The Significance of LabVIEW Development Style

Peter Blume

President

Author

OverVIEW

- Introduction
  - Evolution of style convention at Bloomy Controls
- Benefits of good style
  - Single developer / application perspective
  - Multideveloper / organization perspective
  - Examples
- Style resources

About Bloomy Controls

- Systems integrator
  - Founded in 1992
  - Automated test, data acquisition, and control
  - Windsor, CT; Milford, MA; Fort Lee, NJ
- NI Select Partner
  - 13 Certified LabVIEW & TestStand Developers
  - 5 Certified LabVIEW & TestStand Architects
  - 2 NI Certified Training Centers
- CSIA Certified Member

Evolution of Best Practices

- Steady growth
  - Multiple developers
  - Multiple offices
  - Multiple industries and application types
  - Multiple years in business
- LabVIEW experts
  - Professional quality software
  - Good style is ***essential***

Evolution of LabVIEW Style

- Internal style guide developed in mid 1990s
  - 10 Page document
  - Most details passed on verbally
- Opened remote offices in MA and NJ
  - New organizational structure
  - Had to specify standards more explicitly
- NIWeek presentations
  - “Bloomy Controls Professional LabVIEW Development Guidelines” in 2002
  - “Five Techniques for Better LabVIEW Code” in 2003
- “The LabVIEW Style Book” published in 2007

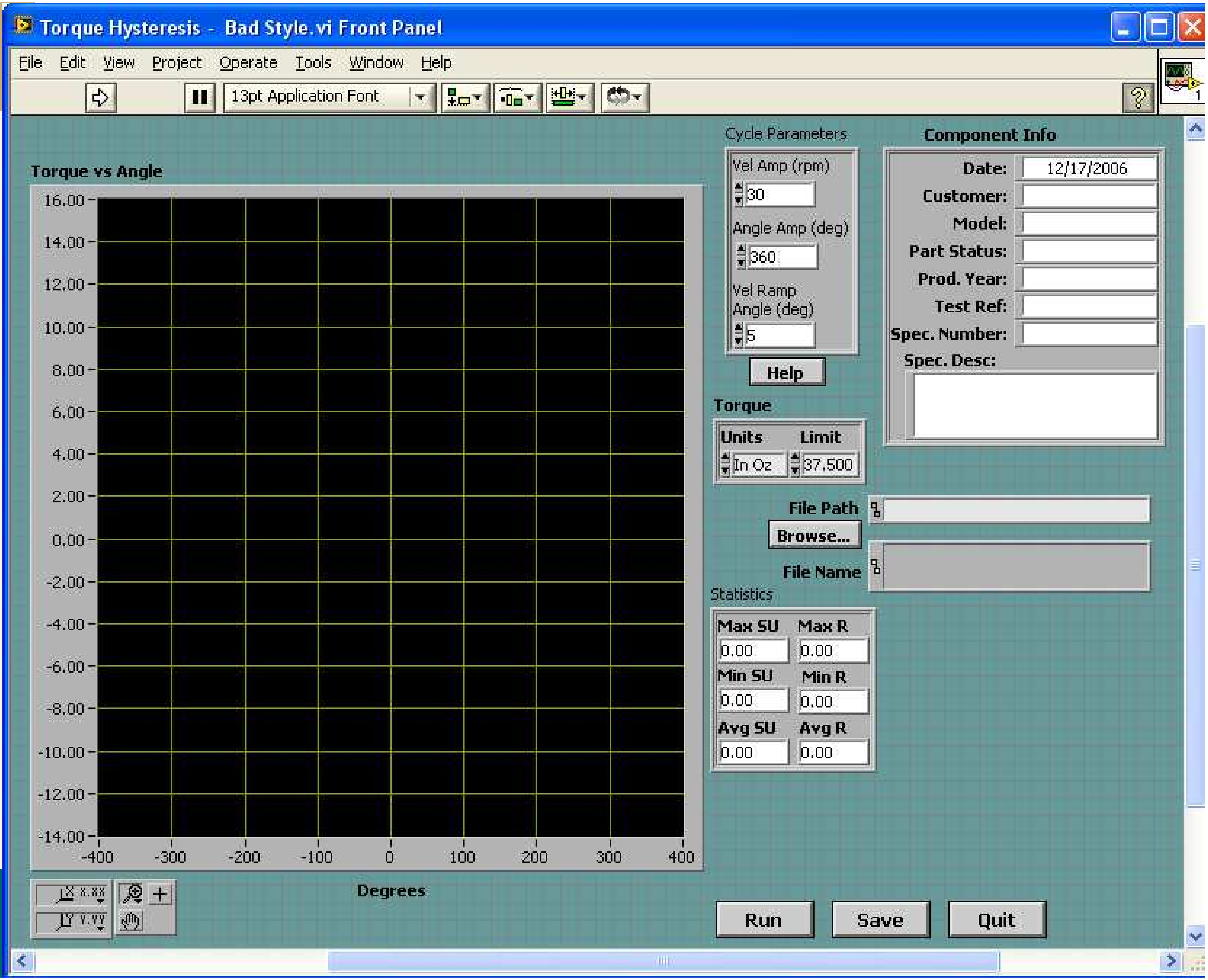
Theorem 1.1

A direct relationship exists between LabVIEW development style and

- Ease of use
- Readability
- Maintainability
- Efficiency
- Reliability
- Simplicity
- Performance
- Development time
- Standards
- Certifications
- Productivity

Ease of Use

- The ease with which the ***end user*** operates the software to accomplish her objectives
- GUI interaction
  - Layout
    - Size, position, color, spacing, density
  - Control types
  - Navigation
  - Responsiveness



Cycle Parameters

Vel Amp (rpm): 30

Angle Amp (deg): 360

Vel Ramp Angle (deg): 5

Torque

Units	Limit
In Oz	37.500

Component Info

Date: 12/17/2006

Customer:

Model:

Part Status:

Prod. Year:

Test Ref:

Spec. Number:

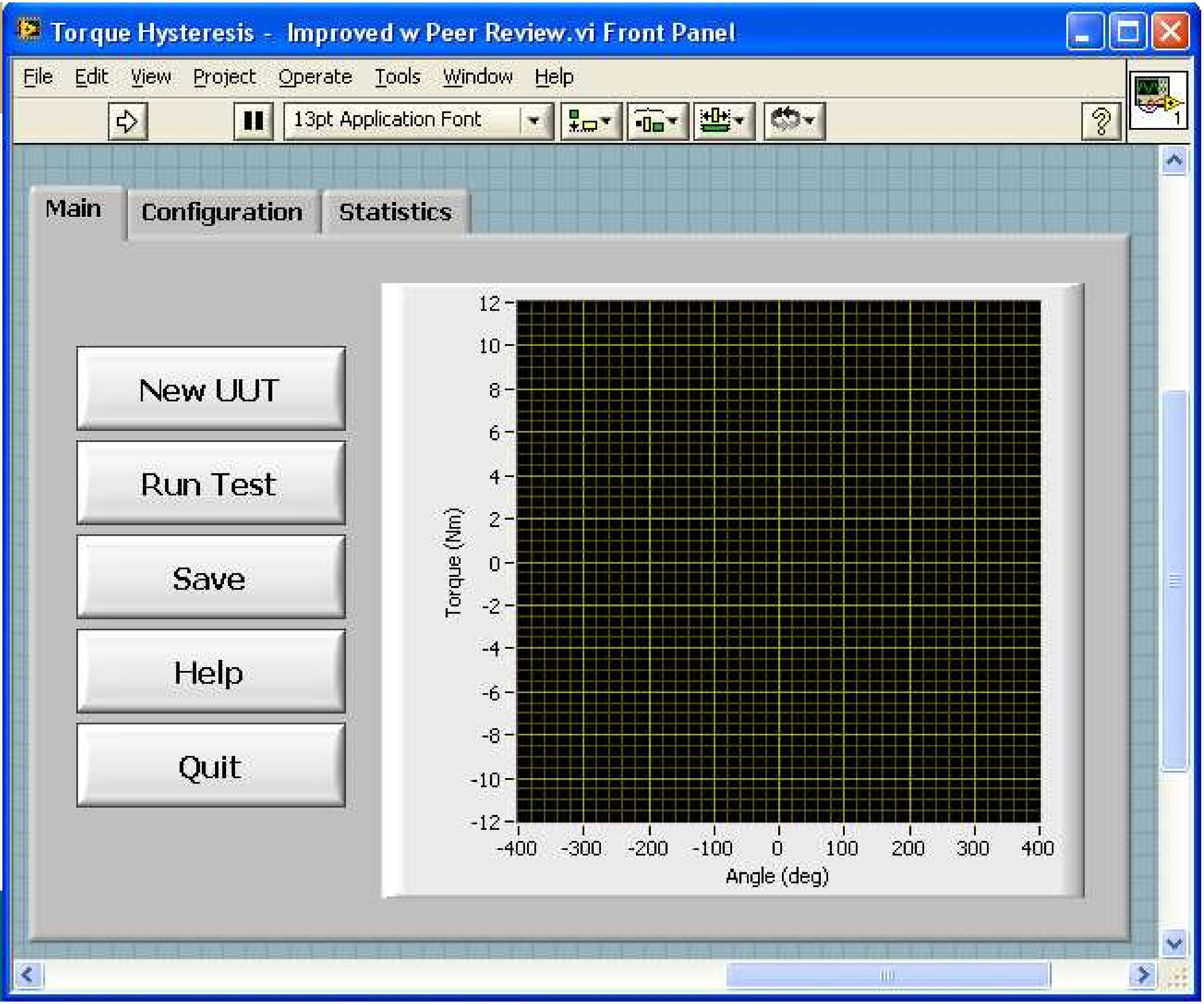
Spec. Desc:

File Path

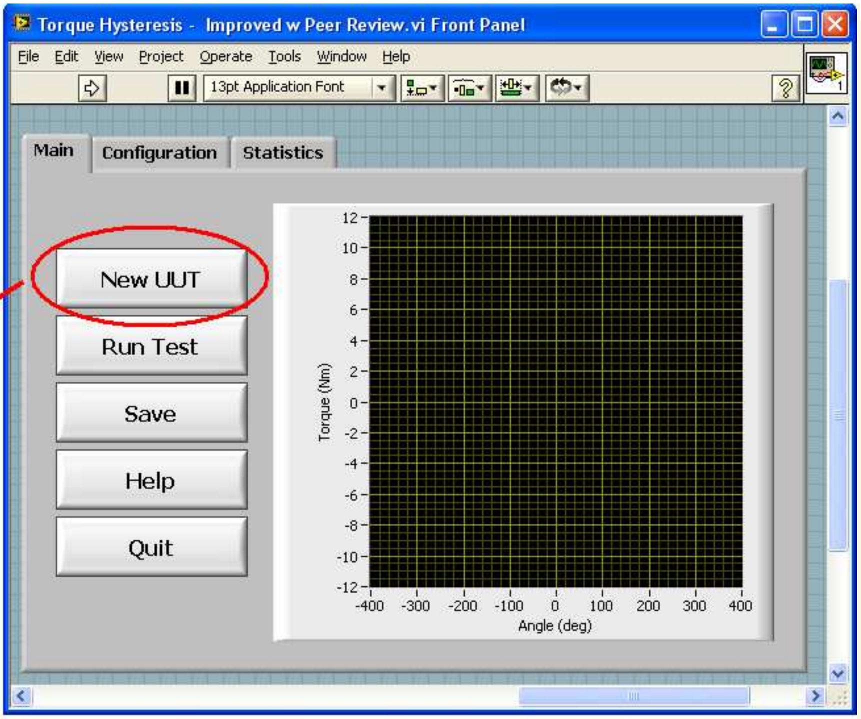
File Name

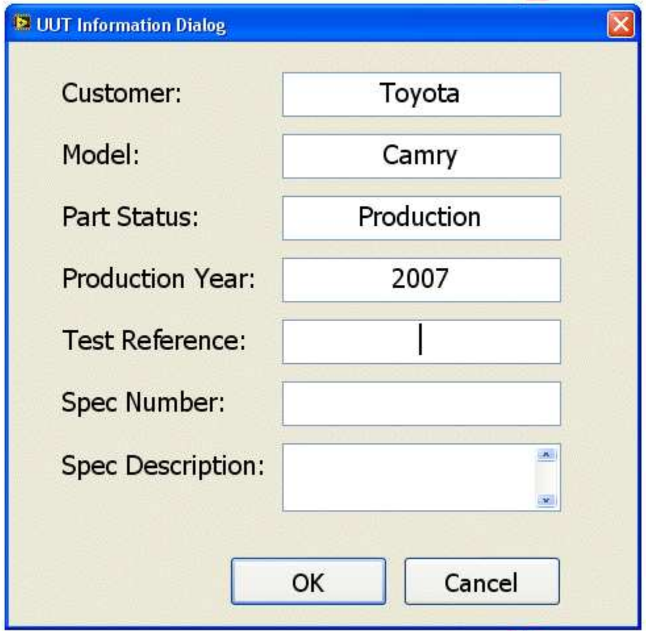
Statistics

Max SU	Max R
0.00	0.00
Min SU	**Min R**
0.00	0.00
Avg SU	**Avg R**
0.00	0.00

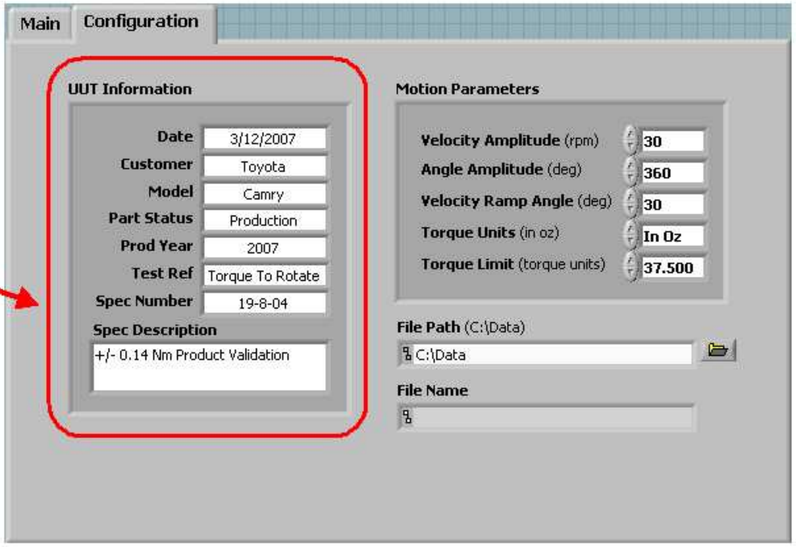


Torque Hysteresis - Improved w Peer Review.vi Front Panel
File
Edit
View
Project
Operate
Tools
Window
Help
13pt Application Font
Main
Configuration
Statistics
New UUT
Run Test
Save
Help
Quit
12
10
8
6
4
2
0
-2
-4
-6
-8
-10
-12
Torque (Nm)
-400
-300
-200
-100
0
100
200
300
400
Angle (deg)




UUT Information Dialog

Customer:	Toyota
Model:	Camry
Part Status:	Production
Production Year:	2007
Test Reference:	
Spec Number:	
Spec Description:	



UUT Information

Date	3/12/2007
Customer	Toyota
Model	Camry
Part Status	Production
Prod Year	2007
Test Ref	Torque To Rotate
Spec Number	19-8-04

Spec Description

+/- 0.14 Nm Product Validation

Motion Parameters

Velocity Amplitude (rpm)	30
Angle Amplitude (deg)	360
Velocity Ramp Angle (deg)	30
Torque Units (in oz)	In Oz
Torque Limit (torque units)	37.500

File Path (C:\Data)

C:\Data

File Name

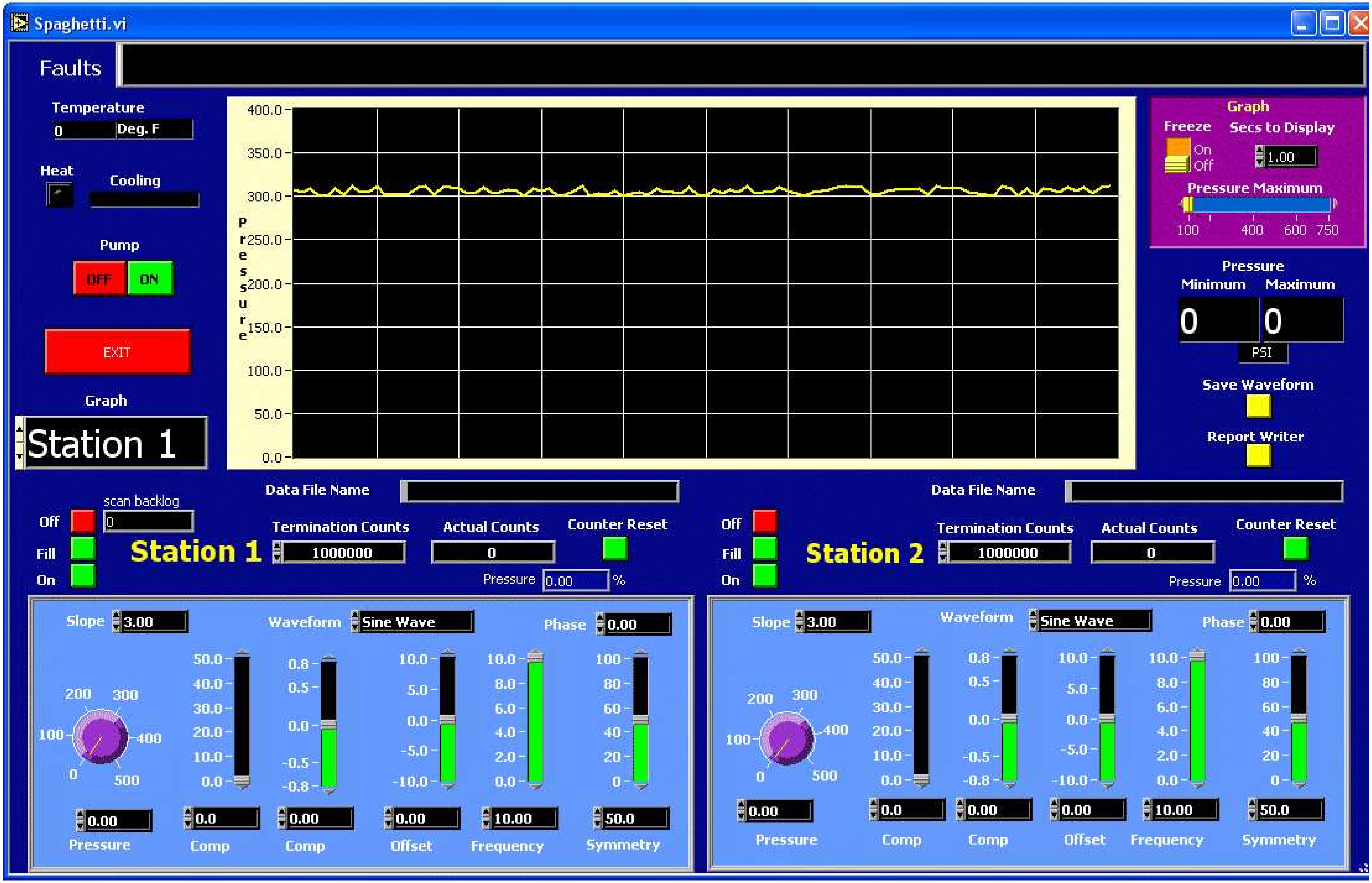
Readability

- Ease with which the ***developer*** comprehends the source code
- Front panel & block diagram
  - Intuitive object labels, comments, icons, and descriptions
  - Clear wiring and data flow

Maintainability

- Ease with which the software is ***modified and expanded*** to change or add new functionality
  - Modular
  - Data structures
  - Standard design patterns
  - Documentation
  - Scalable
- Can ***other*** developers understand your source code?

Spaghetti VI - Panel



Spaghetti.vi

Faults

Temperature 0 Deg. F

Graph: Station 1

Secs to Display 1.00

Pressure Minimum 0 Maximum 0 PSI

Station 1

scan backlog 0

Termination Counts 1000000

Actual Counts 0

Pressure 0.00 %

Slope 3.00

Waveform Sine Wave

Phase 0.00

Pressure 0.00

Comp 0.0

Comp 0.00

Offset 0.00

Frequency 10.00

Symmetry 50.0

Station 2

Termination Counts 1000000

Actual Counts 0

Pressure 0.00 %

Slope 3.00

Waveform Sine Wave

Phase 0.00

Pressure 0.00

Comp 0.0

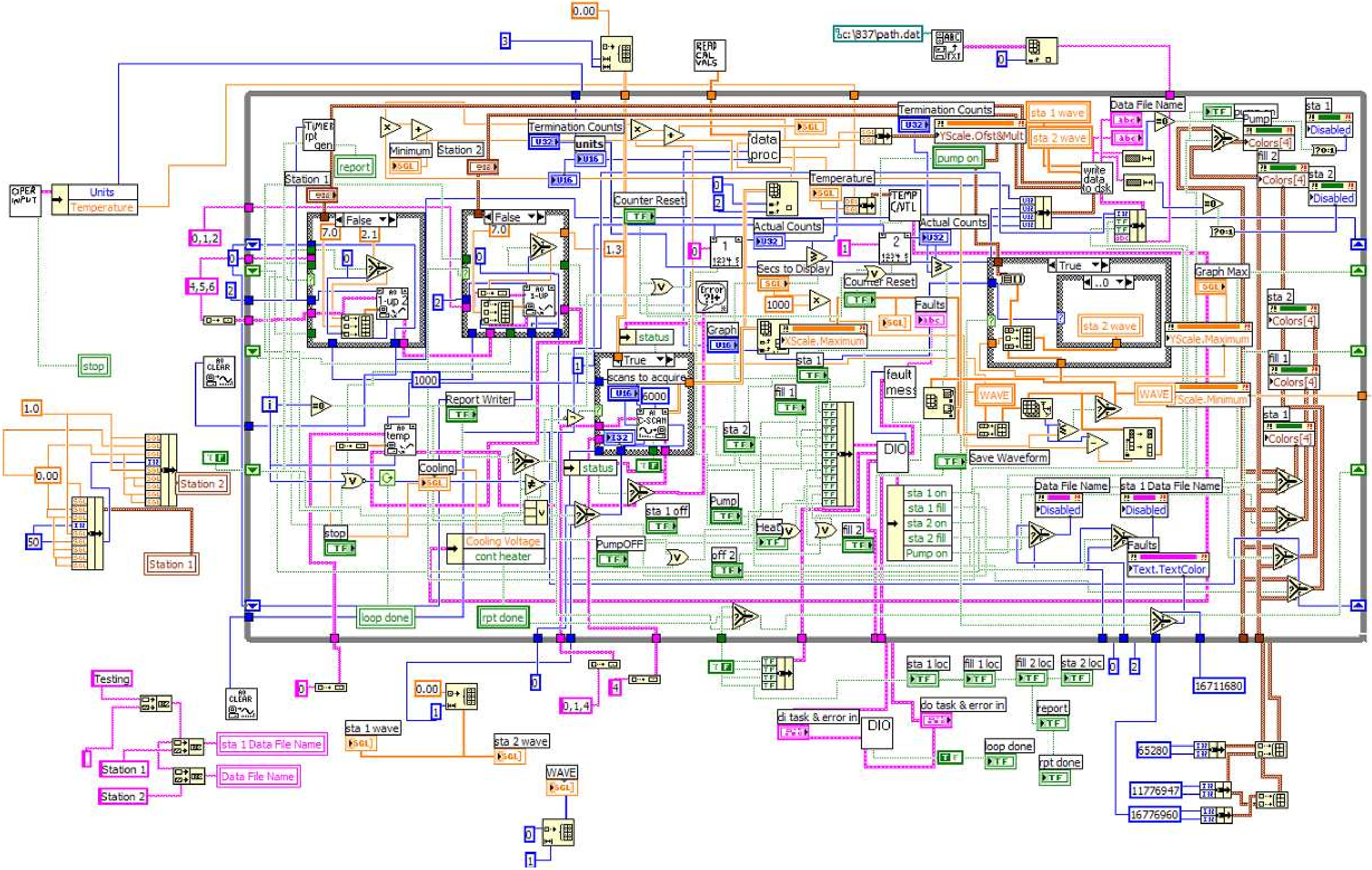
Comp 0.00

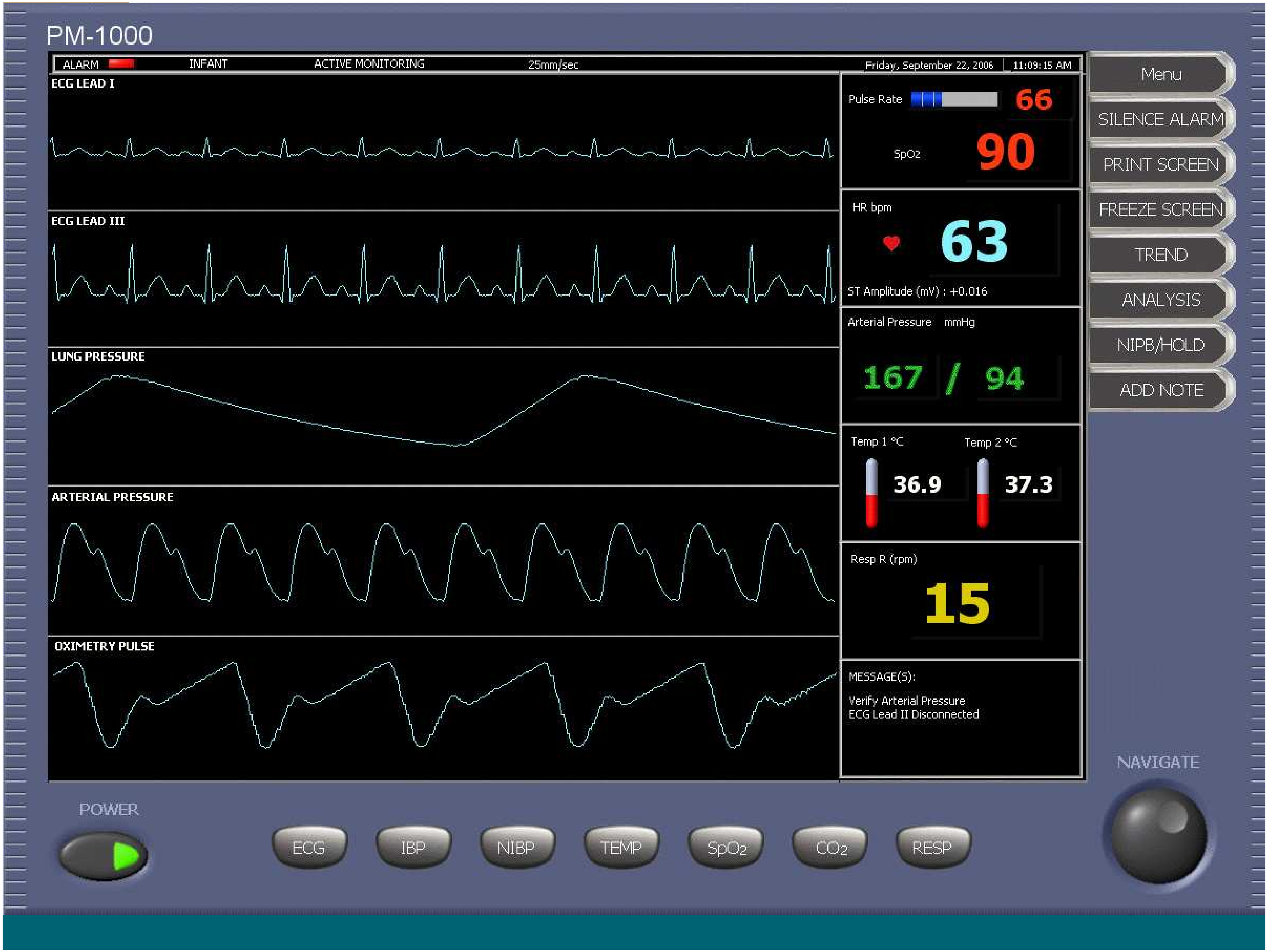
Offset 0.00

Frequency 10.00

Symmetry 50.0

Spaghetti VI - Diagram





PM-1000

ALARM INFANT ACTIVE MONITORING 25mm/sec Friday, September 22, 2006 11:09:15 AM

ECG LEAD I

ECG LEAD III

LUNG PRESSURE

ARTERIAL PRESSURE

OXIMETRY PULSE

Pulse Rate 66

SpO2 90

HR bpm 63

ST Amplitude (mV) : +0.016

Arterial Pressure mmHg 167 / 94

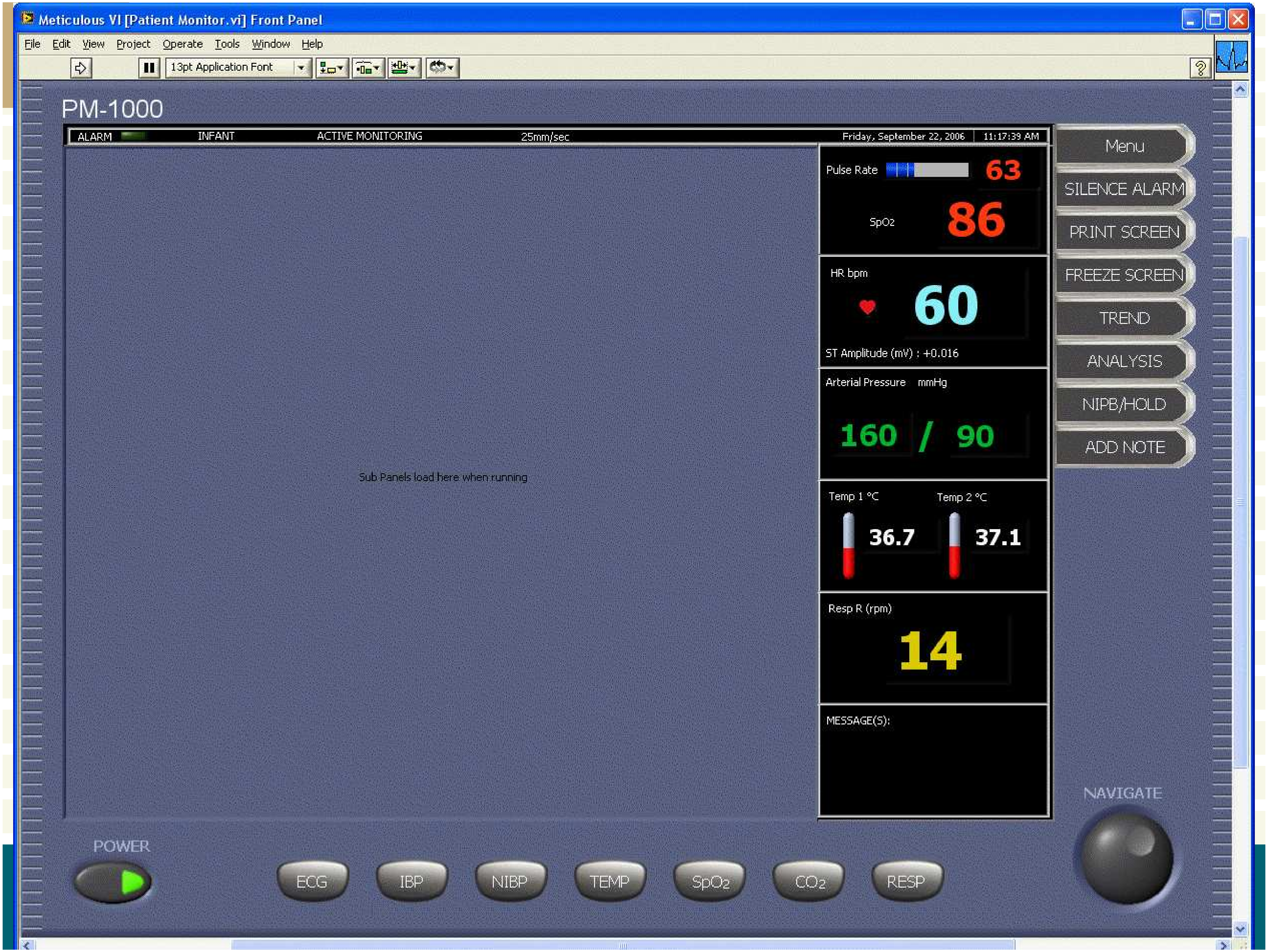
Temp 1 °C 36.9

Temp 2 °C 37.3

Resp R (rpm) 15

MESSAGE(S):

Verify Arterial Pressure
ECG Lead II Disconnected



PM-1000

ALARM INFANT ACTIVE MONITORING 25mm/sec Friday, September 22, 2006 11:17:39 AM

Sub Panels load here when running

Pulse Rate 63

SpO2 86

HR bpm 60

ST Amplitude (mV) : +0.016

Arterial Pressure mmHg

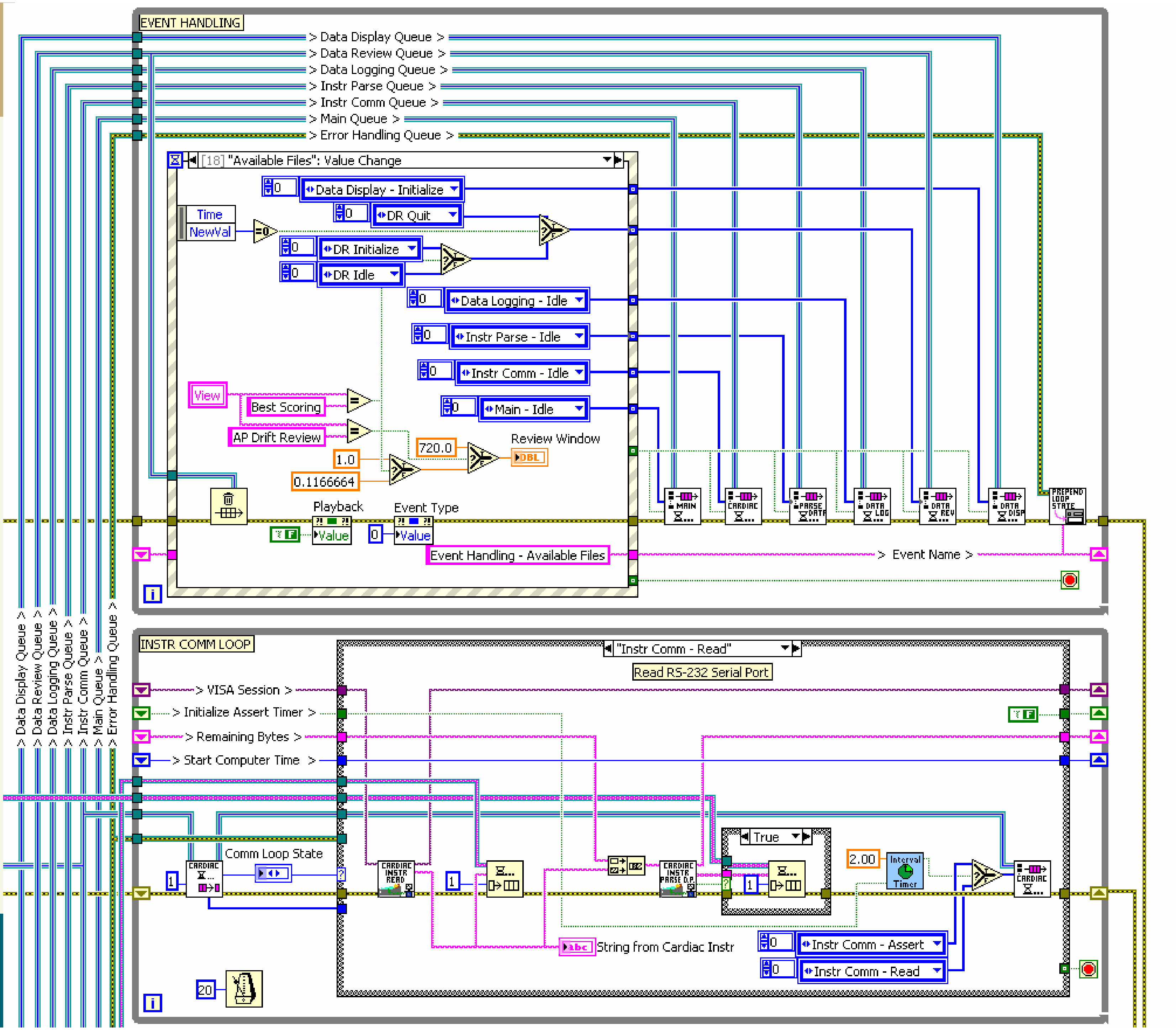
160 / 90

Temp 1 °C 36.7

Temp 2 °C 37.1

Resp R (rpm) 14

MESSAGE(S):


EVENT HANDLING
> Data Display Queue >
> Data Review Queue >
> Data Logging Queue >
> Instr Parse Queue >
> Instr Comm Queue >
> Main Queue >
> Error Handling Queue >
[18] "Available Files": Value Change
0
Data Display - Initialize
DR Quit
Time
NewVal
DR Initialize
DR Idle
Data Logging - Idle
Instr Parse - Idle
Instr Comm - Idle
Main - Idle
View
Best Scoring
AP Drift Review
720.0
Review Window
DBL
1.0
0.1166664
Playback
Event Type
Value
Event Handling - Available Files
> Event Name >
MAIN
CARDIAC
PARSE DATA
DATA LOG
DATA REV
DATA DISP
PREPEND LOOP STATE
> Data Display Queue >
> Data Review Queue >
> Data Logging Queue >
> Instr Parse Queue >
> Instr Comm Queue >
> Main Queue >
> Error Handling Queue >
INSTR COMM LOOP
"Instr Comm - Read"
Read RS-232 Serial Port
> VISA Session >
> Initialize Assert Timer >
> Remaining Bytes >
> Start Computer Time >
Comm Loop State
CARDIAC
1
CARDIAC INSTR READ
CARDIAC INSTR PARSE D.P.
True
2.00
Interval Timer
String from Cardiac Instr
Instr Comm - Assert
Instr Comm - Read
20
i

m

Efficiency

- Application’s utilization of computing resources
  - Processor
  - Memory
  - Hard disk
  - Input/output devices

Theorem 6.1

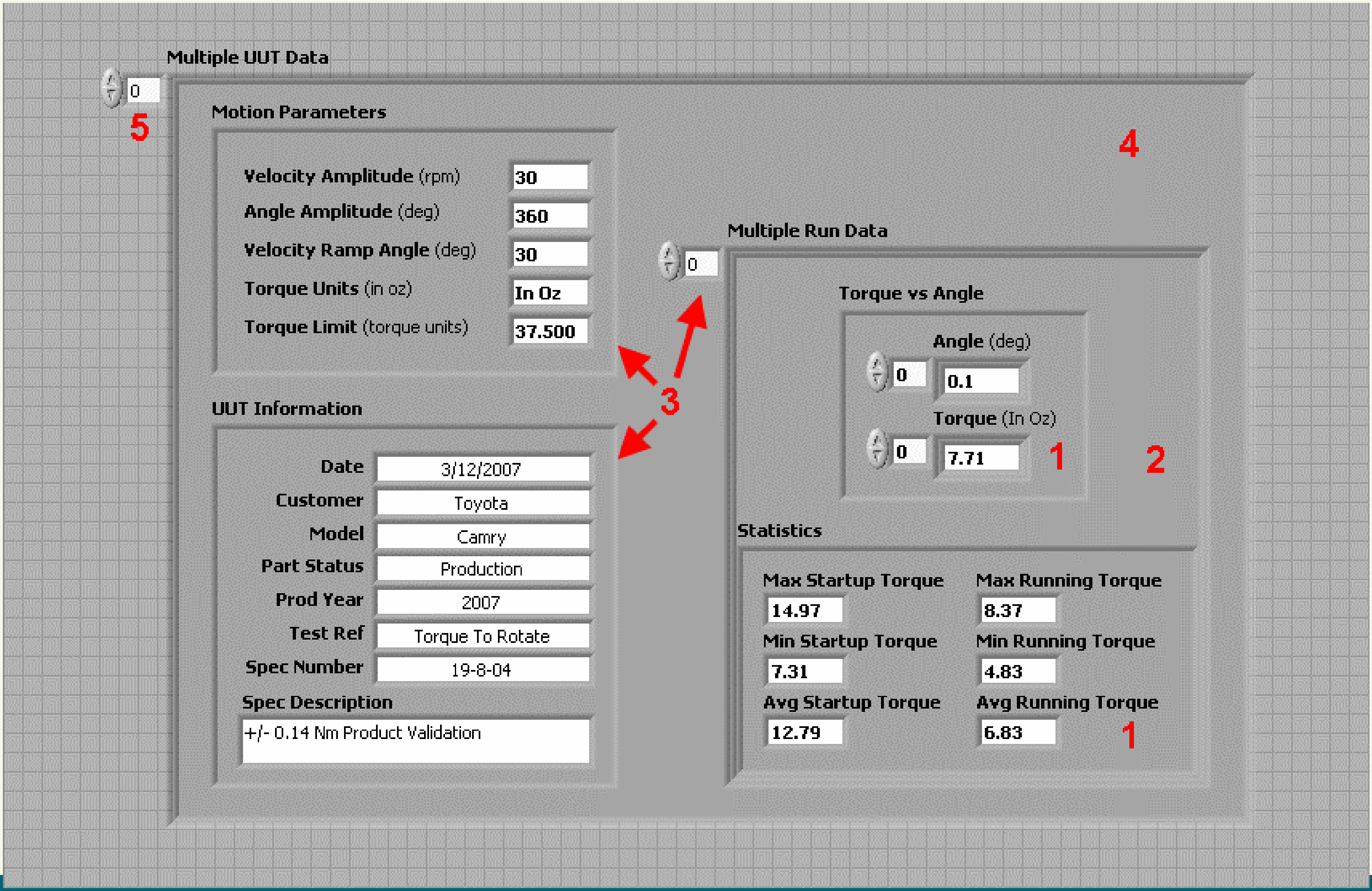
Execution speed is inversely proportional to memory use

- Memory and data storage access rates are the principal latencies
- LabVIEW's memory manager
  - Automatic
  - Delays
  - Can fragment memory

Rules to Improve Efficiency

- **Rule 6.29**
  - Avoid manipulating nested data structures during critical tasks
  - Avoid unnecessary operations in loops
    - Build array, concatenate string
    - GUI polling
    - Redundant computations

Nested Data Structure



Multiple UUT Data

0

Motion Parameters

Velocity Amplitude (rpm) 30

Angle Amplitude (deg) 360

Velocity Ramp Angle (deg) 30

Torque Units (in oz) In Oz

Torque Limit (torque units) 37.500

UUT Information

Date	3/12/2007
Customer	Toyota
Model	Camry
Part Status	Production
Prod Year	2007
Test Ref	Torque To Rotate
Spec Number	19-8-04

Spec Description

+/- 0.14 Nm Product Validation

Multiple Run Data

0

Torque vs Angle

Angle (deg)

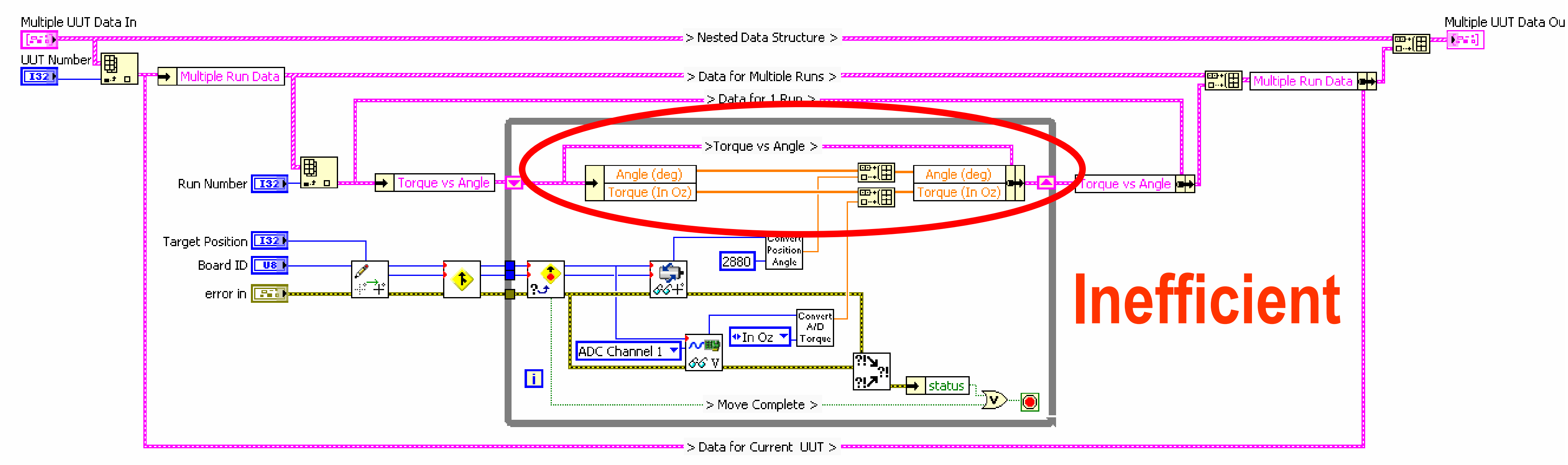
0 0.1

Torque (In Oz)

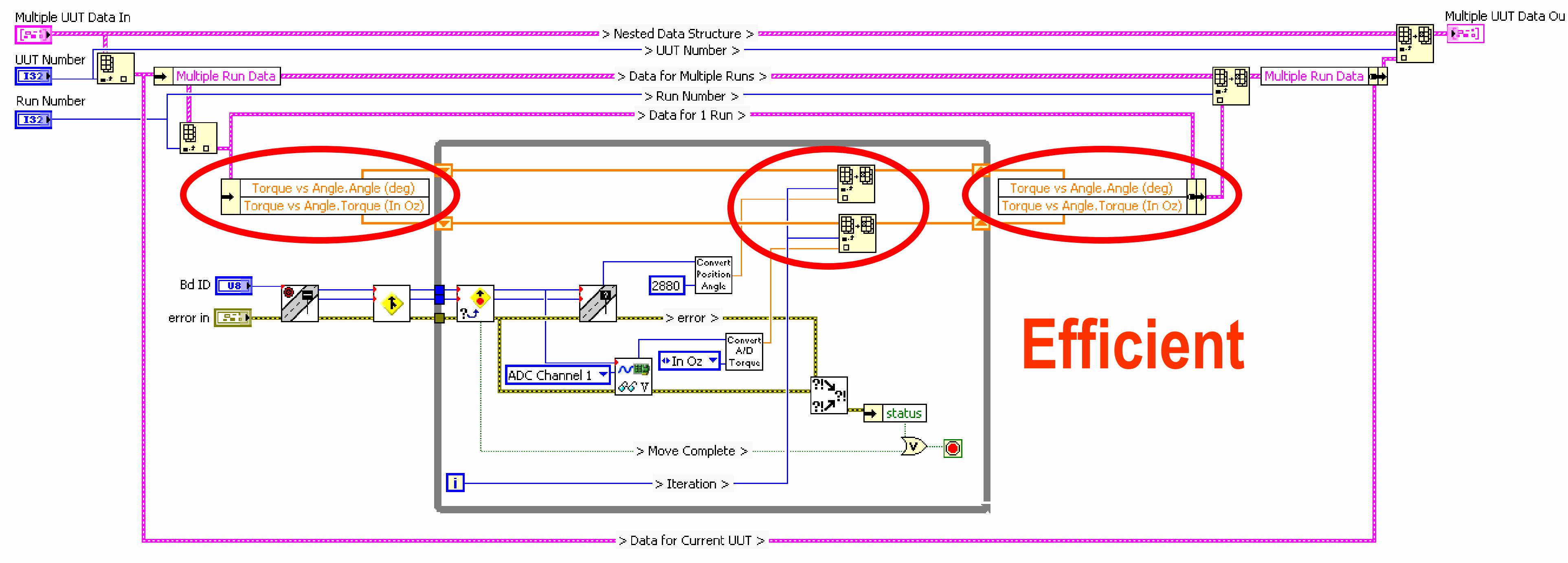
0 7.71

Statistics

Max Startup Torque	Max Running Torque
14.97	8.37
Min Startup Torque	Min Running Torque
7.31	4.83
Avg Startup Torque	Avg Running Torque
12.79	6.83



Inefficient



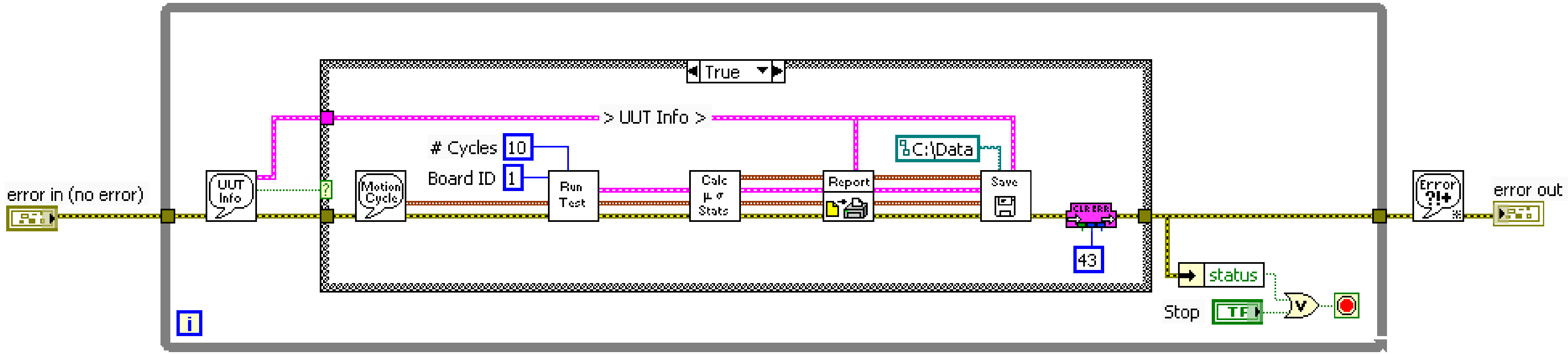
Efficient

Reliability

- Bug free software that never crashes
  - Controls with range checking
  - Data flow versus variables
  - Modular diagrams
  - Error handling

Error Handling

- **Rule 7.1**
  - All VIs must ***trap*** and ***report*** the errors returned from error terminals
  - Trap errors via propagation of the error cluster
  - Report errors using dialog and/or log file



Simplicity

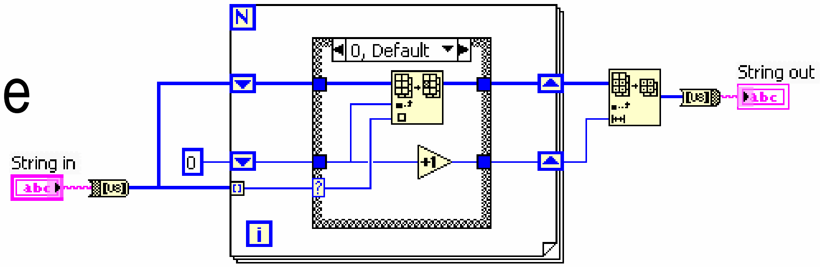
- Relates to the number of objects, nodes and terminals
- Affected by
  - Application requirements
  - Implementation style

Performance

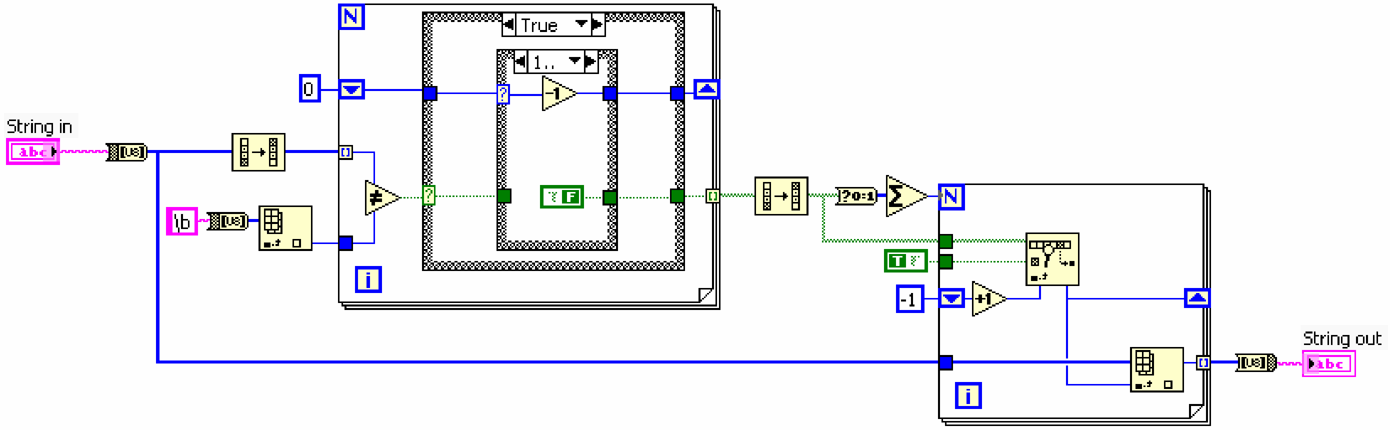
- Execution speed
- Relates to simplicity
- Choose implementations requiring fewest nodes

Remove Backspace VI

- 13 nodes
  - 5.6 mS execution time



- 25 nodes
  - 12.8 mS execution time



Development Time

- The hours required to develop, document, test, modify, and maintain an application ***throughout its entire life cycle***
- Good style ***<u>reduces</u>*** development time and effort
  - Fewer bugs
  - Easier to modify and maintain
- Good style ***<u>increases</u>*** productivity
  - Reusable source code

Organizational Perspective

- Standards
  - Quality
  - Commonality
  - Depth and interchangeability of resources
  - Software reuse
  - Qualify for certifications
- Insurance against bad projects & turnover

Certifications

- CSIA Registration
- ISO 9000
- FAA
- FDA
- Six Sigma

Productivity!

- The benefits ***scale*** across the ***organization***
  - Ease of use
  - Readability
  - Maintainability
  - Efficiency
  - Reliability
  - Simplicity
  - Performance
  - Development time
- This makes the ***entire organization*** more productive!

Style Resources

- The LabVIEW Style Book
  - 200+ Style rules
  - Companion web site at www.bloomy.com/lvstyle
  - Tools and templates
  - The LabVIEW Style Course
- LabVIEW VI Analyzer
- Consulting
  - Application development
  - Code reviews
  - Code refactoring
  - Development processes
- Partnership / automation strategy

Contact Bloomy Controls

- Email info@bloomy.com
- Write or visit

Headquarters:

839 Marshall Phelps Rd.
Windsor, CT 06095
(860) 298-9925

Field Offices:

Milford, MA
(508) 902-0054

Fort Lee, NJ
(201) 818-0117