## 

Smart People. Expert Solutions.<sup>®</sup> LabVIEW User Group Meeting New York Metro Area (Farmingdale) 2015-12-03

#### Agenda

- 1. DMC
- 2. Design Patterns What? Why?
- 3. Basic Tools
- 4. Simple Patterns
- 5. Reference Architectures











#### Established in 1996, offices in New York, Boston,

#### **Industries Served:**

Automotive

**Bio-medical** 

Chemical and Food Processing

Defense

Electronics/Semiconductor

Fuel Cells/Alternative Energy

Hydraulics

Laboratory Testing

Machine Tool Material Handling Medical Devices Packaging Pharmaceutical Printing & Textiles employees &

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## DESIGN PATTERNS





### Why should I use design patterns?

- Save development time
- Improve Modularity
- Increase Readability
- Take advantage of proven code/architecture
- SMoRES





- <u>Scalable</u>: extending to N+1 should be simple
- <u>Mo</u>dular: the application is broken into well-defined components that can stand on their own
- <u>**Reusable**</u>: the code structured in a way that it could be reused in different applications
- **Extensible**: new features can be added easily
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## Basic Tools

- For/While Loops
- Shift Registers
- Enums
- Case Structures
  - Event Structures
  - Queues



## Simple Patterns

- Functional Global Variables
- State Machine
- Event Driven User Interface



#### Functional Global Variables

Need: share data across a large application

- Local Variables?
- Global Variables?

GLOBAL VARIABLES

ONE DOES NOT SIMPLY

#### USE GLOBAL VARIABLES



**DEBUGGED CONTROLLER** 

**USES ALL GLOBAL VARIABLES** 

GLOBAL VARIABLES EVERYWHEREator.ne

#### Functional Global Variables

#### How does it work?

- 1. Functional Global is a Non-Reentrant SubVI
- 2. Actions can be performed on data
- 3. Enumerator (input) selects action, case structure action engine
- 4. Stores data in un-initialed shift register
- 5. Loop only executes once





#### Functional Global Variables



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#### State Machine

Need: execute a sequence of events but the order is determined programmatically (usually user driven)







**Dynamic Sequence** 



#### State Machine





## State Machine

#### How does it work?

- 1. Case structure inside of a While-loop
- 2. Each state in the case structure holds code to be executed in its state
- 3. Each state has decision making code that determines next state
- 4. Enumerators (case selector) is used to pass next state via shift registers





#### Event Driven User Interface

Need: to detect user actions without slowing your application/missing them

- Event structure within While-loop
- Blocking function until event is registered or timeout
- Event structure configured to choose which events are registered (button presses, mouse click, etc)





#### Event Driven User Interface

How does it work?

- 1. Operating system broadcasts system events (mouse click, key press, button click) to applications
- 2. Registered events are captured by event structure and executes appropriate case
- 3. Event structure returns information about events to case
- 4. Event structure enqueues events that occur while it's busy





## Reference Architectures

- Producer/Consumer or Master/Slave
- Queued State Machine & Event-driven User Interface
- Daemon
- SEA Monster
- ??? (Yours!)



#### Producer/Consumer

## Need: to execute code in parallel and communicate between them



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#### Producer/Consumer

How it works:

- 1. Master loop with one or more slave loops
- 2. Master loop controls execution of slaves
- 3. Allows for asynchronous execution of loops
- 4. Decouples processes to allow multi-threading
- 5. Communication between loops





#### Producer/Consumer

Queue-based communication

• Adding elements to the queue



 Dequeueing elements from the queue







Queued State Machine & Event-Driven Producer/Consumer

Need: to enqueue events from a user that control the sequence of events in a state machine

- Event-driven user interface as a producer loop
- State machine as a consumer loop
- Communication between the loops using an event queue



#### Queued State Machine & Event Driven Producer/Consumer

How it works:

- 1. Events are captured by producer loop
- 2. Producer places data on the queue
- 3. Consumer loop dequeues data
- 4. State machine in consumer loop executes on data
- 5. Parallel processes communicate with state machine using queue references





#### Queued State Machine & Event Driven Producer/Consumer



#### Daemon

What is a daemon?

- Used to create and launch applications that run invisibly in the background
  - Auto-save
  - TCP/UDP messaging
  - Garbage collection of temp files
- Perform low-priority monitoring and/or maintenance or communication based processes



#### Daemon

Self-launching:

 Daemon must keep an open reference to itself to keep from being purged

Standard Launched:

- Launcher must transfer responsibility for reference to daemon VI
- Launcher must not close reference to daemon



#### DMC SEA Monster

Need: a very powerful, flexible, prebuilt/proven architecture to speed up development time for complex applications

Solution: internally developed (over the last 15 years) architecture based on a queued state machine & event-driven user interface producer/consumer model.

- S States
- E Events
- A Actions







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#### DMC SEA Monster

	StateA	StateB	StateC
Event1	Actions: ActX, ActY	Actions: ActZ Next State: StateC	
Event2			Actions: ActN, ActW, ActV
Event3	Actions: ActZ, ActX		Actions: ActV, ActY
Event4	Actions: ActM, ActN Next State: StateB	Actions: ActN	
Event5		Actions: ActJ, ActK, ActL	Actions: ActK, ActZ Next State: StateA
Event6		Actions: ActZ, ActY	
Event7	Actions: ActK, ActM Next State: StateC		Actions: ActW, ActX





#### DMC SEA Monster Logic Editor

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		Communication [Start Global, Stop Global, etc]	Start UDP Daemon	
		Global Queue Connection [ADD, REMOVE]	ADD	-
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#### ??? (Yours!)



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#### Too many to list - many readily available NI whitepapers



## Questions?



# 

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## Appendix - Tools

#### Enums & Case Structures







Voltage

J Low High

### Appendix - Tools

#### **Event Structures**



#### Event Structure Components

The following example shows an Event structure with the Key Down? event case.



- ① The event selector label specifies which events cause the currently displayed case to execute. To view other event cases, click the down arrow next to the case name.
- (2) The Timeout terminal specifies the number of milliseconds to wait for an event before timing out. If you wire a value to the Timeout terminal, you must provide a Timeout event case to avoid an error.
- (3) The dynamic event terminals accept an event registration refnum or a cluster of event registration refnums for dynamic event registration. If you wire the inside right terminal, that terminal no longer carries the same data as the left terminal. You can wire the event registration refnums or cluster of event registration refnums to the inside right terminal the dynamically. Depending on the palette from which you select the Event structure, the dynamic event terminals might not appear by default. To display these terminals, right-click the Event structure and select Show Dynamic Event Terminals from the shortcut menu.
- (4) The Event Data Node identifies the data LabVIEW returns when an event occurs. Like the Unbundle By Name function, you can resize the node vertically and select the items you need. Use the Event Data Node to access event data elements, such as Type and Time, which are common to all events. Other event data elements, like Char and VKey for example, vary based on the event you configure.
- Note For more information about event data elements, click the Details link in the event descriptions for the Control, Application, Pane, and VI event class topics.
- (5) The Event Filter Node identifies the event data you can modify before the user interface can process that data. This node appears in Event structure cases that handle filter events. If you want to change event data, you can wire and modify data items from the Event Data Node to the Event Filter Node. You also can change the event data by wiring new values to the node terminals. To completely discard an event, wire a TRUE value to the Discard? terminal. If you do not wire a value to a data item of the Event Filter Node, that data item remains unchanged.
- (6) Like a Case structure, the Event structure supports tunnels. However, by default you do not have to wire Event structure output tunnels in every case. All unwired tunnels use the default value for the tunnel data type. Right-click a tunnel and deselect Use Default If Unwired from the shortcut menu to revert to the default Case structure behavior where tunnels must be wired in all cases. You also can configure the tunnels to wire the input and output tunnels automatically in unwired cases.