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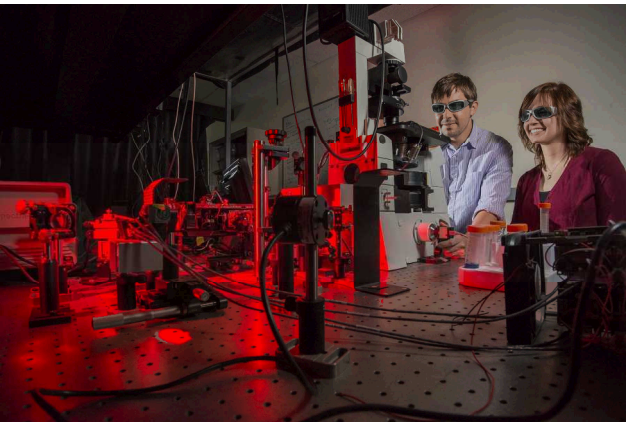

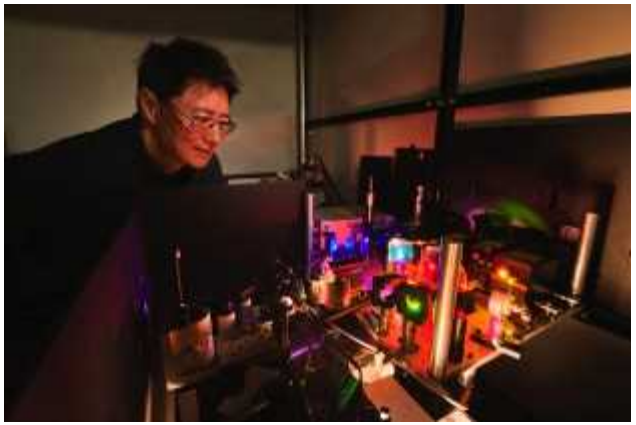

Dynamic Radiography Acquisition Software System for Computed Tomography Applications

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U.S. DEPARTMENT OF ENERGY

National Nuclear Security Administration

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Outline

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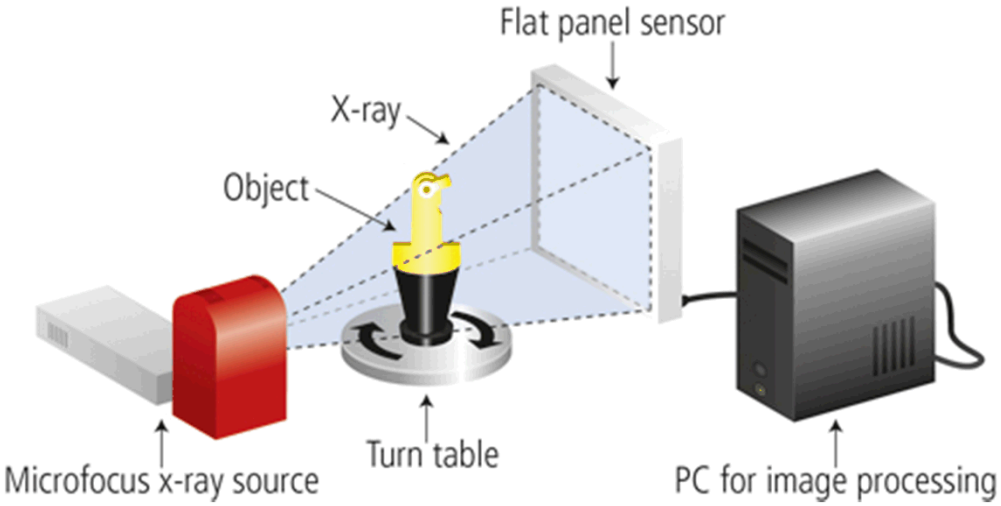
- Introduction
  - X-Ray Imaging Systems
  - Motor Controllers
- Motivation
- Approach
  - Software Development Methodology
  - GUI Design
- Implementation
- Results
- Conclusions

Introduction

- X-ray imaging systems
  - X-ray source
  - X-ray detector
  - Object of interest
  - Multi-axis stage



- Motor Control controls motion of stage
  - Often controlled by computer software

http://www.hamamatsu.com/sp/hpe/community/xndt/images/Industrial/CT/principle.jpg

Motivation

- Motor controllers have multiple manufacturers
  - Each motor controller has unique API
  - Current software has no communication between manufacturer APIs
- Limited control for multiple forms of hardware
  - No way to communicate between multiple hardware species
- Lack of Customization
  - Current software has limited flexibility in CT system configuration
- High cost
  - >$20k in cost per license
- For this work we will focus on:
  - Galil Motor Controller
  - Compumotor Motor Controller

Approach

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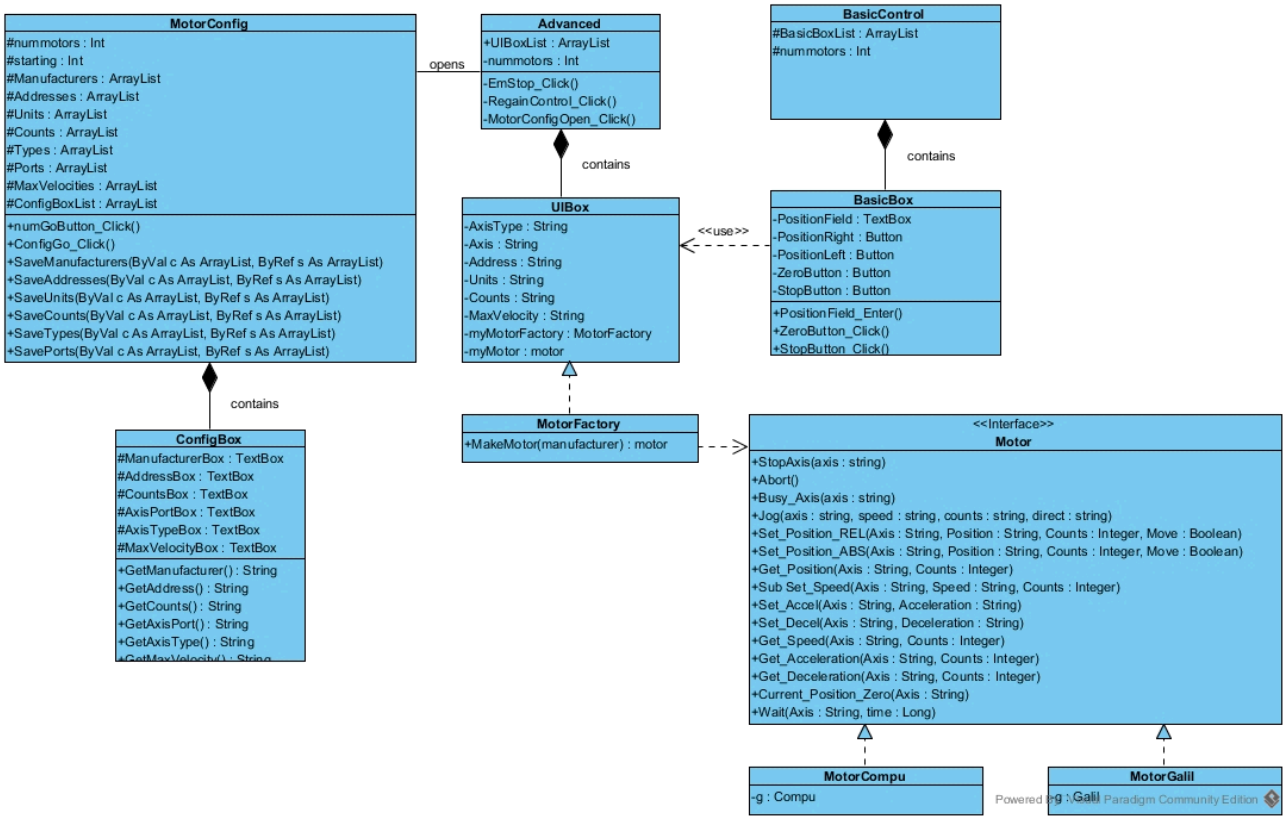
- Develop software capable of communicating with multiple hardware species
- Create software library that can interface and generalize each individual API relevant to CT/Radiography (i.e linear move, rotary move, set velocity, set acceleration, set amperage, set energy, take image, etc.)
- Develop software structure that can dynamically adjust GUI to accommodate various CT systems
- Results
  - Only small code modifications required to integrate new hardware systems/manufacturers
  - Common GUI across all CT/Radiography systems for ease of use

Software Development Methodology

- Developed in Visual Basic .NET
- Object-oriented Factory Design Pattern
  - Allows for dynamic assignment of software controls to hardware interface
  - API-blind
- Dynamic GUI
  - Resizes window based on type and quantity of hardware connected
  - Customizable per user input

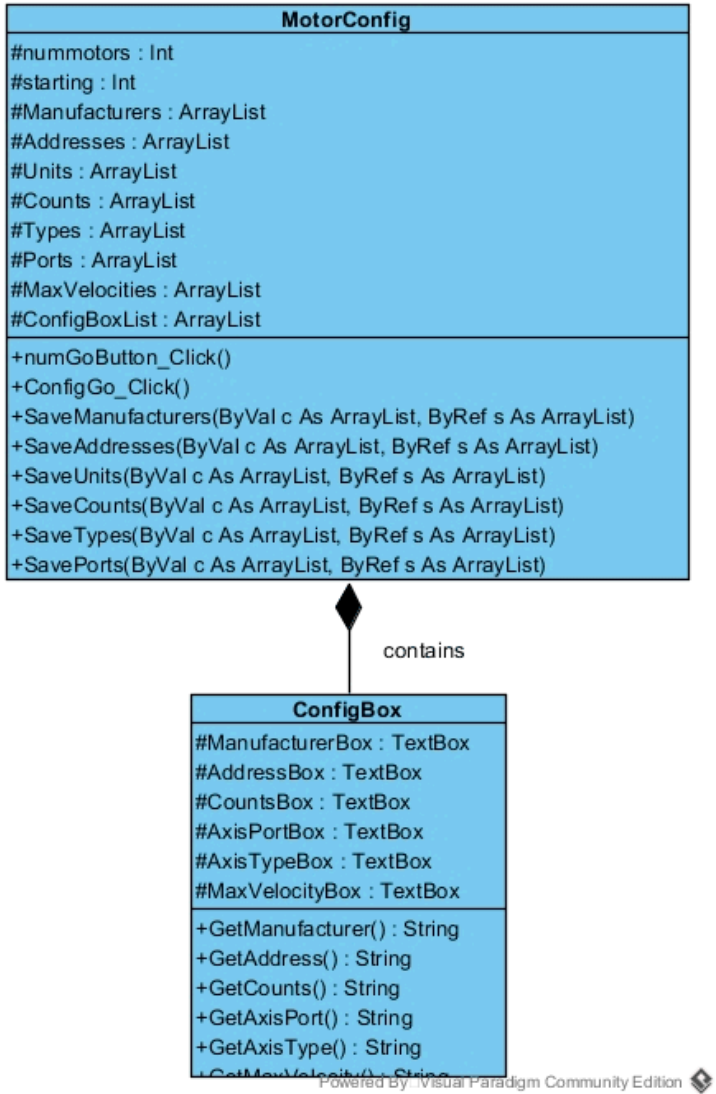
Implementation

- Overall structure of software
- Modeled off Factory Design Pattern structure



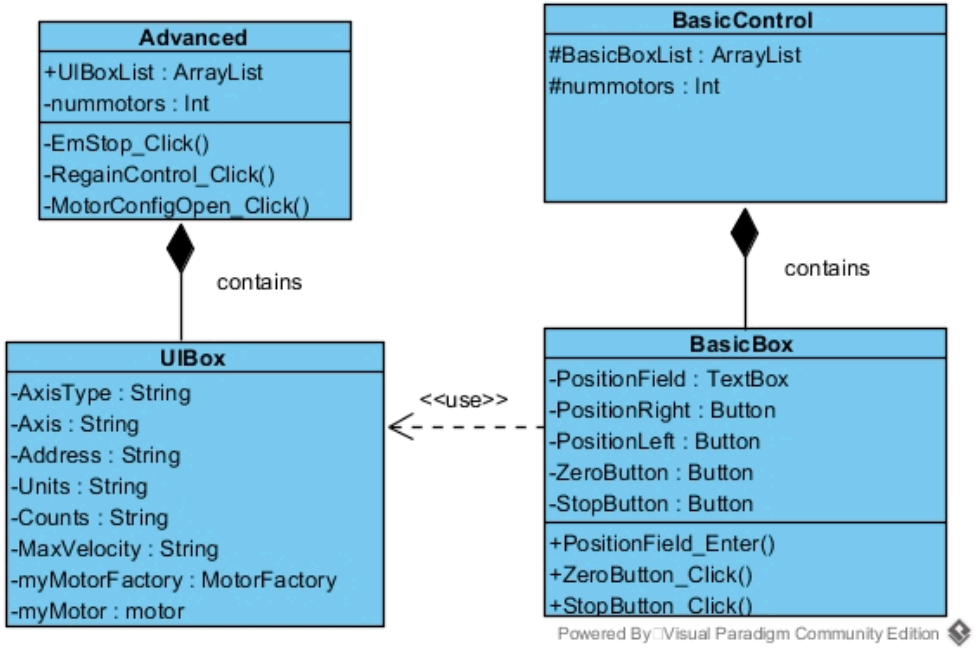
Implementation (ctd.)

- Configuration classes
  - MotorConfig consists of *n* ConfigBox objects
  - Instantiated at run-time based on user input



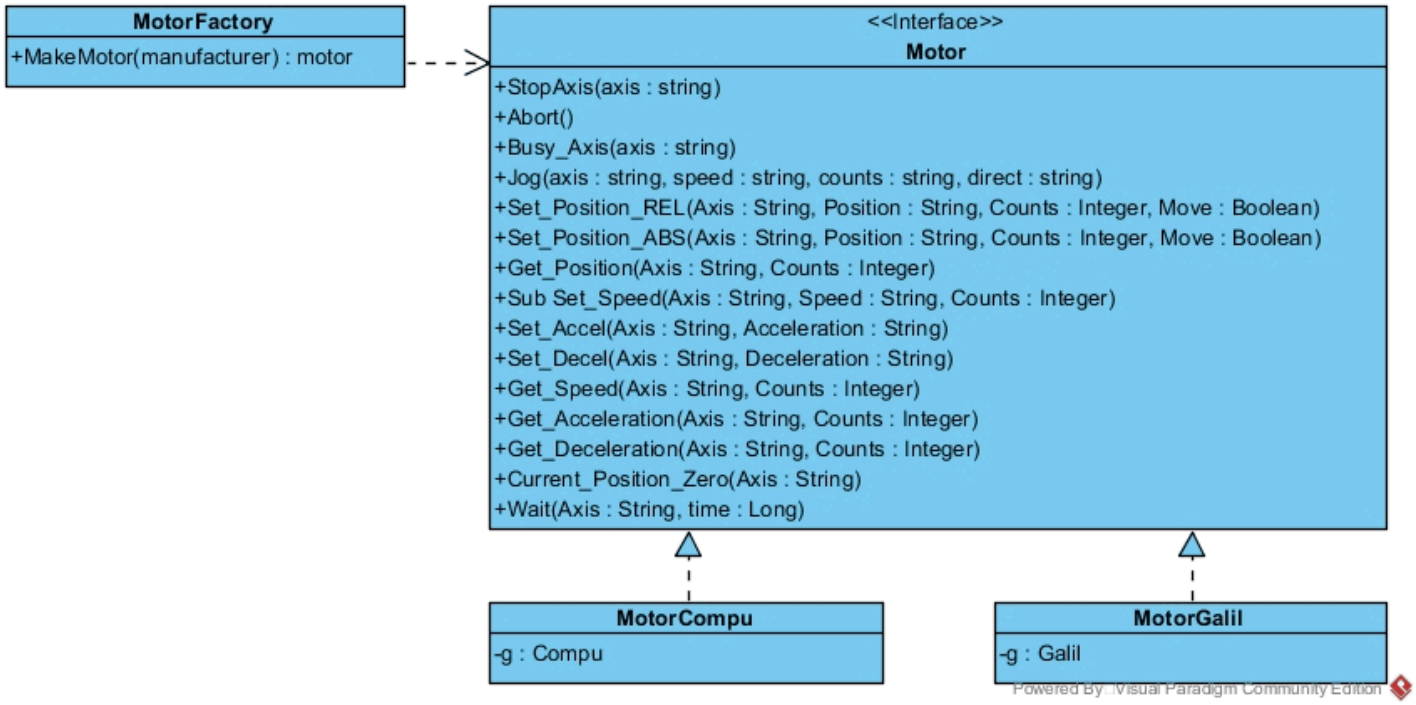
Implementation (ctd.)

- UI Control classes
  - MotorConfig consists of *n* ConfigBox objects
  - Instantiated at run-time based on user input
- UIBox communicates with individual Motor object

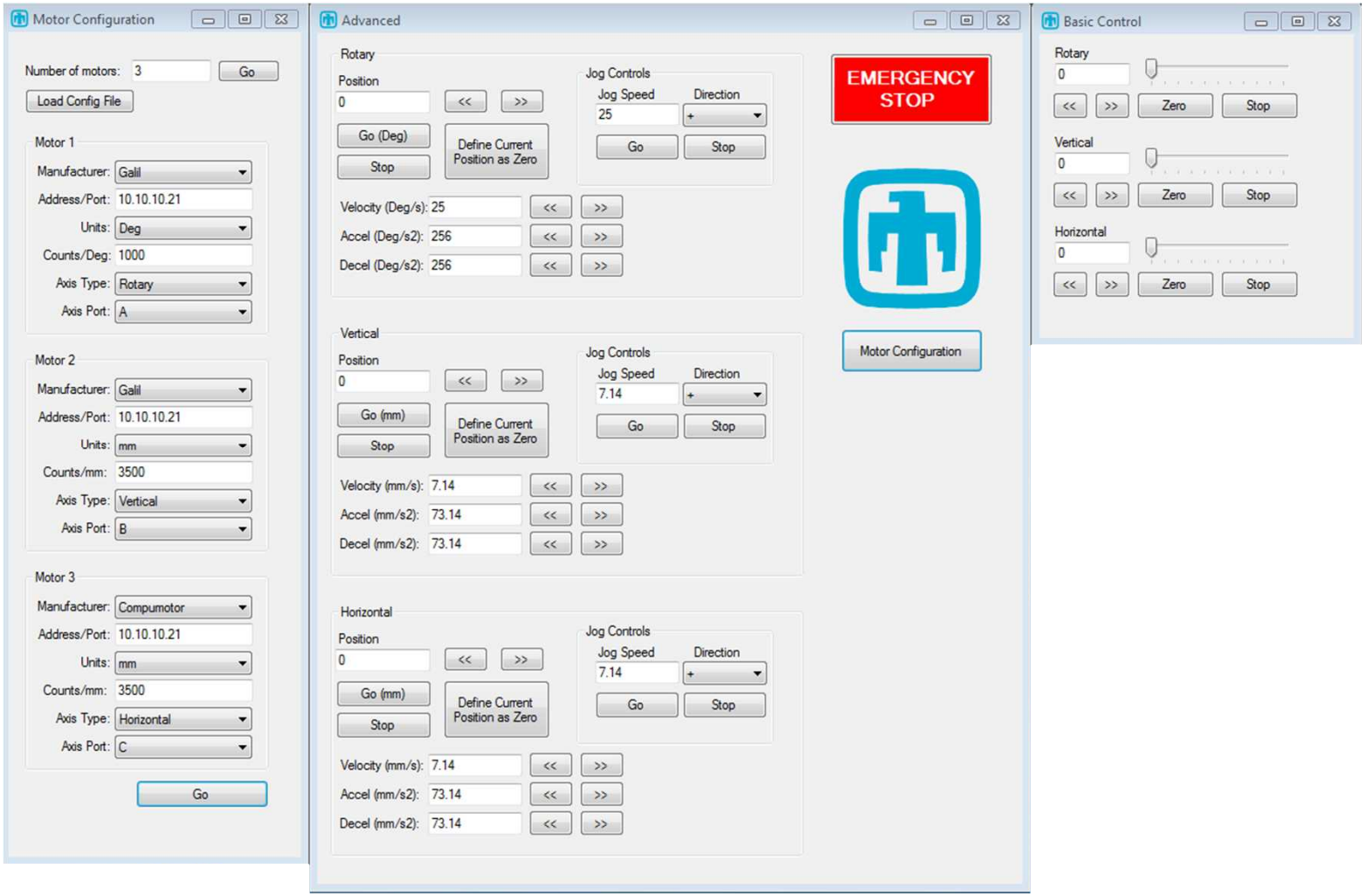


Implementation (ctd.)

- Motor Control classes
  - Each motor generated by unique MotorFactory
  - Motor commands derived from individual manufacturer subclasses
  - Each motor manufacturer class implements specific manufacturer API



Results


Motor Configuration
Number of motors: 3
Go
Load Config File
Motor 1
Manufacturer: Galil
Address/Port: 10.10.10.21
Units: Deg
Counts/Deg: 1000
Axis Type: Rotary
Axis Port: A
Motor 2
Manufacturer: Galil
Address/Port: 10.10.10.21
Units: mm
Counts/mm: 3500
Axis Type: Vertical
Axis Port: B
Motor 3
Manufacturer: Compumotor
Address/Port: 10.10.10.21
Units: mm
Counts/mm: 3500
Axis Type: Horizontal
Axis Port: C
Go
Advanced
Rotary
Position
0
<<
>>
Go (Deg)
Stop
Define Current Position as Zero
Jog Controls
Jog Speed
25
Direction
+
Go
Stop
Velocity (Deg/s): 25
Accel (Deg/s2): 256
Decel (Deg/s2): 256
Vertical
Position
0
Go (mm)
Stop
Define Current Position as Zero
Jog Speed
7.14
Velocity (mm/s): 7.14
Accel (mm/s2): 73.14
Decel (mm/s2): 73.14
Horizontal
Position
0
Go (mm)
Stop
Define Current Position as Zero
Jog Speed
7.14
Velocity (mm/s): 7.14
Accel (mm/s2): 73.14
Decel (mm/s2): 73.14
EMERGENCY STOP
Motor Configuration
Basic Control
Rotary
0
Zero
Stop
Vertical
0
Zero
Stop
Horizontal
0
Zero
Stop

Conclusion

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- One unified software for multiple applications
- Common GUI results in ease of use
  - No more need to learn multiple software systems
- Increased cost efficiency
  - Fewer software licenses (savings of $20k+ per user)
  - Reduction in required training costs for new systems
- Freedom for new unique CT system configurations

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- 2. Ortega G.A., “Desarollo de software de librerias y aplicaciones para el control de sistemas micro-CT,” M.S. thesis, Dep. Bioengineering and Aerospace Eng., Universida Carlos III Madrid, Madrid, Spain, 2013.
- 3. Gamma, E., Richard Helm, Ralph Johnson, John Vlissides, Design Patterns: Elements of Reusable Object-Oriented Software, first edition. Addison-Wesley Professional, Reading, MA, 1994.

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Questions?