

W4995-02 Languages for Embedded System Design

Fall 2001
Prof. Stephen A. Edwards

Copyright © 2001 Stephen A. Edwards All rights reserved

Embedded System Challenges

- Differs from general-purpose computing

- Real-time constraints
- Power constraints
- Exotic hardware
- Concurrency
- Control systems
- Signal processing
- User interface
- Physics



SR-71

Copyright © 2001 Stephen A. Edwards All rights reserved

Syllabus

- Software languages

- Assembly
- C
- C++
- Java



Jeff Koons,
Puppy

- Real-time operating systems

- Concurrency
- Meeting deadlines



Alaskan
Pipeline

- Dataflow languages

- Signal processing

Copyright © 2001 Stephen A. Edwards All rights reserved

Overview

- What are embedded systems?
 - Computers masquerading as non-computers



Casio Camera
Watch



Nokia 7110
Browser
Phone



Sony
Playstation 2



Philips DVD player



Philips TiVo Recorder

Copyright © 2001 Stephen A. Edwards All rights reserved

The Role of Languages

- Language shapes how you solve a problem.
- Java, C, C++ and their ilk designed for general-purpose systems programming.
- Do not address timing, concurrency.
- Domain-specific languages much more concise.
- Problem must fit the language.



M. C. Escher, Tower of
Babel

Copyright © 2001 Stephen A. Edwards All rights reserved

Syllabus

- Synchronous Languages

- Global clock



Big Ben

- Hardware languages

- Discrete-event modeling



Pompidou Center

- SystemC

- Modeling hardware in C

Copyright © 2001 Stephen A. Edwards All rights reserved

Goal of the Class

- **Breadth**
 - Knowledge of many different languages
 - Languages embody design methodologies
 - Broader knowledge, bigger “bag of tricks”
- **Depth**
 - Big design project
 - Gives you in-depth experience with one of the languages



Empire State Building

Copyright © 2001 Stephen A. Edwards All rights reserved

How to Listen to a Lecture

- Ask questions
 - Trick: Presenters do a better job when they think someone is listening
 - I'm from Berkeley
- Every VW bus there sports this bumper sticker:



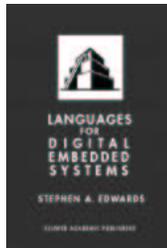
“And should there be a sudden loss of consciousness during this meeting, oxygen masks will drop from the ceiling.”

QUESTION AUTHORITY

Copyright © 2001 Stephen A. Edwards All rights reserved

Required Text

- Languages for Digital Embedded Systems
- Available at Papyrus, 114th and Broadway
- Textbooks are downstairs
- Bookstore may run out: more can be ordered



Copyright © 2001 Stephen A. Edwards All rights reserved

Class Website

www.cs.columbia.edu/~sedwards/classes/2001/w4995-02

- Contains
 - Lecture slides
 - More project ideas
 - Pointers elsewhere
 - PDF/PS files
 - Detailed syllabus



Shortcut from www.cs.columbia.edu/~sedwards/

Copyright © 2001 Stephen A. Edwards All rights reserved

Class Structure

- Four homework assignments
 - Collaboration permitted, but work must be your own
- Two exams
 - One covering first half of class
 - One covering second half
- One big project
 - Project proposal due in two weeks
 - Literature review
 - Presentation of literature review
 - Presentation of final project
 - Final write-up



Copyright © 2001 Stephen A. Edwards All rights reserved

The Project

- Goal is to produce a workshop-caliber paper
 - You don't have to submit it
 - But aim for that level
- Final writeup will consist of
 - Introduction
 - Literature survey
 - Technical details
 - Experimental results
 - Conclusions
- Literature survey due at midterm time



Frank O. Gehry, Disney Concert Hall, Los Angeles (proposed)

Copyright © 2001 Stephen A. Edwards All rights reserved

Project Ideas

- **“Use the languages”**
 - Compare the simulation performance of Verilog and System C
 - Compare the performance of an RTOS and Linux
 - Model a wristwatch in different languages
- **“Analyze or implement the languages”**
 - Verilog Hierarchy browser
 - Implement Kahn Process Networks
 - A Java-to-C translator
 - Compiled event-driven simulator for Esterel
- **More ideas on the class web site**



Pantheon, Interior

Copyright © 2001 Stephen A. Edwards All rights reserved

Project Proposal

- **One-paragraph description of what you plan to do**
- **Due soon: September 26**
- **Use the web site for more ideas**
- **“Related Classes” lists classes at other institutions with additional project ideas**
- **Visit during office hours to discuss ideas**



Copyright © 2001 Stephen A. Edwards All rights reserved

Collaboration

- **You may collaborate on homework, but whatever you turn in must be your own**
- **Project teams should be two or three people**



Frank O. Gehry,
Chiat/Day Headquarters

Copyright © 2001 Stephen A. Edwards All rights reserved

Late Policy

- **No credit for late assignments unless you've made prior arrangements with me**
- **Homework is due at the beginning of class**

Copyright © 2001 Stephen A. Edwards All rights reserved

One-minute Feedback

- **Spend a minute at the end of each class writing a sentence or two.**
- **Examples of desired feedback:**
 - “I really didn’t understand nondeterminism.”
 - “You spent too much time talking about structural Verilog.”
 - “I found the part about Ritchie’s hatred of Pascal really interesting.”
- **Won’t be graded, but sign your name.**



Mies van der Rohe,
Farnsworth House

Copyright © 2001 Stephen A. Edwards All rights reserved