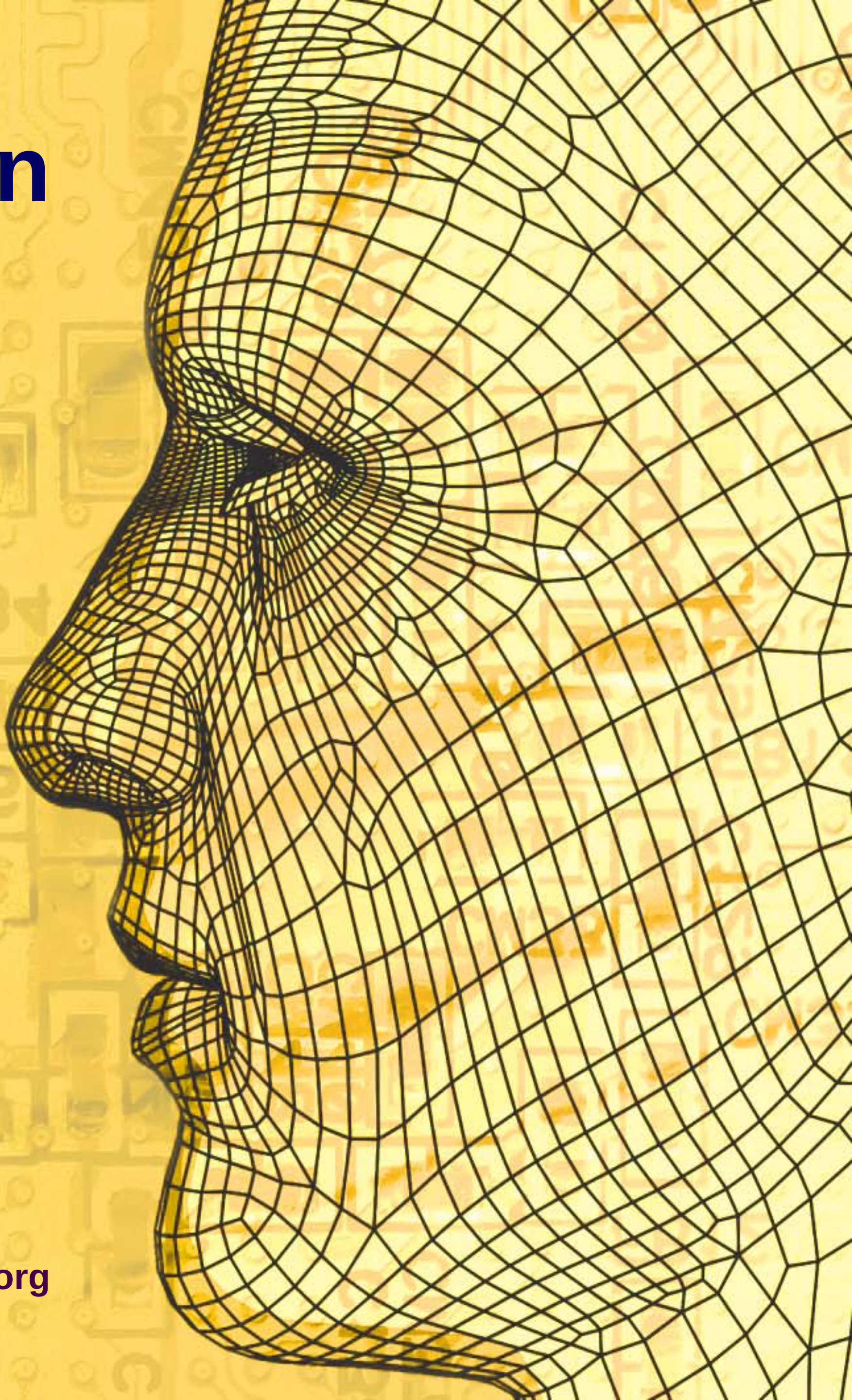
eSyst Implementation Webinar Series Part Four: Microprocessors

Maricopa Advanced Technology Education Center

NSF ATE Grant #0702753



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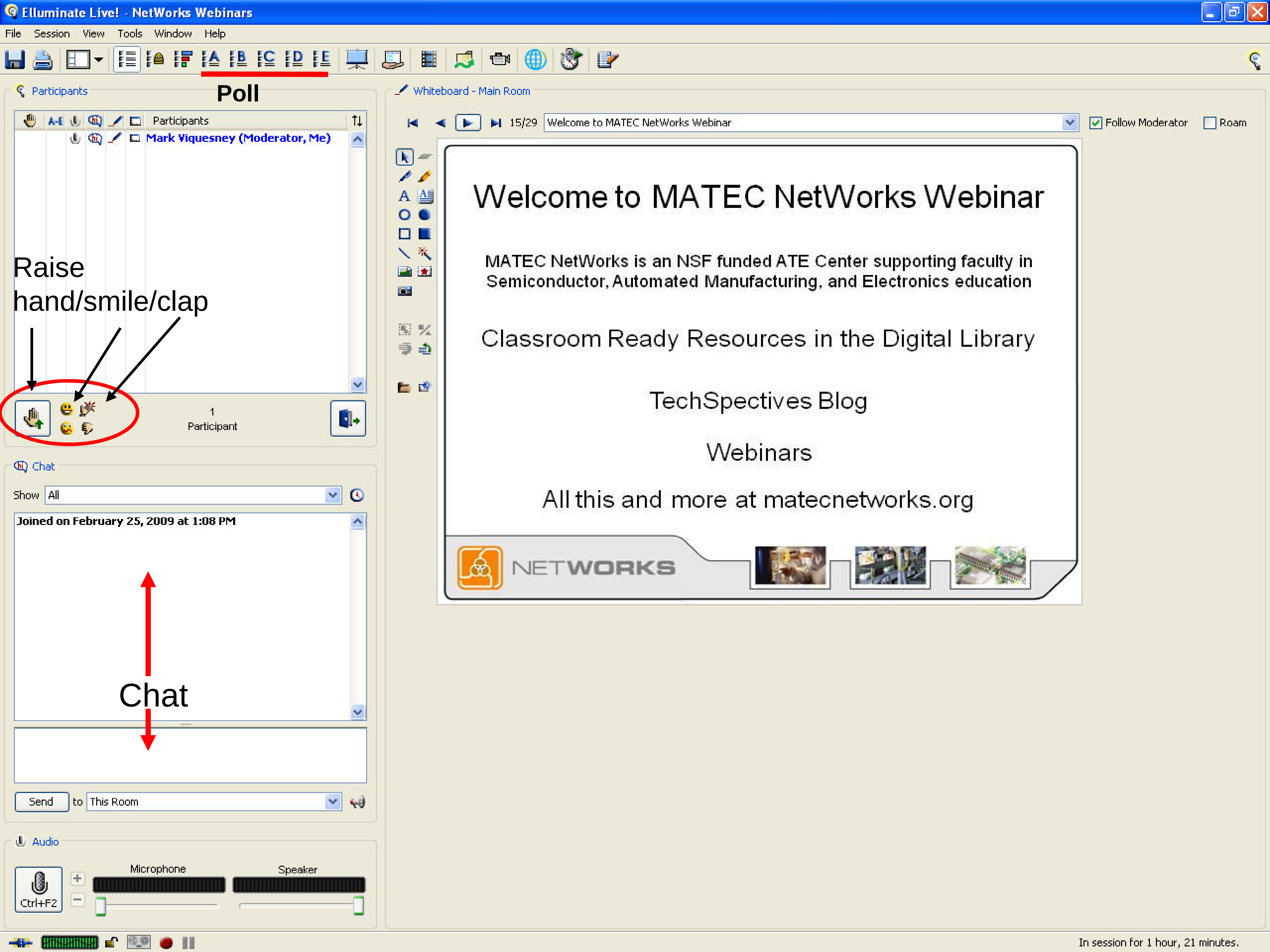
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In session for 1 hour, 21 minutes.

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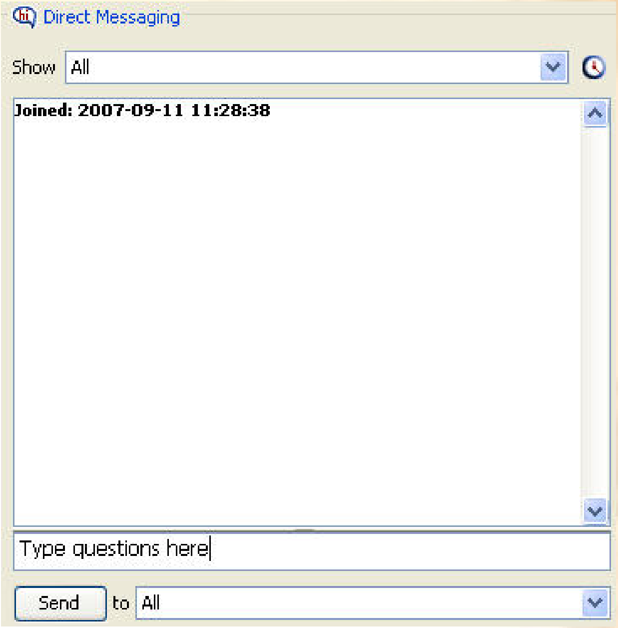

- If you have questions during the presentation, please submit them in the Chat Window and Send to "All" so that others can follow along.

- Throughout the presentation and at the end of the session we will answer as many questions as we can.

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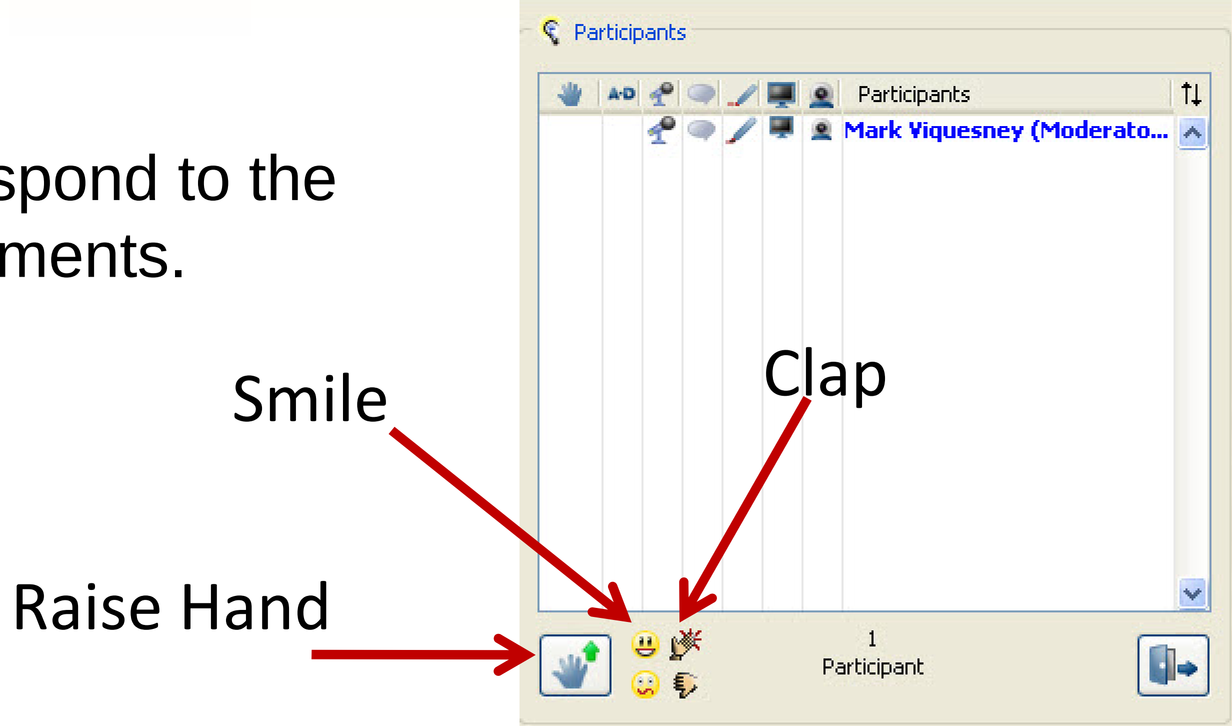
Participants Box

Allows you to respond to the presenter's comments.



eSyst Webinar Presenter

Tom McGlew:
eSyst Project Manager

eSyst Webinar Agenda

- Overview of the eSyst Project
- Review of the eSyst Implementation Guide
- Demonstration of a Security Monitor and Control System Lab
- Demonstration of the Microprocessor Animation
- Web site tour
- Survey and Final Questions from Participants

eSyst Project Overview

So what has changed and what is a System?

HOW TO USE

SONY TR-86

To switch on
Turn the Volume Control Knob ① in the direction shown by the red arrow. Power is switched on with a slight click.

To select stations
Desired station is tuned by turning the Tuning Knob ④. The tuned frequency is indicated by the Dial Pointer ③.

To adjust volume
As the Knob ① is turned in the direction shown by the red arrow, sound volume increases. However, excessive volume not only distorts sound quality, but makes the battery life shorter.

To switch off
Turn the Volume Control Knob ① in the opposite direction to the red arrow until "OFF" appears in the small window ②.

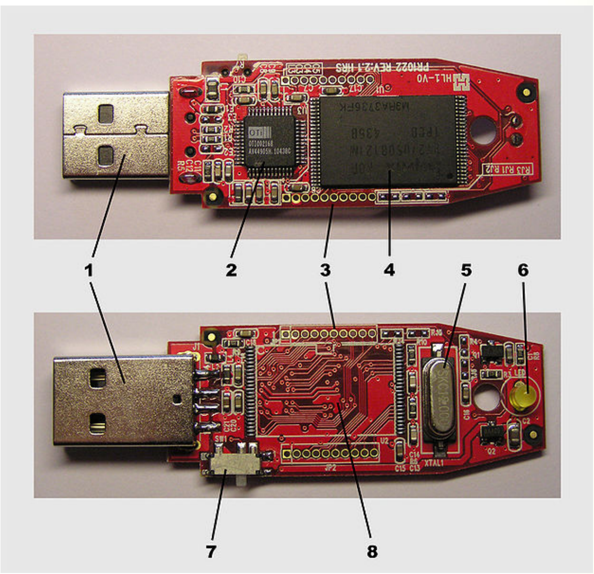
"POCKETABLE"

To use earphone
By plugging earphone plug into the Earphone Jack ⑤, the speaker is cut off and you can enjoy quiet listening without disturbing others.

Important
When not in use for long periods, it is recommended that the set is kept in a dry and cool place with batteries removed.

8 SONY transistors

Then to Now



Now to the future

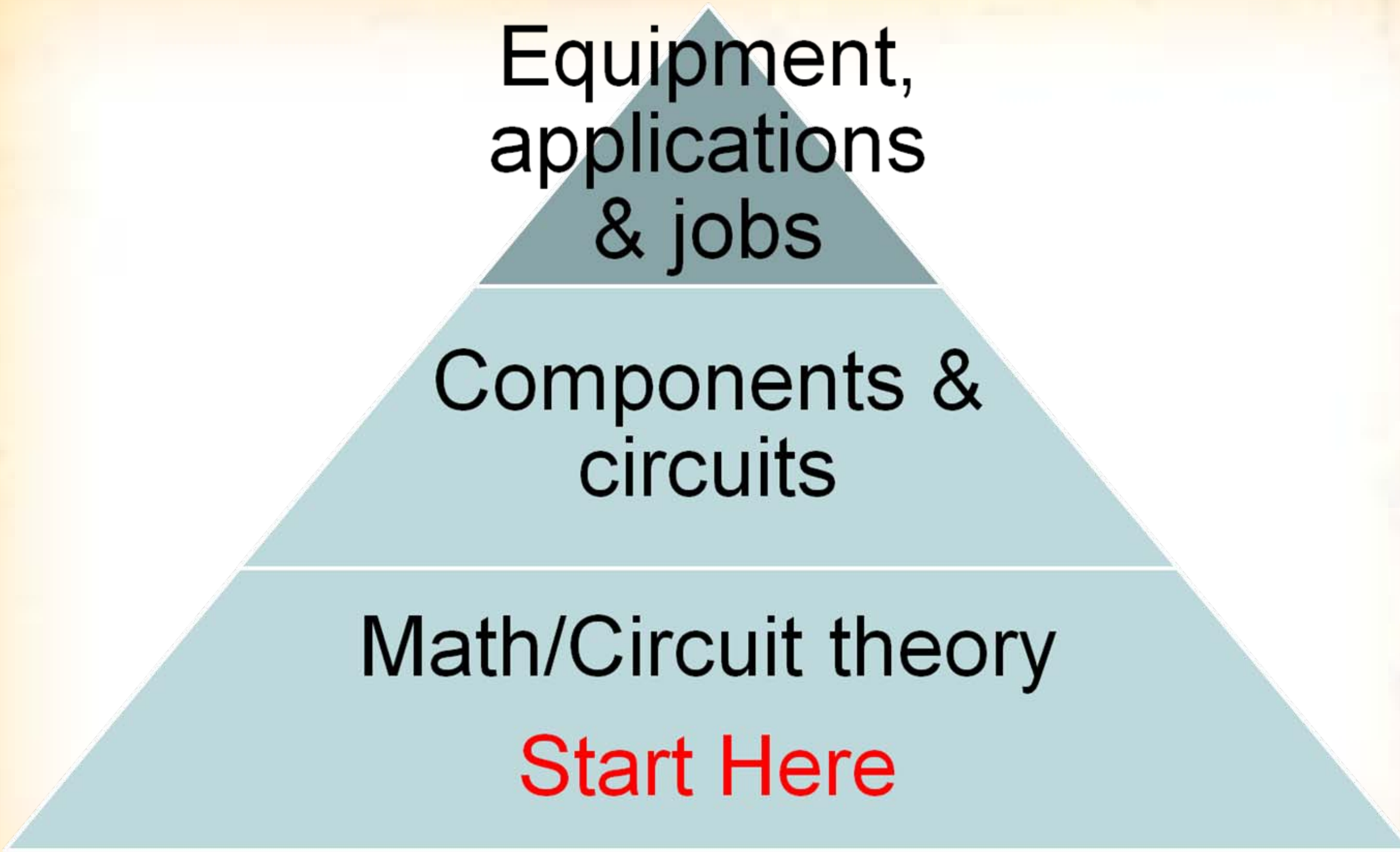
Impact to Graduating Technicians

- Major implications for graduating 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

eSyst Home Media Animation

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

Electronics Courses Identified by eSyst Project Team

- DC and AC Circuits Analysis
- Solid State Devices
- Digital Fundamentals
- Microprocessors including microcontrollers
- Data Acquisition and Measurement
- Electronics Communications

Project Status

- Project has resources for the following on eSyst.org:
  - Implementation Guide
  - DC/AC Circuits
  - Solid State Devices
  - Digital Fundamentals
  - iLabs Remote Phase Two is now available on the Student Resources webpage
  - Microprocessors
  - Data Acquisition – under development
  - eCommunications – under development

Questions?

Type them in your Chat Window

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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

The ***Implementation Guide*** can be found on the **Faculty** tab menu on the eSyst web site.

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 both Digital and Microprocessor fundamentals courses. The Digital course teaches 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.

- Today, virtually all digital circuits are made with a microprocessor or a programmable logic device (PLD) like an FPGA. Most colleges have gotten around to adding PLD coverage to some extent. Some also introduce microcontrollers in a microprocessor course. The importance of a microcomputer course that emphasizes embedded controllers is an essential part of any electronics technology curriculum.

Traditional View versus Systems View

Traditional View continued:

- The goal of this course is to introduce a popular embedded controller and show how it is used to implement almost any digital function. That involves programming the microcomputer and using the interfaces that connect it to those devices it will monitor and control.

- 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

- Virtually every electronic product has at its heart a microcontroller. In fact, for larger pieces of equipment and systems, two or more microcontrollers are very common.
- Technician work involves testing and troubleshooting, and that will typically involve the microcontroller. To work at the systems level in electronics means having a grasp of how the microcontroller connects to the rest of the equipment and how it is programmed to perform the desired system functions.
- The Microcontroller course described here serves to teach those fundamentals and to show how the microcontroller is part of a larger system.

General Course Recommendation

The primary recommendation is to offer an overview course that teaches how microcontrollers are used in all areas of electronics. The idea is to teach the fundamentals of programming a widely used commercial microcontroller. A key part of the course is learning about the many useful interfaces that are used in practice.

1. Review the binary/hex/decimal number systems, codes, and representation.
2. Re-introduce the idea of the input/process/output model showing how inputs are processed by the circuit or equipment to produce new output signals.
3. Mention the wide range of processing options like math, logic, decision-making, code conversion/translation, data storage, and other common operations.
4. Teach computer operation fundamentals generally called the stored program method. We will see the eSyst Adder Animation shortly.
5. Introduce the architecture and instruction set of a popular commercial microcontroller.

General Course Recommendation

General Recommendations continued:

6. Teach basic programming methods using assembly language or a higher level language like C.
7. Discuss all of the commonly used interfaces used with microcontrollers.

The following recommendations are based on graduates' needs and industry's requirements:

8. Introduction to microcontrollers, computer concepts, and basic programming.
9. Increased coverage of buses and interfaces.
10. Introduction to the sampling theory, analog to digital conversion (ADC) and digital to analog conversion (DAC).
11. Greater emphasis on programming, interfacing, testing and troubleshooting.
12. Introduce the concepts of digital signal processing (DSP).

New Systems Topics

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

1. Ensure solid 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. 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 electronic equipment. The 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 and C language later.

New Systems Topics continued

2. Teach a specific popular microcontroller in some depth.

Rationale: Most microcontroller courses do teach a specific commercial device. The best prospects are the most widely used devices such as Microchip Technology PIC, Freescale 68HC11/12 and subsequent devices, or the 8051 in one of its many derivatives. These devices are low cost and widely available.

3. Today 32-bit microcontrollers are very common. These should be covered as well. The ARM processor is an example. The student should become familiar with the basic architecture, specifications, features and the instruction set.

Rationale: While 8-bit microcontrollers are still widely used, the 32-bit embedded controller has become almost as common. The student should be at least familiar with the common 32-bit devices such as ARM, Power PC, MIPS and others.

New Systems Topics continued

4. Add coverage of programming in assembly and C language.

Rationale: Learning the microcontroller assembly language further helps the student understand the architecture of a computer and how processing takes place. It is not necessary in this course to produce a formal assembly language programmer, but some elementary programming concepts will help establish a strong knowledge of how the data flows through the system. Introducing the C language will also be helpful, as this is the most widely used language in programming microcontrollers. A separate C programming course should be required as a prerequisite to the more advanced microcomputer course if one exists. The introduction to programming may be easier if the instruction starts with the BASIC language which is quickly and easily grasped.

New Systems Topics continued

5. Add or increase coverage of buses and interfaces. Parallel buses using 3-state logic should be covered as well as common parallel and serial buses like PCI, PCI-X and PCIe. Low-voltage differential signaling or 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

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

Rationale: If this topic is not covered in the prerequisite Digital course, it must be added here. 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 Microprocessor 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

7. Add a brief introduction to digital signal processing (DSP).

Rationale: Many if not most electronic products use DSP principles. The concept of implementing analog functions in digital form should be explained. It is not necessary to discuss algorithms or the mathematical principles but do teach the idea that analog signals can be digitized and manipulated by software with algorithms that perform filtering, modulation/demodulation and other analog processes.

8. 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 test and debug a microcontroller circuit. The debugger in a common integrated development system is an ideal tool.

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.

Questions?

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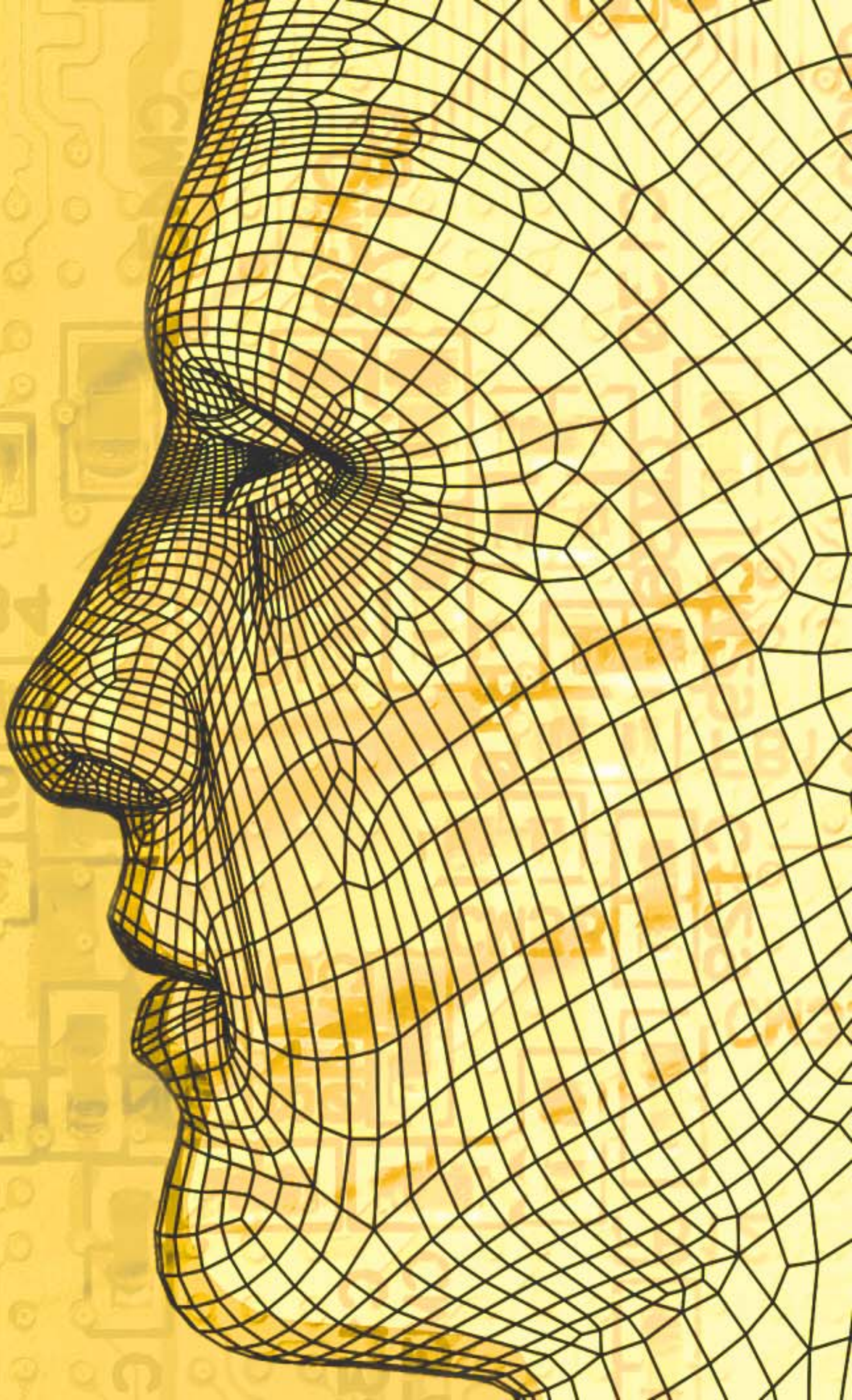
Security Monitor & Control System

Bassam Matar / Chandler-Gilbert Community College

Ui Luu / Glendale Community College

eSyst Project



Presentation Outline

- Lab activity Overview
- Test Equipment
- System Block Diagram
- Functional Description
- Task 1: Verification System Operation
- Demo: Uploading Assembly code and running program
- Task 2: Response to Change Request
- Summary / Q&A

Overview

- The Security Monitor and Control lab is designed to provide a quick start for the student to learn Assembly language using Freescale development system.
- The onboard switches are used to simulate the arm switch and the security sensors; built-in LEDs are used to indicate system outputs.
- A template is provided that is ready to upload to the Freescale controller board.
- System functional requirements are provided. Students are tasked to verify that system is operational as described.
- In this lab a change of I/O assignment is made to help students practice reconfiguring the I/O statements using Assembly language.

Test Equipment

- 68HC12 development kit (APS12DT256SLK) includes
  - CodeWarrior Development Studio for HCS12 Microcontrollers (This version works with Window XP)
  - For Vista & Window 7, download Special Edition: CodeWarrior for S12(X) Microcontrollers V5.0 (www.freescale.com)

- The board is USB powered

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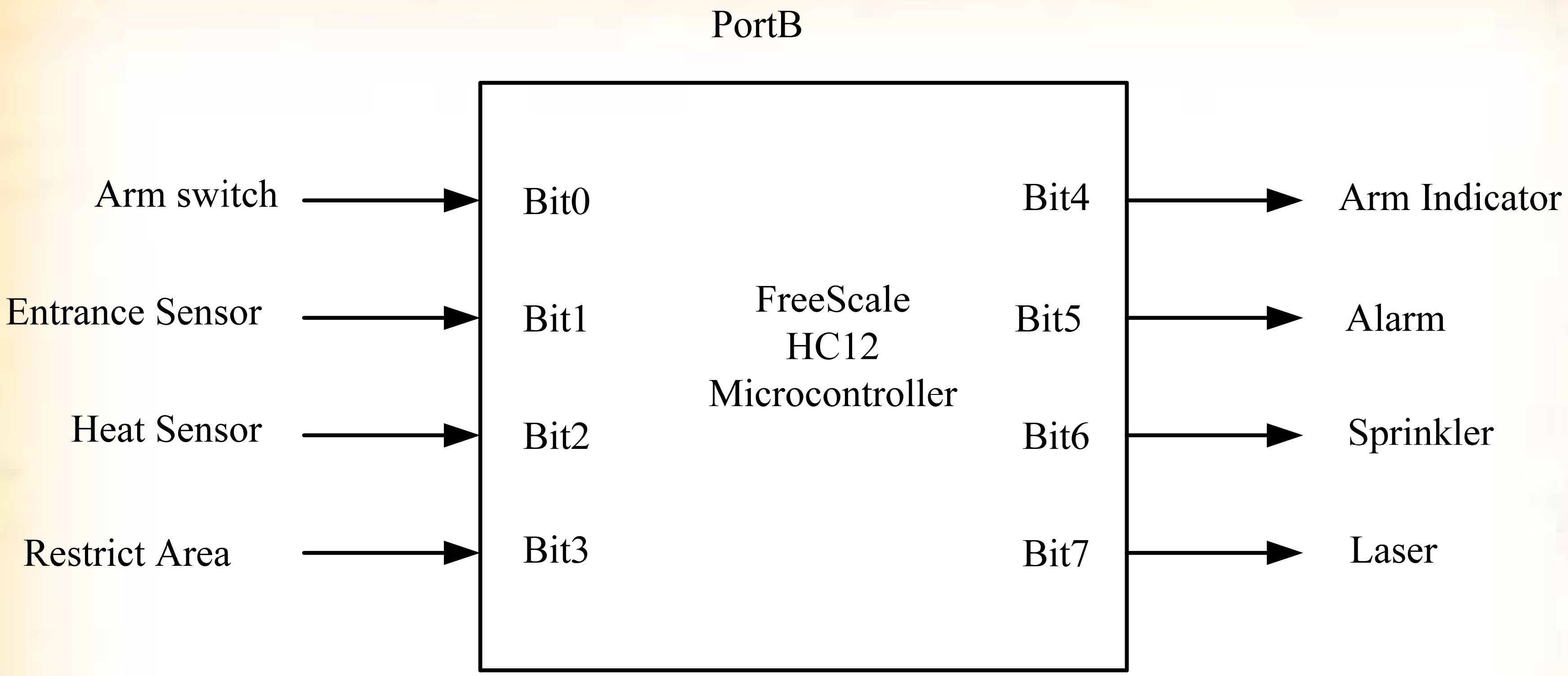
System Block Diagram



I/O Interface / Security Control System

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Functional Description

The control system provides the following functions:

- When Arm switch is OFF, disable all outputs.
- When Arm switch is ON, turn on Arm Indicator with the following actions:
    - When any of the sensors (Entrance, Heat, Restricted Area) is detected, turn on the Alarm.
    - When Heat is detected, turn on Sprinkler.
    - When Restricted Area is detected, turn on Laser.

Task 1: Verify system operation

- Verify system operation with given Assembly code

Fill in your observation of system outputs corresponds to all input combinations in the following table:

Bit 0	Bit 1	Bit 2	Bit 3		Bit 4	Bit 5	Bit 6	Bit 7
Arm switch	Entrance Sensor	Heat Sensor	Restrict Area		Arm Indicator	Alarm	Sprinkler	Laser
0	0	0	0					
0	0	0	1					
0	0	1	0					
0	0	1	1					
0	1	0	0					
0	1	0	1					
0	1	1	0					
0	1	1	1					
1	0	0	0					
1	0	0	1					
1	0	1	0					
1	0	1	1					
1	1	0	0					
1	1	0	1					
1	1	1	0					
1	1	1	1					

Does the system work as prescribed in the functional requirements?

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Demo

Uploading Assembly code
and running program

Task 2: Respond to change request

- Customer requests the following I/O assignment changes:

Inputs:	Outputs:
Bit 0: Arm switch	Bit 4: Arm Indicator
Bit 1: Restrict Area	Bit 5: Laser
Bit 2: Entrance Sensor	Bit 6: Alarm
Bit 3: Heat Sensor	Bit 7: Sprinkler

- Revise the Assembly code provided in part 1 to meet the new I/O assignments.
- Verify system operation with all input combinations.

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Questions?

Type them in your Chat Window

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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 Microprocessors
- Microprocessors Systems Lab Activities

eSyst Web Site

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

Questions?

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April 2: Electronics Communications

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Thank You to everyone for participating in today's Electronics Systems Technology Project Implementation Webinar Series
Part 4: Microprocessors Implementation

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