

# Computers and Nuclear Energy - Fall 2012

- **EECE 499-01 Sp. Topic: Computers and Nuclear Energy**
  - CRN 85152
  - 3 credit hours
  - R1510 – 1800
  - LKD 3113 or LKD ~~3220~~ = LKD 3022
- **Instructor**
  - Dr. Charles Kim and Dr. Peter Keiller
  - (202)806-4821
  - ckim@howard.edu
  - Office Hours (LKD3014)
    - M 1:00 – 3:00 pm
    - R 1:00 – 3:00 pm
    - Scheduled appointment
- **Web ---Syllabus, Notes, etc**
  - [www.mwftr.com/CNE.html](http://www.mwftr.com/CNE.html)
- The class is sponsored by the grant from Nuclear Regulatory Commission: Grant #27-10-1123

# Why Computers and Why Nuclear Energy

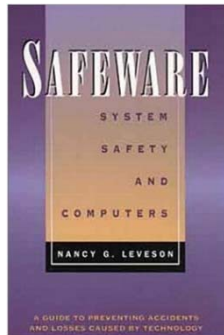
- Why Computers
  - Ubiquitous computing
  - Embedded/Mobile/Intelligent Computing
  - Computer/Digital System Control
  - Are computers reliable?
    - Computer glitches in air line industry
    - Explosion of rockets due to coding error
- Safety-Critical System
  - Safety is the highest priority
  - A failure or accident causes substantial amount of damage
  - But failures are rare
  - Computer controlled
  - Example: Nuclear power system, aircraft control system, petrochemical plant, oil exploration, nuclear weapon system, etc
  - We choose Nuclear Energy as the backdrop of the safety-critical system

# Course Objectives & Topics

- Objectives
  - Understanding of general nuclear science and engineering concepts
  - Defense-in-Depth of computer system
- Topics of the Course
  - Nuclear System Fundamentals & Nuclear Power System Safety (Parallel Guest Lectures)
  - Computer (H/W and S/W) reliability problems in mission critical systems
  - Investigation of Accidents caused by H/W or S/W
  - Defense-in-Depth of Computer Systems for System Safety
  - Hands-on experience of the failures and faults

# Course Material, expectation, and grading

- Textbook
  - None
- Related book
  - “Safeware – System Safety and Computers” by Nancy Leveson
  - published by Addison-Wesley
  - ISBN: 0-201-11972-2
  - \*NOTE: Used book is cheap
- Other Resources
  - Handouts
  - Book excerpts
  - Articles
  - Reports
- **Expectation**
  - Attendance
  - Active Participation
  - Reading Assignments
  - Writing Essay or Report
  - Everything counts
  - Professional manner
  - Courteous and respectful to guest speakers
  - Active engagement with speakers and lecturers



- Grading
  - Attendance (10%): only on-time arrival counts
  - In-Class activities (20%)
  - Assignments (65%):
    - Reading
    - Essay writing
    - Fact Reporting
    - Etc
  - Survey Participation (5%)
- Grades
  - A: 90 – 100
  - B: 80 – 89
  - C: 70 – 79
  - D: 60 – 69
  - F: 0 - 59

# Class Schedule (Parallel)

- 1. Class by HU Profs
  - Computer-caused/related accident investigation
    - H/W and/or S/W
  - Defense-in-Depth Concept
  - Hardware Diversity
  - Software Reliability
- 2. Guest Lectures by NRC speakers
  - Subjects (Tentative)
    - Reactors
    - Digital Instrumentation and Control
    - Security of NPP
    - Cyber security
    - Licensing Process
    - Fukushima
- 3. On-line Study (TBD)

## Guest Lecture Series – (Last year)

- New reactors and small modular reactors
- Digital I&C (and Method of Defense-in-Depth in reactor protection)
- Security and safeguards of NPP
- Nuclear criticality and nuclear engineering Power Uprates
- Power generation and Electrical Components
- Cyber Security
- NPP Licensing Process
- Accident Analysis of Japan's Fukushima Daiichi reactors
- NRC Op Center Tour – Field Trip

# A long history of “Computers and Nuclear Energy”

- Computers & Society, 1980 (?)

## THE ROLE OF COMPUTER SYSTEMS IN THE NUCLEAR POWER DEBATE

*Kevin W. Bowyer*

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Duke University  
Durham, N. C. 27706

### ABSTRACT

One of the primary reasons for the current "decline" of nuclear power is that reactors have not operated reliably. This unreliability has raised questions of both safety and economics. Computer systems have been a part of this failure of technology. If nuclear power is to be revived as an energy option for our country, both the quantity and quality of computer applications must increase.

### THE ROLE OF COMPUTER SYSTEMS

Computer systems play a major role in four different aspects of the provision of nuclear-generated power; 1) data base/statistical applications in forecasting, 2) real-time optimization of load distribution, 3) simulation experiments of reactor operation, and 4) real-time process monitoring and control. The role of computer systems in 1) and 2) is essentially the same for all forms of centralized power provision (fossil fuel, nuclear, solar, wind, etc). In areas 3) and 4) however, computer applications are especially crucial to the reliable operation of nuclear-powered plants. Thus it should be clear that the quality of the use made of computer systems in these two areas is fundamental to the future acceptability of nuclear power.

- **Role of Computers in Nuclear Energy**
  - Simulation Experiments of Reactor Operation
  - Real-time process monitoring and control

# Computers in Nuclear Energy

In March of 1979, the NRC ordered the closing of five reactors due to an error found in a computer program used in their design. The error occurred in a subroutine used by Stone and Webster Engineering to compute stress figures for pipe supports in auxiliary cooling systems. The subroutine used straight algebraic summation, rather than summation of absolute values or square root of sum of squares, to calculate total stress. This error in algorithm implementation resulted in the design of fittings "one third to one sixth the strength required by regulations" [13].

- **Operator and Control Room Design**

A 1975 symposium indicates that the technology does currently exist to implement greatly improved "advanced control rooms" [16]. No future reactor should be licensed without extensive examination of how the proposed control room design will function under accident conditions. All existing control rooms should be upgraded at least to the point that all problems identified by the TMI accident are cured.

SONGS in 2012 (San Onofre Nuclear Generation Station) – Steam Pipe issues





# Fault in Nuclear Software

## Hitachi Finds Nuclear Software Fault; Undetected for 28 Years

*By Shigeru Sato - April 10, 2008 22:57 EDT*

April 11 (Bloomberg) -- [Hitachi Ltd.](#), Japan's third-largest builder of nuclear reactors, discovered a programming error in software used for almost three decades to measure the impact of earthquakes on pipes at atomic power stations.

The mistake, made by a Hitachi programmer, allows the software to underestimate the quake impact on steel pipes associated with eight nuclear reactors owned by six utilities, including [Tokyo Electric Power Co.](#), Hitachi spokesman [Keisaku Shibatani](#) said by telephone.

Confidence in the safety of Japan's nuclear power plants has been shaken after a 6.8-magnitude earthquake caused a fire and radiation leaks at a Tokyo Electric facility in Niigata prefecture last July. Twelve power producers, responding to a government request, revealed in March 2007 more than 300 cases of improper safety practices. Hitachi reported the software problem to the utilities this week, Shibatani said.

"It was a human error," he said. "We're closely looking into this now."

# Fukushima 1 Year Earlier

## Computer problems hit three nuclear plants in Japan

January 03, 2000

by Martyn Williams

Tokyo IDG Only a handful of computer problems have been reported in Japan in the new year to date; however, at least three hit systems associated with nuclear power plants, according to the government and power generating companies.

The potentially most serious problem occurred not at midnight but at 858 a.m. local time on Jan. 1 at the Fukushima Number 2 nuclear power plant of Tokyo Electric Power Co. TEPCO. The system that shows the position of the control rods in the reactor core failed, leaving operators unable to gauge the rods positions using the system.

TEPCO officials said a plant processing computer enabled operators verify the position of the rods until the problem was located. Engineers confirmed the power supply and central processor associated with the system were fine and, at 1115 a.m., found the problem to be in a clock used in the board that controls the display screen. The clock was set to Feb. 6, 2036. After being reset to Jan. 1, 2000, the system returned to normal operation at 212 p.m., TEPCO officials said.

The cause of the failure is still under investigation.

# Recalls



## Volvo Cars Recalled Following Software Bug Discovery

16 | JUL 2012

Volvo Cars of North America, LLC, is reportedly recalling Volvo S80 vehicles with model years from 2011 to 2013. The cause of the recall is a software bug in the vehicle's computer causing the transmission to fail downshifting, which could lead to a fatal accident. Owners of said car will be notified or may call 1-800-458-1552. The computer repairs will be shouldered by the company.

## Honda recalling 2.26M vehicles world-wide over automatic transmission failure

Posted by Vincent Van On August - 5 - 2011



In the automotive software industry, for example, software failure has led to expensive and embarrassing recalls. In May, 2008, auto manufacturer Chrysler recalled 24,461 Jeep Commanders, after it was found that embedded software could cause the engine to stall in some operating conditions.

## Toyota Cites Brake Software Problems in New Prius Recall

On Monday night, Toyota recalled its flagship high tech hybrid, the Prius, due to a brake software problem. The year that the company already wants to forget after [unintended acceleration woes](#) just got worse. Here are the details.

## Quarter Of Medical Device Recalls Linked to Software Failures

by Ryan L. Thompson on 07/11/2012

# Recall Details - Example

## Exemplary Vehicle Software Recalls

NHTSA Identifi- cation Number:	Date of Company Notifica- tion	Make	Model	Model Year	Number of Vehicles
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<a href="#">03V-124</a>	3-14-03	BMW	325I, 325CI	2003	1,056
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### **Brief Description of Defect**

Mfg. Campaign No. N/A - ECM. DOM-8/13/02-10/10/02. Increase of engine idle speed occurs with engine running and vehicle at rest. Correct by reprogramming the digital engine management control unit.

### **Brief Description of Defect**

Mfg. Campaign No. P8201 - Airbag. DOM: N/A. Due to incorrect software programming, airbag control unit may cause passenger airbag not to operate as designed if vehicle battery becomes significantly discharged. This could result in airbag not inflating in crash and increased risk of injury. Correct by reprogramming airbag control unit.

<a href="#">08V-303</a>	07-07-08	Mercedes	C-Class	2005-08	404
			CL-Class	2004, 2008	
			CLK Class	2003-04, 2006-08	
			CLS	2008	
			E-Class	2003-08	
			G Class	2003	
			M-Class, R-Class	2006-08	
			S-Class	2004, 2007-08	

## Accident and Complication of the Cause Determination: Example – “Friendly Fire”

- April 14, 1994
- Iraq
- No Fly Zone
- AWACS (Airborne Warning and Control System)
- F-15 fighters
- UH-60 Helicopters (“Black Hawk”)
- 26 Peacekeepers killed
- Many approaches to understand the incident
  - Social and organizational approach
  - My view: component intermittency of IFF (Identification Friend or Foe)

# Homework 1

- Investigation of a **computer** related **accident** in:
  - Nuclear Power
  - Nuclear Medicine
  - Aircraft and Aerospace
  - Petrochemical process
  - Mass-Transit System
  - Military and Defense
  - Automobile
- Individual Work
- Written report in Slide (softcopy only in PPT or PPTX format)
  - Slide 1: Title and Your Name & the root cause component (H/W, S/W. or both)
  - Slide 2: What happened
  - Slide 3: How happened
  - Slide 4: Why happened
  - Slide 5: How could have been prevented
  - **Slide 6: one paragraph summary of the slides 1 – 5**
    - **Remember that a pair of scissor and 1 inch cut (See next slide)**
  - Due: W SEP 12, 2012 (2000 hour)

# News Staff Writer Style? Compare 2

By Andrew Quinn

BEIJING | Wed Sep 5, 2012 7:45am EDT

(Reuters) - [China](#) and the United States were divided on Wednesday over how to end the bloodshed in Syria and defuse tension in the South China Sea and other global troublespots, but stressed hope for steady ties as they navigate political transitions at home.

U.S. Secretary of State Hillary Clinton and Chinese Foreign Minister Yang Jiechi vowed goodwill after talks which had been preceded by criticism from Beijing of Clinton's calls for a multilateral solution to the territorial disputes in the South and East China Seas.

Clinton told reporters that such disagreements did not have to hobble cooperation.

"I'm very proud of the strength and resilience that we have built into our relationship," she said after talks with Yang in the cavernous Great Hall of the People in Beijing.

"It makes it possible for us to talk about anything, and to find ways to tackle issues frankly and forthrightly," Clinton said, adding that the two sides would not see eye-to-eye on all the issues that are part of their vast relationship.

Yang also cast relations in a positive light, saying both sides could work together as long as "mutual respect for each other's core interests and major concerns" continues.

The Philadelphia Eagles don't start their season [until Sept. 9](#) against the [Cleveland Browns](#). Yet Eagles fans like myself know full well that the season really begins on Sept. 5. And unlike most of the other 29 teams still waiting around to kick off, there is extra reason for Philadelphia to pay attention to the year's very first game.

To reach their big goals, the Eagles will probably need to win the NFC East - and to do that, they must dethrone the defending division and Super Bowl champion New York Giants. But Philadelphia also has to hope that the [Dallas Cowboys](#) can't overtake New York first. As such, it will be required viewing in Philadelphia to see Dallas and New York meet [on opening night](#) on Sept. 5.

The best hope for the Eagles is that neither of them look good, which could be plausible. Expectations have gone down for the Cowboys recently, with Jason Witten doubtful to play and Miles Austin and Dez Bryant also banged up. Given the two gut wrenching losses the Cowboys suffered to the Giants late last year - which changed the entire direction of the season - Dallas has to hope that New York doesn't have its number.

Yet expectations are also middling for the Giants, despite their championship. Given that they merely caught fire late last season - just like in 2007 - that the Green Bay Packers, San Francisco 49ers and Eagles are still in the NFC, and that New York is not an