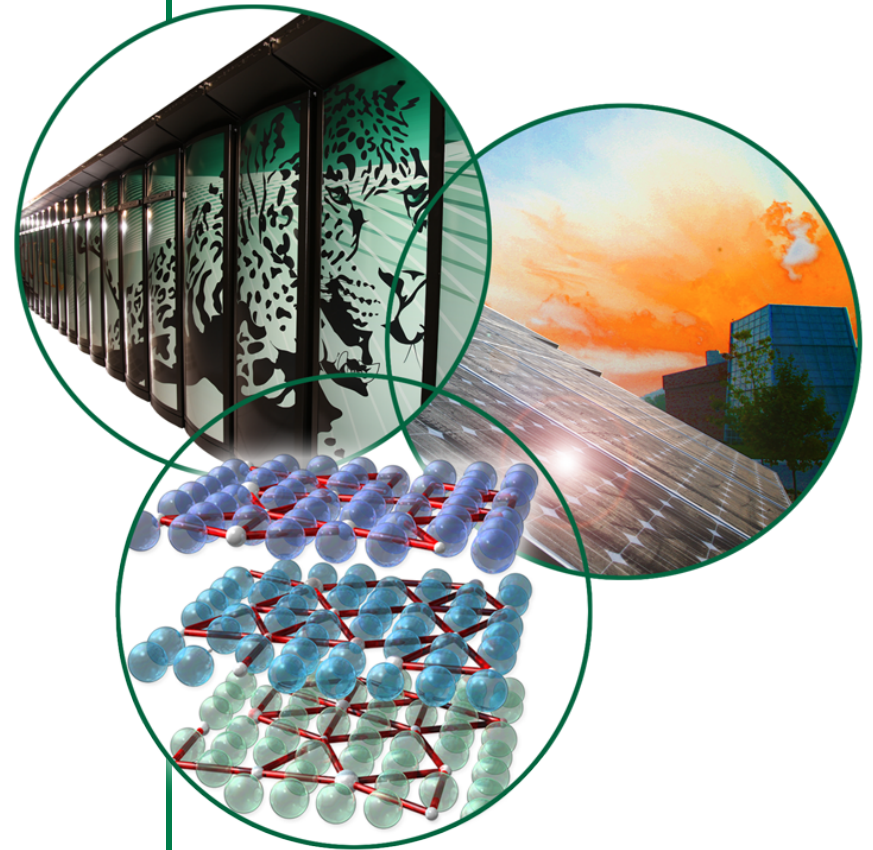


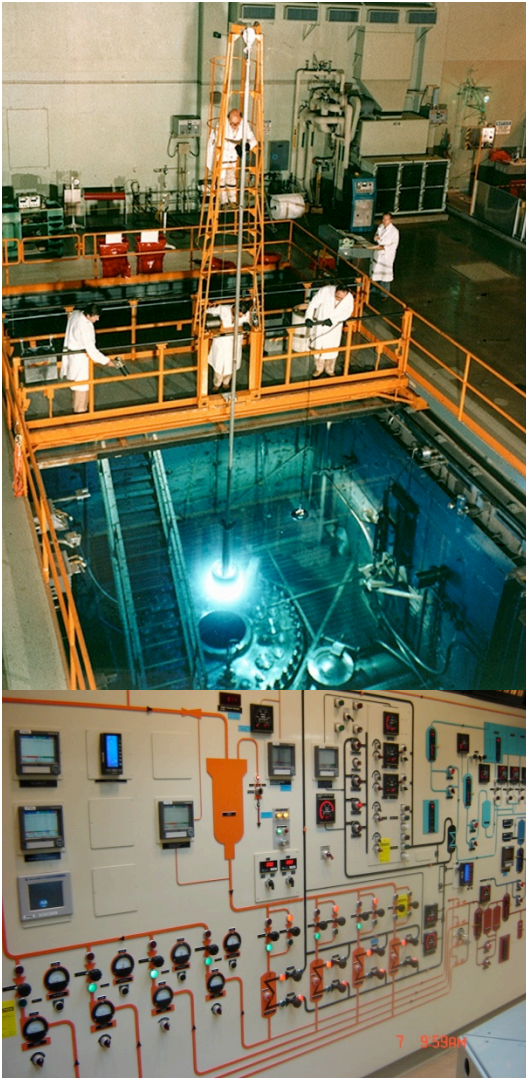
RRD Software Engineering

Digital Systems at the HFIR

September 20, 2010

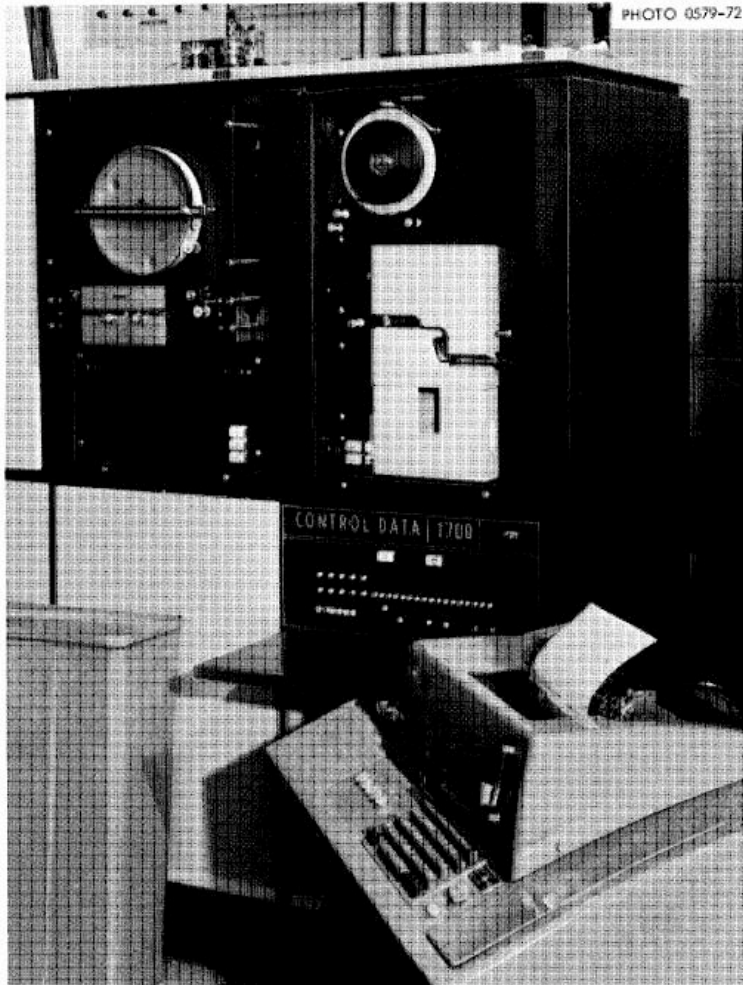


High Flux Isotope Reactor



One of the first reactors in U.S. to demonstrate direct rod control at power, with a computer.

HFIR On-Line Computer



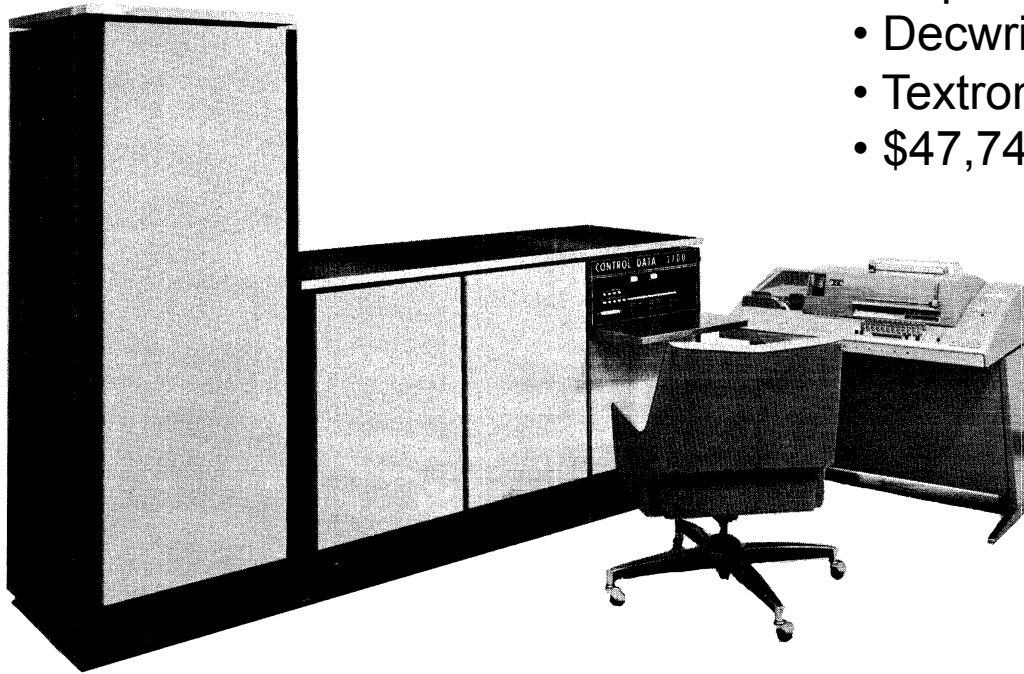
- 32K Memory
- Fortran Language
- Teletypewriter
- \$275,000



**CDC-1700 Computer by
Control Data Corporation**

Plant Computer

- 64K Memory
- Paper Tape Reader
- Decwriter
- Textronix Graphics Display
- \$47,745



PDP-11/60 by Digital Equipment Corporation

Balance of Plant Computer



Intel 80486 CPU by Northgate

Digital Instruments

Transmitters by Yokogawa



Recorder by Chessell

Programmable Logic Controllers (PLC)



Programmable Logic Controllers



Software Quality Assurance

Conformance to:

- explicit functional and performance requirements,
- explicitly documented development standards, and
- implicit characteristics

that are expected of all professionally developed software.

Software Engineering

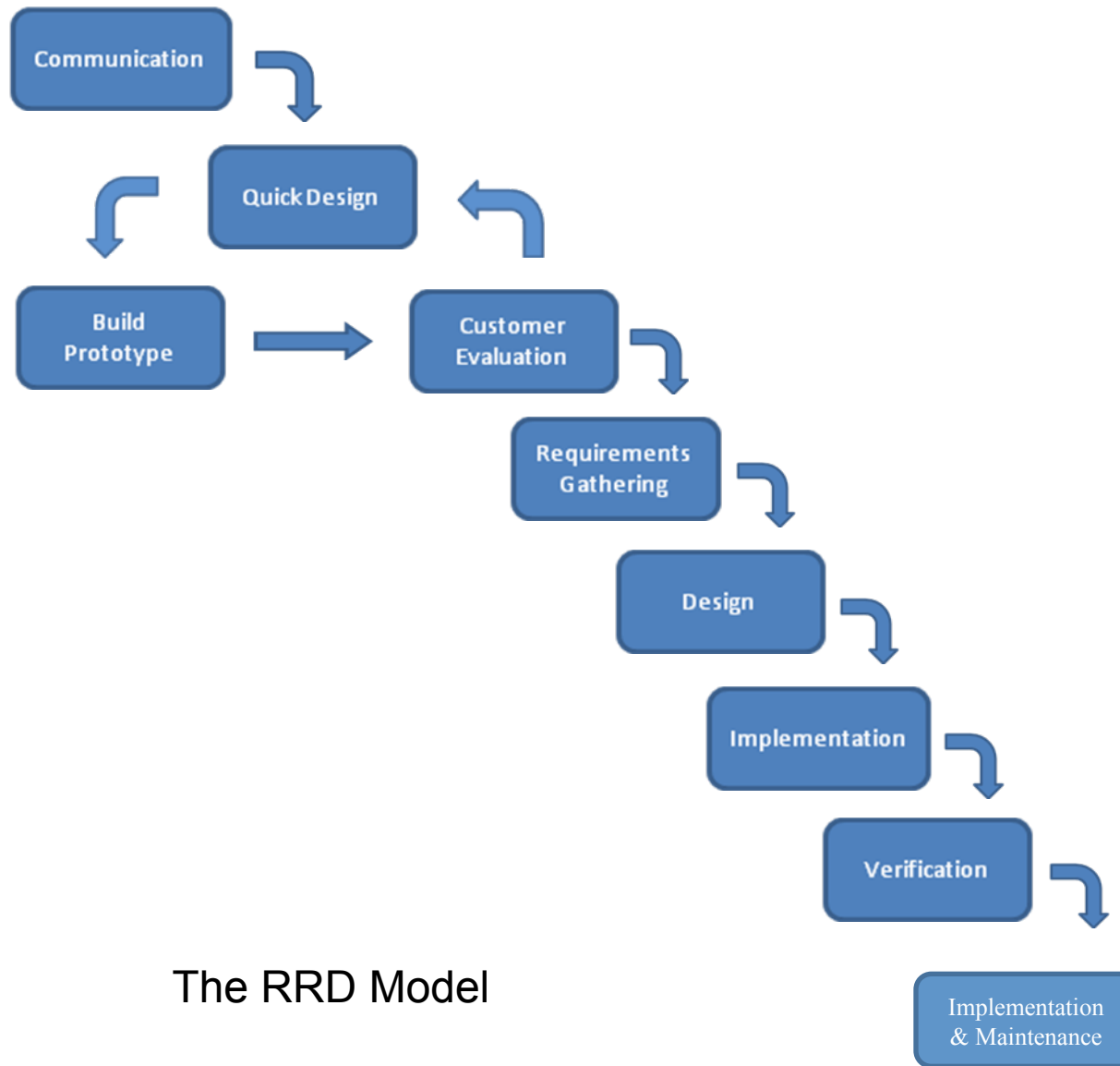
The application of a systematic, disciplined, and quantifiable approach to software development, operation, and maintenance.

Process Development Input



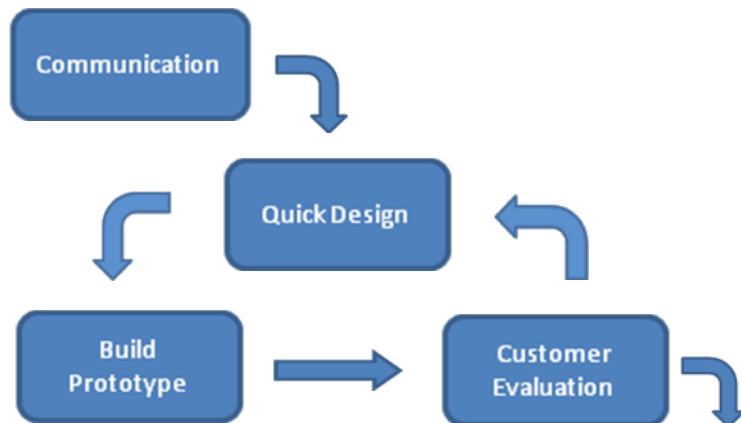
- DOE Requirements
- Industry Standards
- Internal Procedures
- Lessons Learned

Process Models



The RRD Model

Prototype Phase



- Begin Team Meetings
- Discuss Functionality and General Design
- Purchase Hardware for Evaluation
- Setup Network
- General HMI
- Training

Detailed Design Phase



- Write Functional Description and SQA Plan
- Requirements Walkthrough
- Review of FD and SQAP



- Write SRS and SQA Umbrella Documents
- Review of SRS and SQA
- Process Audit by QA

Implementation Phase



- Write Code
- Code Walkthrough
- Review of Code



- Write SRL and Test Plans
- Review of SRL and Test Plans
- Perform Testing
- Final Audit by QA



- Write Backup/Recovery Plans
- Write Maintenance Plan
- Review of Plans
- Work Closeout

Metrics

Classifications

Logic Problem		
	Forgotten cases or steps	A100
	Duplicate logic	A200
	Extreme conditions neglected	A300
	Unnecessary function	A400
	Misinterpretation	A500
	Missing condition test	A600
	Checking wrong variable	A700
	Iterating loop incorrectly	A800
Computation Problem		
	Equation insufficient or incorrect	B100
	Missing computation	B110
	Operand in equation incorrect	B120
	Operator in equation incorrect	B130
	Parenthesis used incorrectly	B140
	Precision Loss	B200
	Rounding or truncation	
	Mixed modes	
	Sign convention fault	
Interface/Timing Problem		
	Interrupts handled incorrectly	
	I/O timing incorrect	
	Timing fault causes data corruption	
	Subroutine/Module mismatch	
	Wrong subroutine call	
	Incorrectly located subroutines	
	Nonexistent subroutine	
	Inconsistent subroutine	
Data Handling Problem		
	Initialized data incorrectly	
	Accessed or stored data incorrectly	
	Flag or index set incorrectly	
	Packed/unpacked data incorrectly	
	Referenced wrong data	
	Data referenced out of range	

Software Development Metrics Summary																			
System:														Date:		Deployment: Pre or Post			
														Deployment Age:					
Source	Class	Qty	Class	Qty	Class	Qty	Class	Qty	Class	Qty	Class	Qty	Class	Qty	Class	Qty	Class	Qty	
A1	A100		A200		A300		B100		B110		B120		B130		C100		C200		
	D100		D200		D210		D220		D230		E100		E200		F100		F200		
A2	A100		A200		A300		B100		B110		B120		B130		E200		C100		C200
	D100		D200		D210		D220		D230		E100		E200		F100		F200		
A3	A100		A200		A300		B100		B110		B120		B130		E200		C100		C200
	D100		D200		D210		D220		D230		E100		E200		F100		F200		
A4	A100		A200		A300		B100		B110		B120		B130		E200		C100		C200
	D100		D200		D210		D220		D230		E100		E200		F100		F200		
B1	A100		A200		A300		B100		B110		B120		B130		E200		C100		C200
	D100		D200		D210		D220		D230		E100		E200		F100		F200		
B2	A100		A200		A300		B100		B110		B120		B130		E200		C100		C200
	D100		D200		D210		D220		D230		E100		E200		F100		F200		
B3	A100		A200		A300		B100		B110		B120		B130		E200		C100		C200
	D100		D200		D210		D220		D230		E100		E200		F100		F200		
C1	A100		A200		A300		B100		B110		B120		B130		E200		C100		C200
	D100		D200		D210		D220		D230		E100		E200		F100		F200		
C2	A100		A200		A300		B100		B110		B120		B130		E200		C100		C200
	D100		D200		D210		D220		D230		E100		E200		F100		F200		
C3	A100		A200		A300		B100		B110		B120		B130		E200		C100		C200
	D100		D200		D210		D220		D230		E100		E200		F100		F200		
D1	A100		A200		A300		B100		B110		B120		B130		E200		C100		C200
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D2	A100		A200		A300		B100		B110		B120		B130		E200		C100		C200
	D100		D200		D210		D220		D230		E100		E200		F100		F200		
E1	A100		A200		A300		B100		B110		B120		B130		E200		C100		C200
	D100		D200		D210		D220		D230		F100		F200		F300		F100		F200

Metrics Example

Defect Tracking Sheet

Date	Origin	Description	Severity	Classification	Resolution
02/18/2010	Requirements	Annunciator Text Missing	4	F400	Fix at next revision. Review HMI structured walk through requirements.

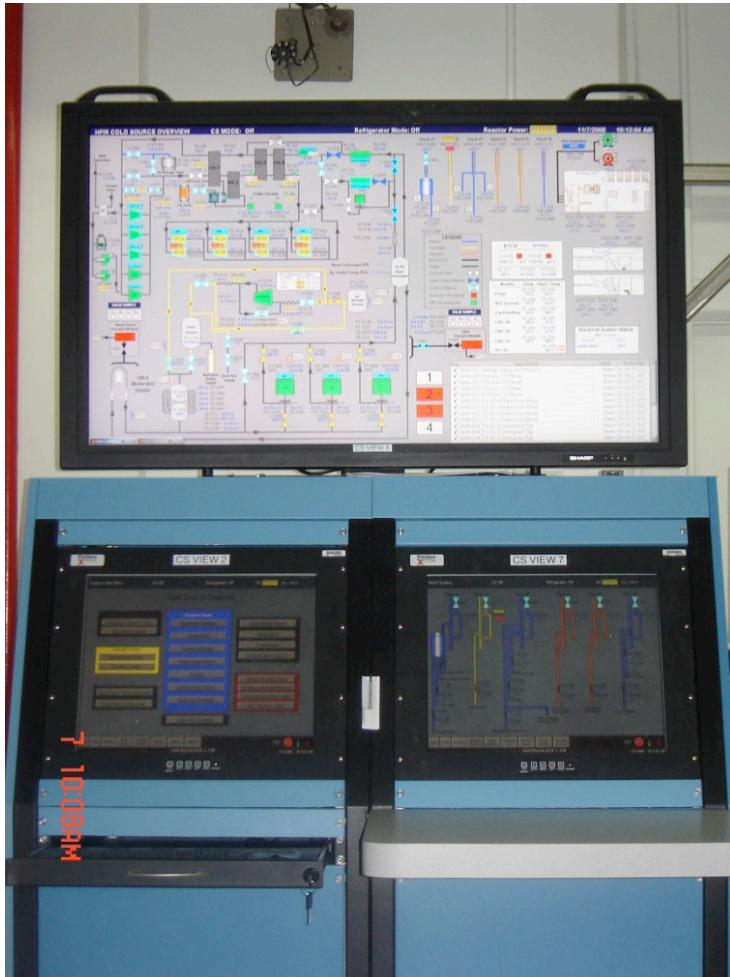
Origin:

Requirements (missing from FD)
Design (prototype doesn't work)
Code (wrong instruction in code)
Testing (test plan incomplete)
Secondary (bad fixes/changes)

Severity:

1 – Unanticipated SCRAM
2 – Operator Action
3 – Operator Work Around
4 - Cosmetic

Digital Upgrades



Cold Source
Distributed Control System



Control Rod
Time-Of-Flight PLC

Digital Upgrades



HFIR Data System



Wide Range Counting Channel

Summary

- **Digital Controls are not new to HFIR**
- **Online Computer successful at calculating reactivity and performing rod control**
- **Successful Software Development Process**
- **Process Validation = History + Metrics**
- **Digital Upgrades are the future.**