eSyst Implementation Webinar Series Part Two: Solid State Devices

Maricopa Advanced Technology Education Center

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A presentation of eSyst.org

This webinar is hosted by MATEC NetWorks

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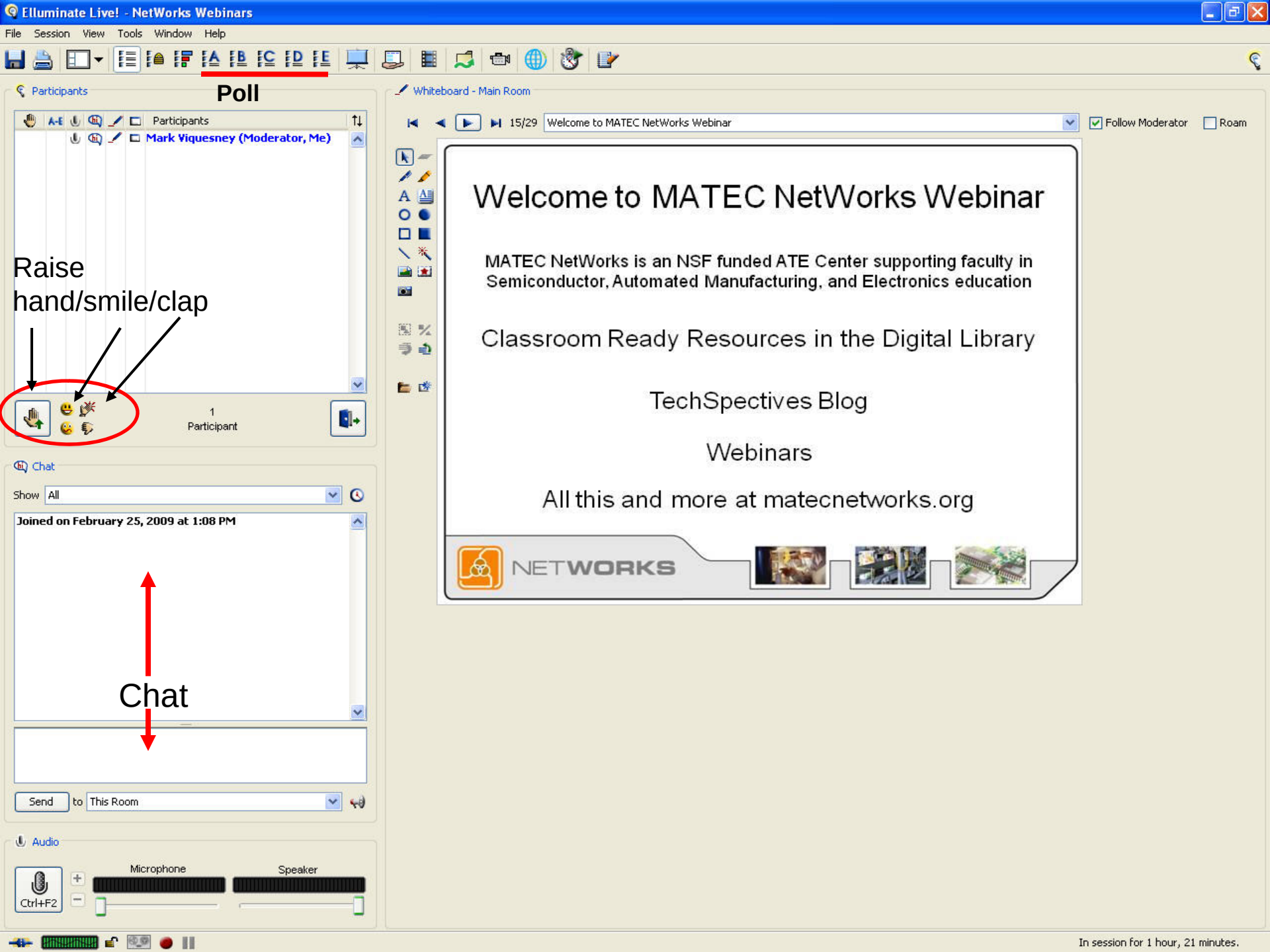
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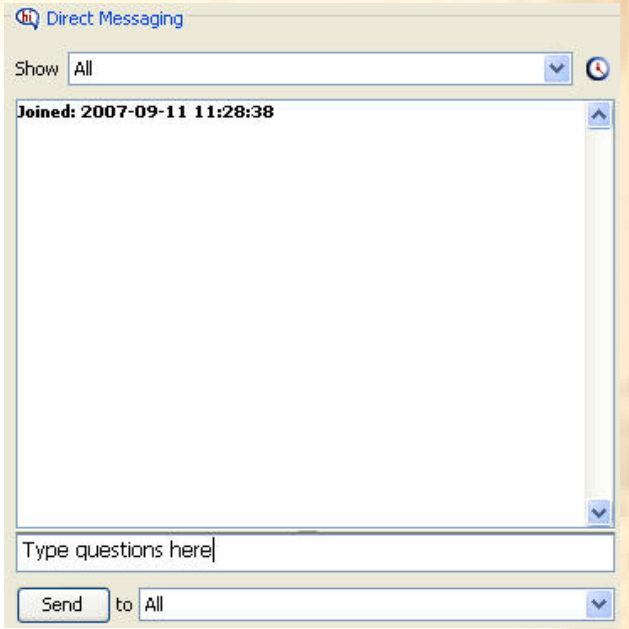
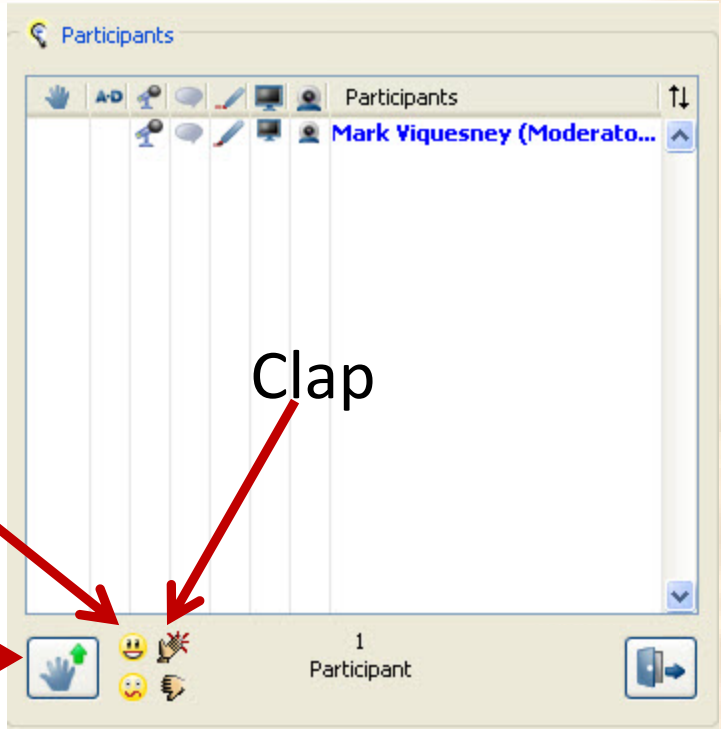


- If you are listening by phone, please mute your phone by pressing #5.
- If you have questions during the presentation, please submit them in the Chat Window and Send to "All" so that others can follow along.
- Throughout the presentation and at the end of the session we will answer as many questions 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 M.I.T. eSyst iLabs project
- Review of eSyst Solid State Systems 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

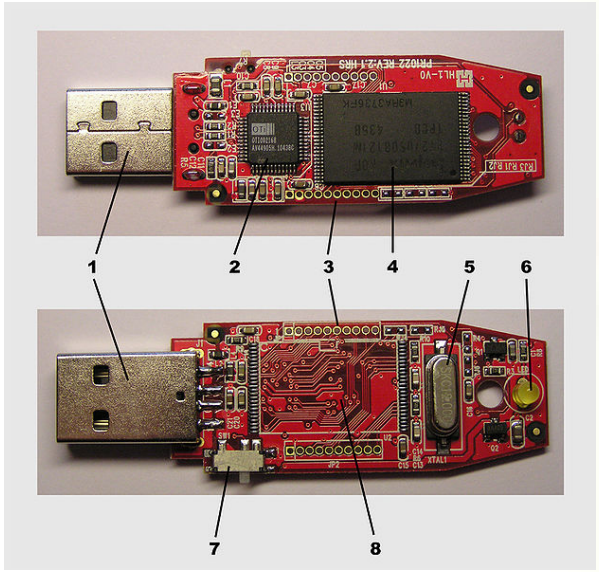
Tom McGlew – Project Development Manager

eSyst Project Overview

A presentation of eSyst.org

So what has changed and what is a System?

Then to Now



Now to the future

eSyst Home Media Animation

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

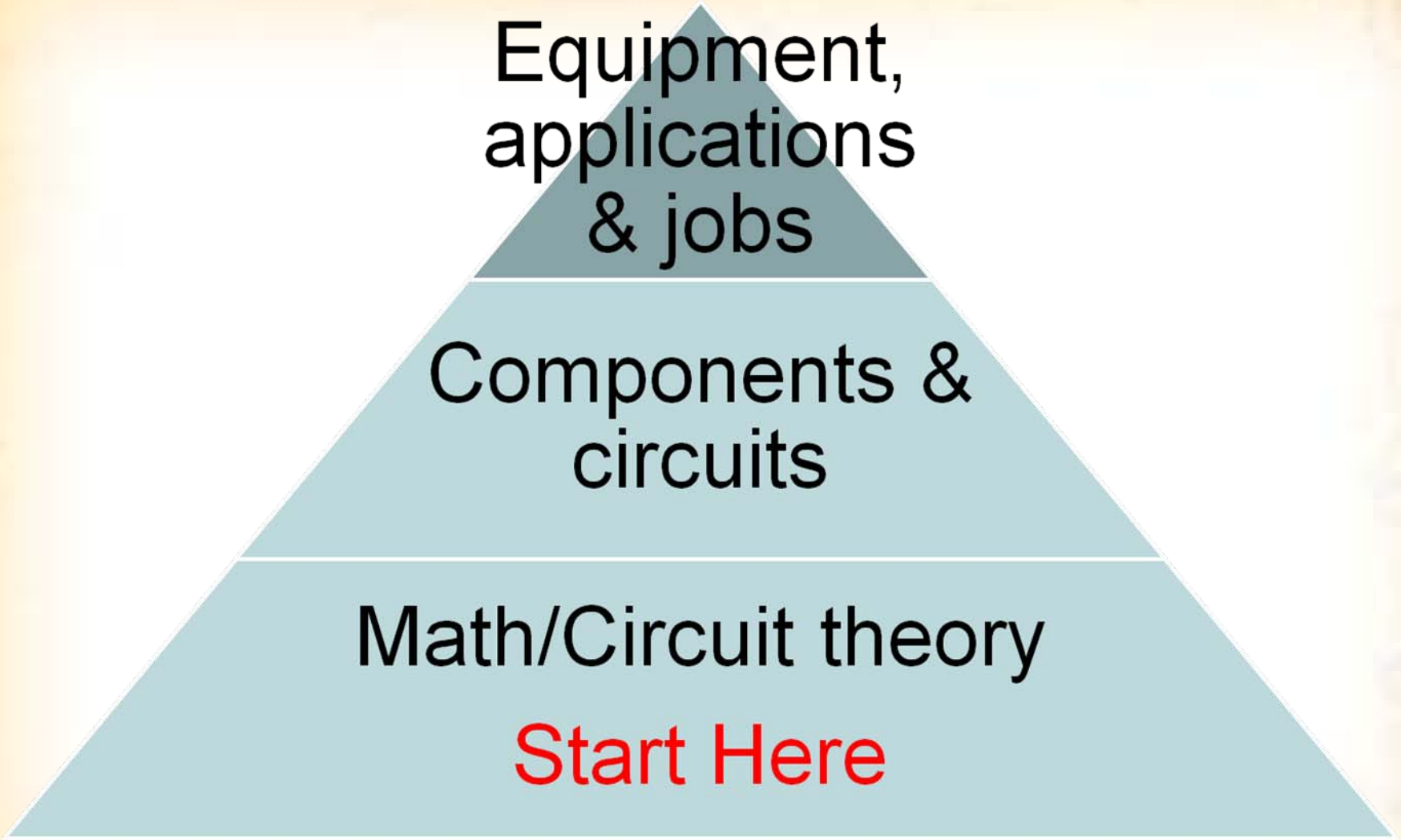
Impact to Graduate Technicians

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

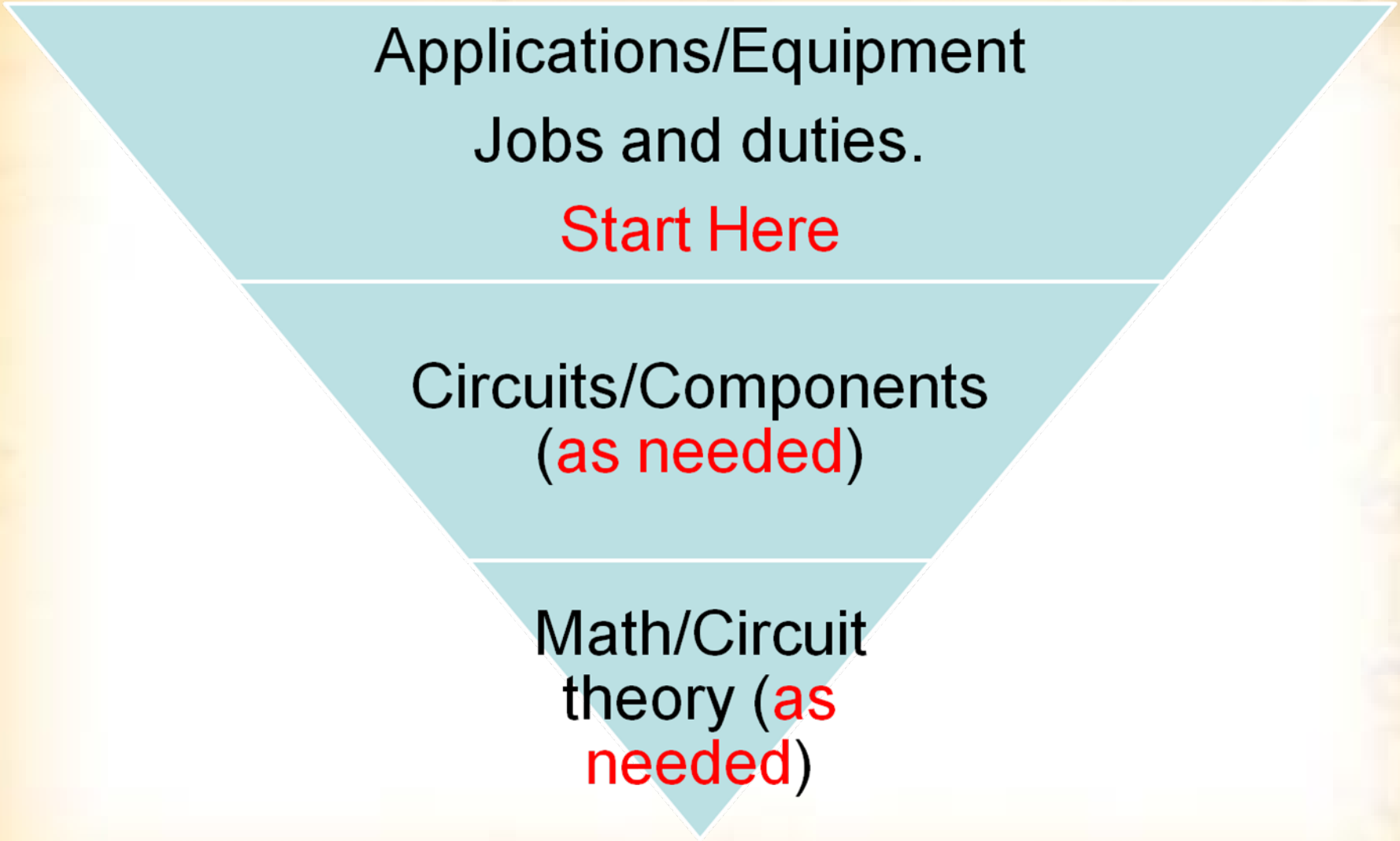
Results in:

- Legacy programs being out of touch with reality.

The Legacy Bottom Up Approach



The Top-Down Approach



A Solution: eSyst

- Project conceived to address the systems view of electronics and industry's current needs.
- Develop new systems resources.
- Encourage colleges to update programs.

Electronics Courses Identified by eSyst Project Team

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

Project Status

- Project has resources for the following on eSyst.org:
  - DC/AC
  - Solid State Fundamentals
  - Digital Logic
  - iLabs Application Phase Two now available online
  - Microprocessor Applications
  - Data Acquisition - underdevelopment
  - Communications - underdevelopment

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
  - Deemphasized Topics
  - New Systems Topics
  - General Lab Recommendations
  - Textbook Recommendations
- Student Learning Outcomes
- Systems Course Outlines
- Systems Instructional materials

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Traditional View versus Systems View

Traditional View

- Most AAS degree curricula in electronics technology contain a course called Solid State Electronics or Solid State Circuits. Alternate names are Semiconductor Devices or Linear Circuits. Whatever the name, most of these courses teach the basics of semiconductor materials and semiconductor devices like diodes and transistors. The courses go on to introduce basic electronic circuit such as power supplies, amplifiers and other related analog or linear circuits. Integrated circuits are introduced. The course usually concludes with an introduction to SCRs and thyristors of various types.
- In these courses, the emphasis has always been on bipolar junction transistors (BJTs) and their circuits. FETs are introduced but with less circuit coverage. There is extensive coverage of BJT circuit biasing as well as in-depth circuit analysis of basic amplifier circuits using BJTs. Less coverage is given to FET circuits.
- Most IC coverage is directed at op amps. While some courses only mention op amps in preparation for a later more advanced linear circuits' course, most do a good job of covering the basic op amp circuits. Some coverage is given to IC audio power amps and well as 3-terminal linear regulators.
- With today's electronic technician doing more troubleshooting, maintenance and repair at the systems level, there is actually little need for much of the material covered in these courses. Most courses were developed in the 1970s and 1980s so they are severely dated and skewed from current needs. While some of the material, especially the fundamentals, can be retained most of it can be greatly minimized and replaced with more current relevant material.

Traditional View versus Systems View

New Systems View

- The technician of today works more with PC boards, ICs, modules, sub-assemblies, equipment and complete systems there is little need to teach in-depth circuit analysis. While it is essential that the technician understand basic semiconductor principles, there is little need to learn of the detailed particle physics some courses still teach. Some elementary principles are usually sufficient.
- There is also a need to shift emphasis from a BJT emphasis to a more FET centric approach. While BJTs must still be taught, today most transistors in use today, inside ICs as well as discretes are MOSFETs. Better than 90 % of all transistor usage is MOSFET. There must be more FET coverage and related FET circuits. And even that coverage can be minimal since so much of that circuitry is in IC form that can never be accessed by a tech anyway.

General Course Recommendation

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

- Less math and computation overall. Less detailed circuit calculation and analysis.
- Less theory and more practical coverage of real world devices and equipment. Focus on how things work and essential concepts rather than precise mathematical representation.
- Remove material that relates primarily to circuits analysis methods and design.
- Add more coverage of larger circuits and systems at the block diagram level.
- More emphasis on integrated circuits and their specifications, features and applications.
- Increased coverage of testing, measuring and troubleshooting.
- Continue to teach the course in essentially the same way but follow the guidelines give in the sections below.

Deemphasized Topics

The following traditional topics should be de-emphasized a Solid State Devices course:

- Reduce coverage of semiconductor physics. Doping, covalent bonding and related topics are ok.
  - Rationale: No one, technicians or engineers, needs to know the deep physics of semiconductors (energy levels, etc.) to do their work. Stick to simple concepts.
- Significantly reduce the coverage of BJTs. Include only basic biasing methods and configurations. Reduce coverage of BJT circuit analysis and design. Reduce or even eliminate things like load lines.
  - Rationale: Most circuits today are made with MOSFETs. There is simply little or no need to teach the intimate details of BJT circuit analysis or design of discrete component circuits. They are no longer used. Huge parts of the course content can then be redirected to more widely used components and circuits.

New Systems Topics

The following new systems topics should be integrated into a Solid State Devices course:

- Add coverage of compound semiconductors such as SiGe, GaAs, etc. Include benefits and basic applications.
  - Rationale: Many modern semiconductors especially ICs are made with these compound materials. SiGe, GaAa, InP, GaN, SiC and others are increasingly more widespread.
- Increase coverage of Schottky (hot carrier) diodes specifications and benefits.
  - Rationale: Most rectifiers and diodes in high speed circuits are of this type.
- Increase coverage of FETs especially MOSFETs. JFET coverage can actually be minimized as few new devices, circuits and applications are in use. Increase coverage of enhancement mode MOSFETs, biasing and relevant digital (switching) and linear circuits. Add topics like current sources and sinks, active loads, and resistor-less linear and digital circuits. Keep in mind that most of these circuits are in IC form and cannot generally be accessed. A final recommendation is that MOSFETs be taught before BJTs since they are the predominant transistor type in use.
  - Rationale: Most (over 90%) digital and linear circuits in IC form are MOSFETs.

New Systems Topics continued

- Increase the coverage of the transistor as a switch. Emphasize switching time, rise fall times, pulse characteristics, on resistance, etc.
  - Rationale: Most transistors are used in digital or switching circuits.

- Increase coverage of IC amplifiers of all types. While op amps are generally well covered, increase coverage of all types of linear amplifiers, power amplifiers, programmable gain amplifiers, video and RF amplifiers. Emphasize specifications like gain, input and output impedance, frequency response, and voltage/power output limits. Be sure to cover switching amplifiers: theory, operation, specifications and applications.
  - Rationale: There are very few discrete component amplifiers in use today. Most amplifiers are ICs except for those with very high power or voltage outputs in which case special discrete devices are ***used.***

New Systems Topics continued

- Add coverage of the relationship between frequency response and bandwidth to pulse switching time and data speeds. Re-introduce Fourier theory at the most fundamental level.
  - Rationale: All applications today, linear or digital make use of this concept that is rarely if ever taught today.
- Increase coverage of switch mode power supplies and circuits. Add coverage of the bus architecture of power supplies so common today. Emphasize power consumption, power management circuits, and the green movement. Use a systems approach to show signal flow and teach troubleshooting.
  - Rationale: Most power supplies today use a bus-architecture with a linear rectifier and filter followed by a mix of switching and LDO regulators, switching regulators, DC-DC converters and other circuits. Over 80 % of all power supplies are of the switch mode variety.

General Lab Recommendations

1. Do less breadboarding of discrete component circuits. Use more ICs.
2. Work with complete wired circuits and end equipment as much as possible. Use available kits of power supplies, amplifiers and other equipment.
3. Increase coverage of test equipment usage and measurement techniques.
4. Add more troubleshooting activities.

General Textbook Recommendation

1. Continue to use your current textbook, but eliminate the following suggested material:
   - Semiconductor physics
   - Load lines
2. Supplement the text with new systems topics and instructional materials from magazines, websites, etc.
3. Encourage publishers to update current texts or develop new texts supporting a systems approach.

M.I.T iLabs Solid State Devices Lab

Online iLab Demonstration

Presented by:

James Hardison

eSyst iLabs Developer

in Banff Canada today

Web Site Tour

Demonstrate eSyst web site:

- Implementation Guide for Solid State Devices
- Solid State Systems Lab Activities
- Online Evaluation forms
- eSyst Videos

http://www.esyst.org

Questions?

Webinar Recordings

To access this recording, visit **www.matecnetworks.org**,
Keyword Search: "**Solid State Implementation**"

eSyst Upcoming Webinars

November 13: Digital Fundamentals

January 29: Microcontrollers

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

NetWorks Upcoming Webinars

November 13: **Nanotechnology in the Classroom**

December 11: **Reaching and Teaching Across Generations**

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

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Thank You to everyone for participating in today's Electronics Systems Technology Project Implementation Webinar Series
Part 2: Solid State Implementation

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