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Howard University
Department of Electrical and Computer Engineering

DEVELOPMENT OF A TRAINING SYSTEM FOR DEFENSE AGAINST COMMON MODE FAILURE

Progress Presentation

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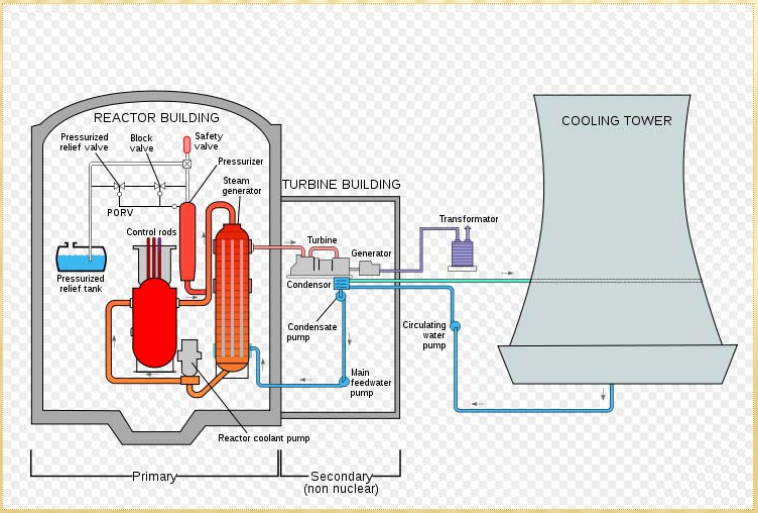
OUTLINE

- Background
- Problem Formulation
- Current State of Art
- Design Requirements
- Scenario for Kit
- Alternative Designs
  - Design A “One Kit”
  - Design B “Two Levels”
  - Design C “Simplistic”
- Design Selection
- Implementation Plan
- Milestones Achieved
- Conclusion & Future Work

BACKGROUND

- Three Mile Island melt down that took place in Dauphin County, Pennsylvania.
- The most significant accident in American history in commercial nuclear power generating industry.
- Failures in the non-nuclear system.
- Followed by a stuck-open pilot-operated relief valve (PORV)
- The situation spiral out of control because of the combination of mechanical and human errors.

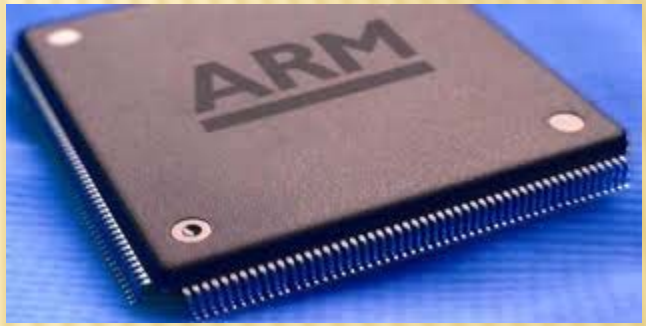


BACKGROUND

- What is Common Mode Failure?
  - Common Mode Failure is a phenomenon that occurs when events are not statistically independent. That is, one event causes multiple systems to fail. e.g. Power Spikes, Water, Magnetism, Temperature Variation, and Software Errors.

BACKGROUND

- Why Hardware Diversity?
  - Intel, AMD, ARM Cortex
  - PC, MAC



PROBLEM FORMULATION

- Problem Definition
  - To develop a kit that would assist in educating engineering students in the area of Common Mode Failure.

CURRENT STATE OF ART

- A training kit for teaching CMF is not currently on the market.
- There is no single course in any university that educate students in CMF in both hardware and software applications.
- There are many institutions that lecture on CMF in hardware using FPGAs, PICs, and PLDs.
- Also a lot of research is being done on CMF in software, and hence there exist graduate level courses that lecture on CMF in software applications.

DESIGN REQUIREMENTS

- Designed for engineering students

- Common Mode Failure Test

- High Mobility

- Safety Regulations

Toy Industry Association, Inc.

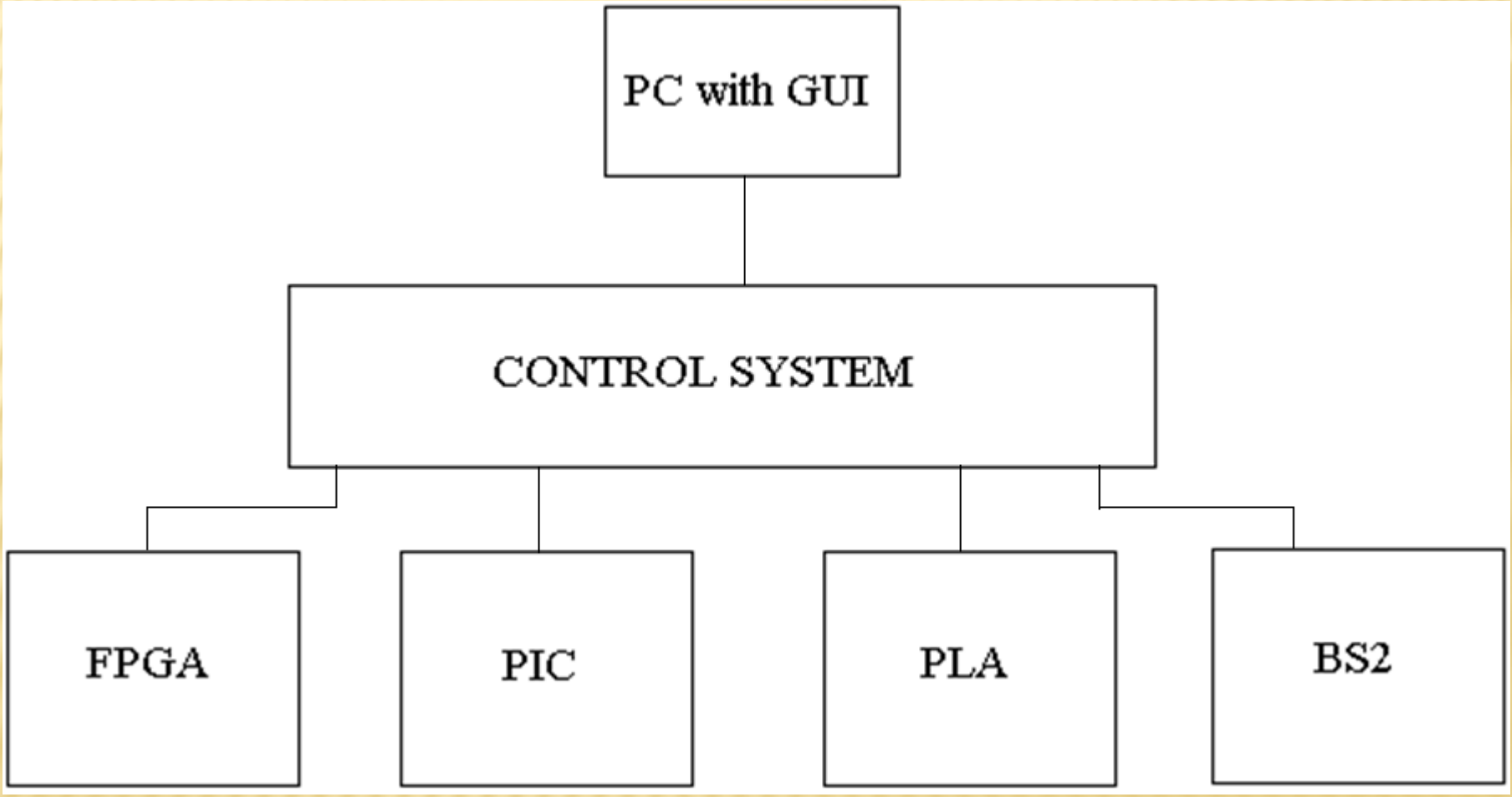
SCENARIO

- The conditions to be monitored are pressure, temperature, water level, and thermal power.
- 0 is normal 1 is abnormal
- When the LED's are 0 there is no action being taken, but when the LED's are 1 it means the power plant would be performing a certain action.
- LED1 = Inject More Coolant
- LED2 = Containment Spray System
- LED3 = Insert Control Rods into Reactor
- LED4 = Plant Shutdown

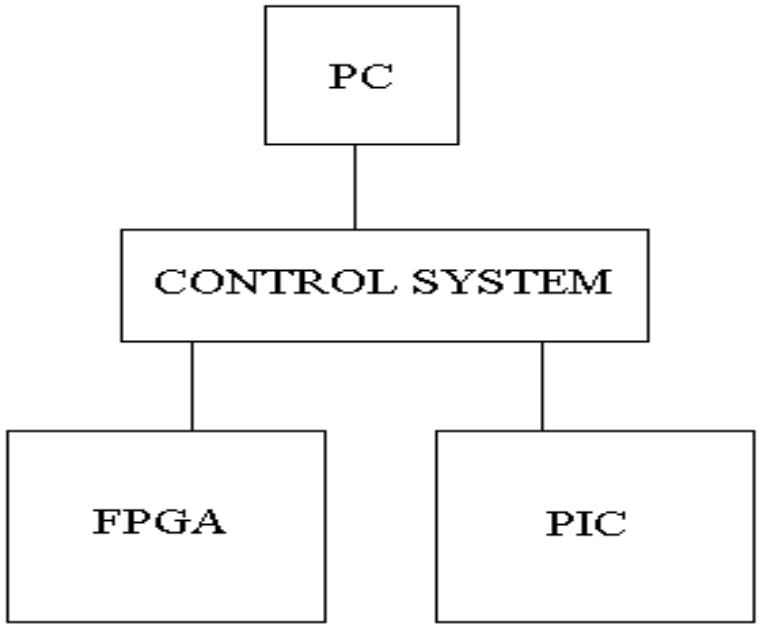
SCENARIO

Pressure	Temperature	Water Level	Power	LED1 Inject More Coolant	LED2 Containment Spray System	LED3 Insert Control Rods into Reactor	LED4 Plant Shutdown
0	0	0	0	0	0	0	0
0	0	0	1	0	0	1	0
0	0	1	0	0	0	1	0
0	0	1	1	0	0	0	1

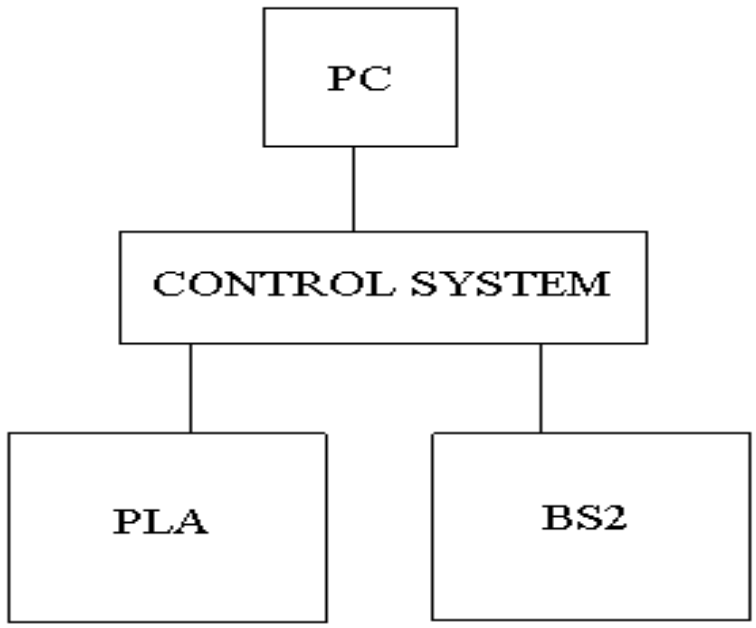
DESIGN "A" ONE KIT



DESIGN "B" TWO LEVELS

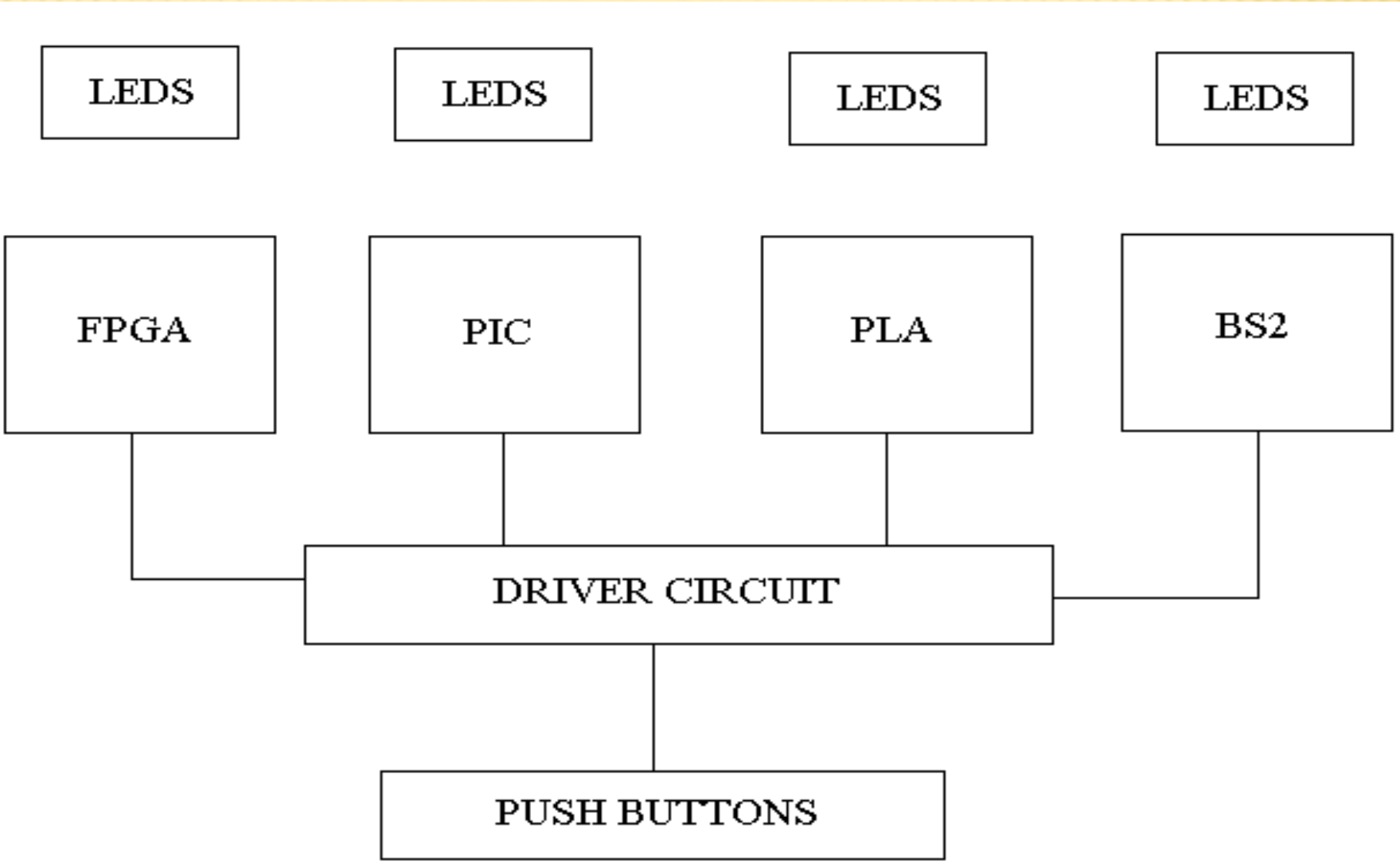


High Level Kit for Computer and Electrical Engineers



Low Level Kit for inexperienced programming students

DESIGN “C” SIMPLISTIC



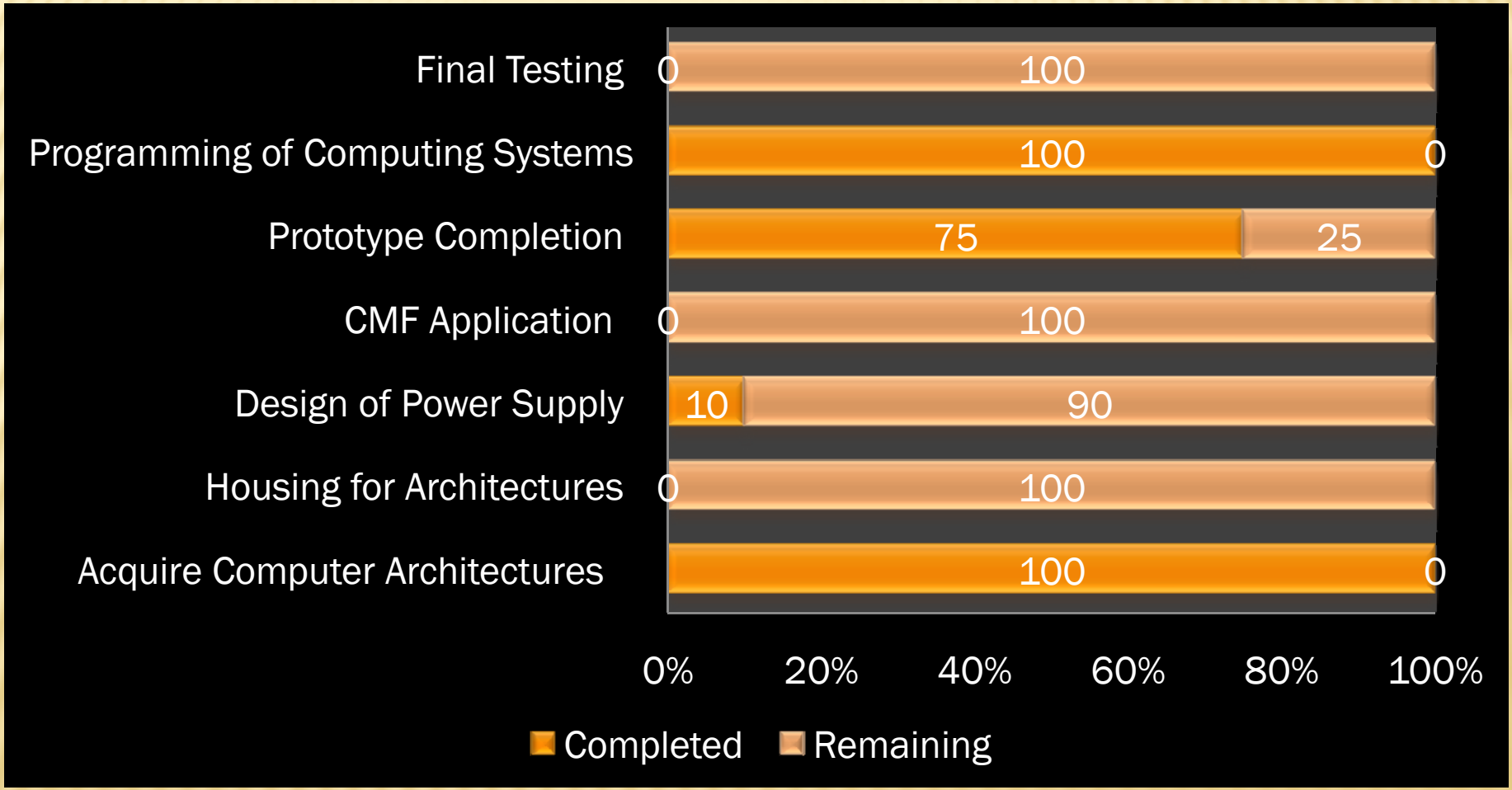
DESIGN SELECTION

Design	Mobility	Student Comfort	Teacher Comfort	Learning Curve	Price	Difficultly to Construct	Total (30)
A	5	3	5	2	1	2	18
B	4	5	4	4	3	3	23
C	2	5	1	5	3	5	21

IMPLEMENTATION PLAN

Objective	Due Date
Acquire Computer Architectures	1/19/2011
Housing for Architectures	2/2/2011
Design of Power Supply	2/2/2011
CMF Application	2/23/2011
Prototype Completion	3/9/2011
Programming of Computing Systems	3/9/2011
Final Testing	3/16/2011

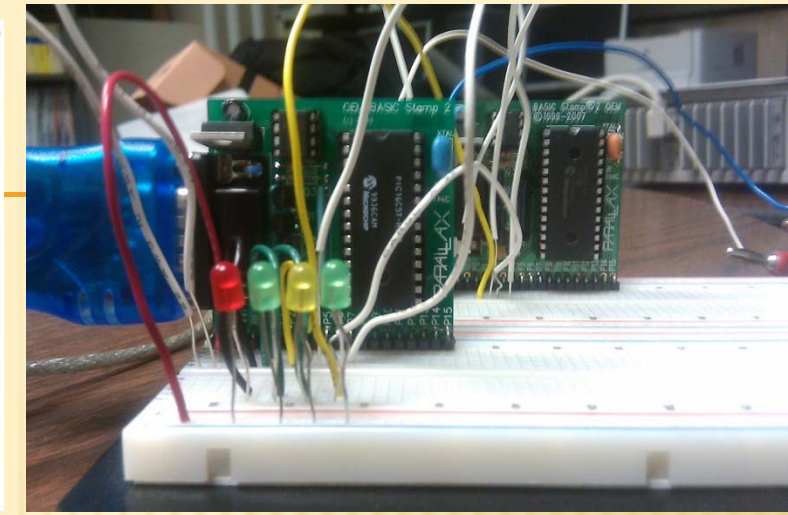
IMPLEMENTATION PLAN



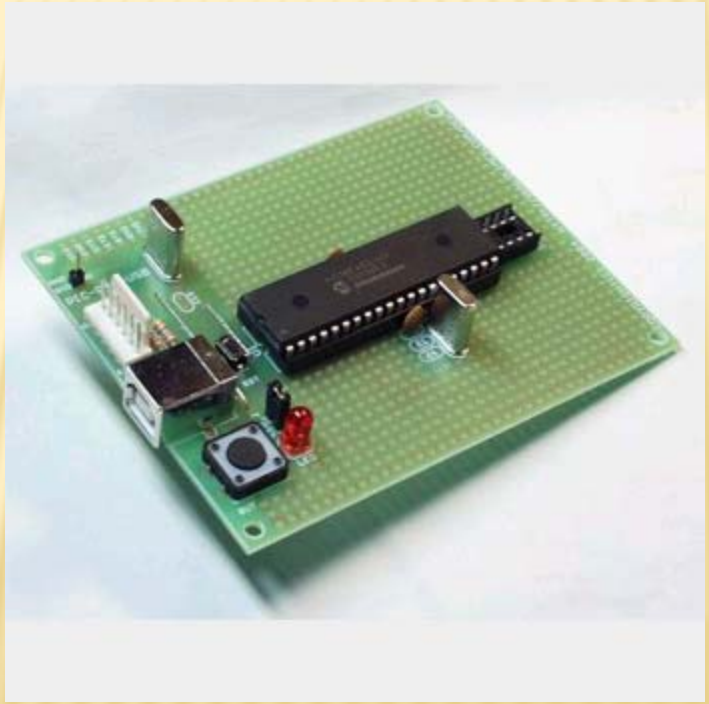
PROGRESS

- Controller
- BS2
- PLA
- PIC
- FPGA

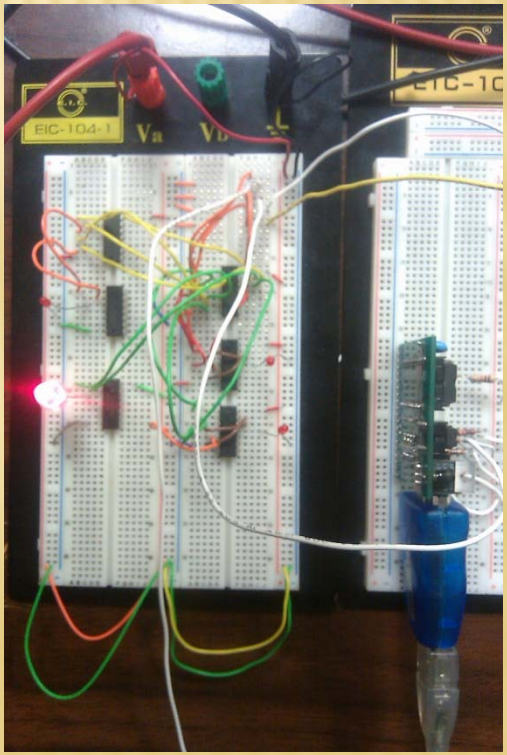
FPGA



BS2 & Controller

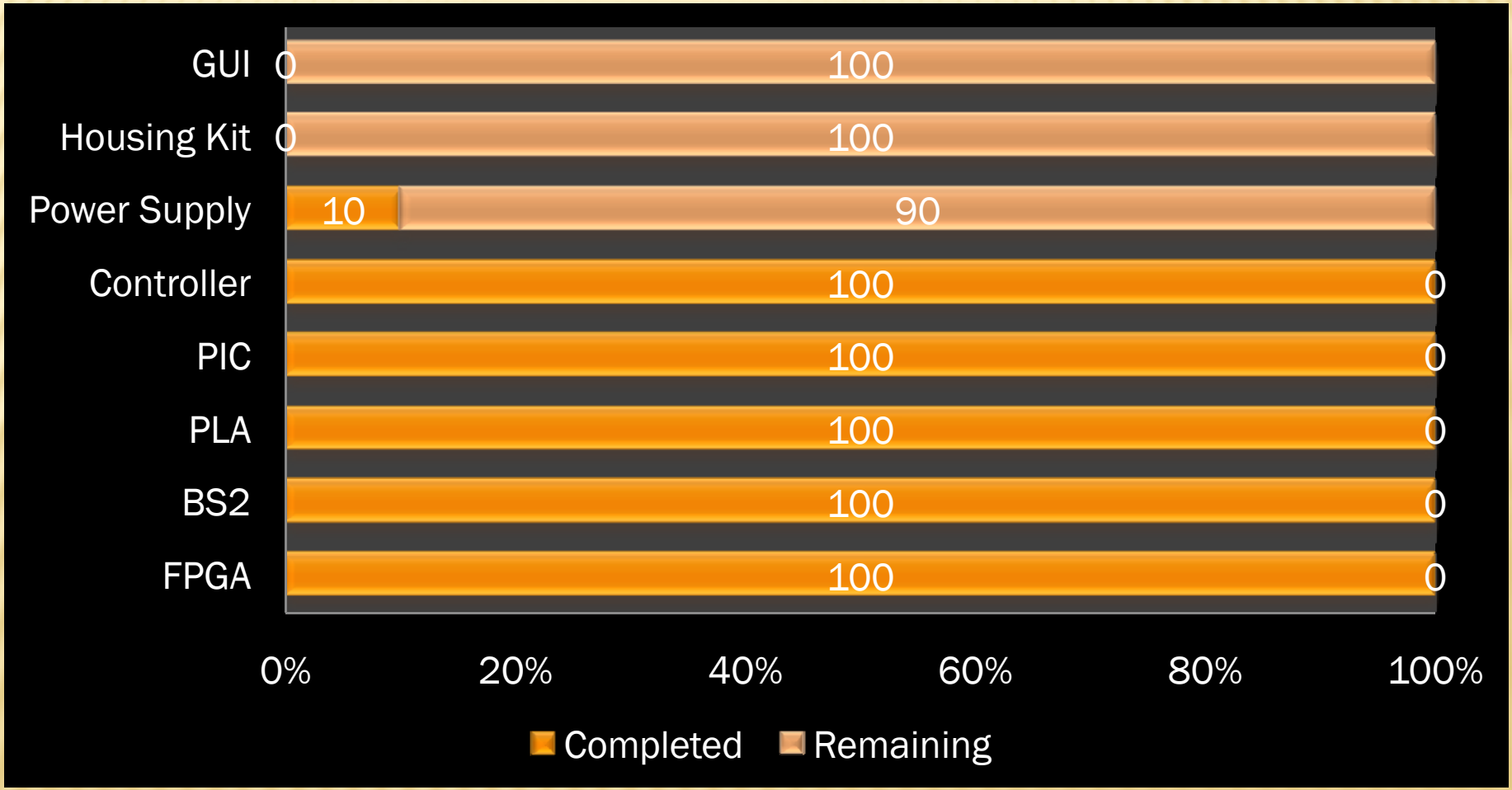


PIC Microcontroller



PLA & Controller

PROGRESS


GUI
Housing Kit
Power Supply
Controller
PIC
PLA
BS2
FPGA
0
100
0
100
10
90
100
0
100
0
100
0
100
0
0%
20%
40%
60%
80%
100%
Completed
Remaining

CONCLUSION & FUTURE WORK

- Power supply
- Housing for Computing Systems
- Test complete kit for response to input
- Develop Graphical User Interface

QUESTIONS