model showing how inputs are processed by the circuit or equipment to produce new output signals.
- Mention the wide range of processing options like math, logic, decision making, code conversion/translation, and other common operations.
- Indicate that digital processing is performed in one of three basic ways: (a) Discrete logic, e.g. TTL, (b) PLD (define briefly), and (c) microcontroller/computer (define briefly). Only the latter two are used today.
- With this context and approach, the student will understand that the remaining topics are just different ways to process the signals.

General Course Recommendation

The following recommendations are congruent with graduates' needs and industry's requirements:

- Less Boolean algebra manipulation.
- Less design techniques like Boolean minimization and Karnaugh maps and state diagram-to-circuit implementation.
- Less coverage of TTL and CMOS discrete logic circuits.
- Increased coverage of PLDs including PAL/GAL, CPLD and FPGA including basic programming.
- Introduction to microcontrollers, computer concepts, and basic programming.
- Increased coverage of buses and interfaces.
- Introduction to the sampling theory, analog to digital conversion (ADC) and digital to analog conversation (DAC).
- Greater emphasis on circuit specifications, testing and troubleshooting.

De-emphasized Topics

The following traditional topics should be de-emphasized for a Digital Fundamentals course:

Reduce coverage of Boolean algebra manipulation.

- Rationale: It is important to know the concepts of Boolean algebra but extensive practice and problem solving is not helpful as technicians rarely if ever need it on the job.

Reduce coverage of design methods.

- Rationale: Technicians do not design digital circuits. Digital circuits are designed by engineers who create the integrated circuits. Any design other than ICs is done for a specific application using a PLD or microcontroller. Techniques like minimization with Boolean algebra or Karnaugh maps can be eliminated.

De-emphasized Topics

The following traditional topics should be de-emphasized for a Digital Fundamentals course:

Reduce coverage of TTL/CMOS discrete logic circuits.

- Rationale: TTL and CMOS logic ICs are not used in new designs which are virtually 100% either microcontroller or PLD based. While such basic circuits do give a student a hands-on way to demonstrate basic logic functions, it should be pointed out that such circuits are not a part of modern equipment.

New Systems Topics

The following subjects should be added to a Digital course or more detailed coverage should be included:

Increased coverage of PLDs. This should include PALs, ROM logic/look up tables, CPLDs and FPGAs. The basic format and architecture should be introduced with an analysis of several representative products including specifications. Basic programming techniques in VHDL, Verilog or an equivalent language should be introduced to allow a student to create simple circuits for evaluation.

- Rationale: A large percentage of new digital designs use a PLD and students must be familiar with the basic types, inputs, outputs, specifications and architectures. Students must know how to access inputs and outputs and assess functionality.

New Systems Topics continued

Add or increase coverage of computer fundamentals and microcontrollers.

- Rationale: All electronic equipment contains at least one embedded controller. It is a fundamental electronic component and students need to be introduced to it as early as possible. Many Digital courses omit this topic saving it for a later course. However, since the microcontroller is at the heart of all designs, early knowledge of these devices will give the student the proper perspective in how to approach the analysis and troubleshooting of any piece of equipment. The coverage does not have to be in-depth at this point, but concepts such as the stored program approach, instruction sets, programming languages and basic programming techniques must be taught. A language such as BASIC is easy to teach and learn and is a good starting point for learning assembler or C language later.

New Systems Topics continued

Add or increase coverage of buses and interfaces. Parallel buses using 3-state logic should be covered as well as common parallel buses like PCI, PCI-X and PCIe. LVDS must be covered. In the serial interface category, all the key standards should be explained and where each is used. Examples: RS-232/422/423/485, USB, SPI, I2C, CAN, and Ethernet.

- Rationale: Buses and interfaces are the places where data is transmitted and received between circuits and equipment. This is where the tech works in a systems-oriented world. Specifications and connectors are essential knowledge.

New Systems Topics continued

Add data conversion. Cover sampling theory (Nyquist, etc.), ADC methods, and DAC methods as well as common applications.

Rationale: Most electronic products today incorporate some form of data conversion such as ADC or DAC. It is difficult to name something that does not use it. Therefore it is a critical fundamental. One issue that may arise is that some Digital courses are taught before a student has had courses in linear circuits like op amps making some of the circuitry difficult to describe. If that is the case, simply teach a higher level version of data conversion where detailed circuits are not discussed.

New Systems Topics continued

Increase coverage of testing, measuring and troubleshooting.

- Rationale: This is what technicians actually do on the job. It is important that a student know how to use an oscilloscope and pulse generator to stimulate and test a digital circuit. If the budget allows, a logic analyzer should be added to the instruction. Test to specifications and standards.

General Lab Recommendations

1. Less breadboarding with discrete TTL or CMOS logic. It is OK to introduce that early in the course lab but do not extend it throughout the course. This is best for teaching the basic functions but remember it is also possible to do that with a CPLD.
2. Add significant PLD coverage with PAL or GAL ICs that can be programmed as well as including an Altera or Xilinx student demo board with prebuilt I/O devices (switches, LEDs, LDC display, etc.), and multiple common interfaces.
3. Add introductory coverage of an embedded controller with simple I/O. Teach a simple programming language. A recommended lab set up is made by Parallax and called the BASIC Stamp. It uses a popular PIC processor and a BASIC interpreter in ROM. The Parallax PBASIC language is easy to learn and students can quickly understand the concepts and implement basic monitor and control functions.
4. Add activities that allow students to practice test and measurement techniques and troubleshooting. Add a logic analyzer to the lab as budget permits.

General Textbook Recommendation

1. Use your existing textbook but edit the content to avoid or de-emphasize the above mentioned topics and to enhance the suggested topics.
2. Change to a textbook that incorporates the most recent techniques like PLDs and microcontrollers. See recent book reviews of Digital texts attached.
3. Search for supplementary material on the Internet and other sources to cover topics not adequately covered in the textbooks.
4. Encourage publishers to update current texts or develop new texts supporting the systems approach.

Microprocessor Animation

Presented by:

Bassam Matar

Electronics Engineering Faculty at Chandler Gilbert Community College

Microprocessor Animation

Web Site Tour

Demonstrate eSyst web site:

- Implementation Guide for Digital Fundamentals
- Digital Fundamental Systems Lab Activities
- Online Evaluation forms
- eSyst Videos

eSyst Web Site

Questions?

Type them in your chat window

A presentation of eSyst.org

Webinar Recordings

To access this recording, visit **www.matecnetworks.org**, Keyword Search: "**Digital Fundamentals webinar**"

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January 29: Microprocessors

February 19: Data Acquisition

Visit ***www.esyst.org*** for more details about these and upcoming webinars

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February 12: **Evaluating Student Impact**

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Thank You to everyone for participating in today's Electronics Systems Technology Project Implementation Webinar Series
Part 3: Digital Fundamentals Implementation

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