

# Breaking the Time Barrier: The Temporal Engineering of Software

a book by  
Gordon E Morrison



www.VSMerlot.com

# Model-Driven Development

- Calculator example
- Keep it simple
- Select one or more views



www.VSMerlot.com

# Choose a View



Diagram

Application

Logic

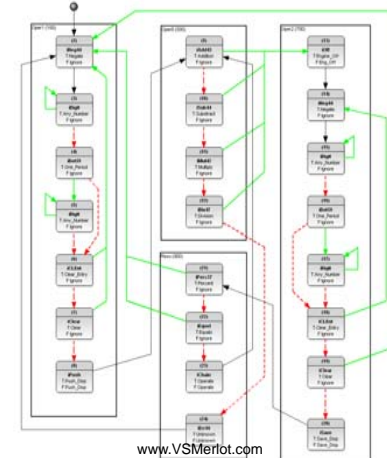


Model

www.VSMerlot.com



# COSA Calc Diagram



www.VSMerlot.com



# Calculator Engine

```

152 function TCOSAcalc.Run(intState : integer; sNumber : String): String;
153 begin
154   bEngine := TRUE; iState := intState; sArgNumber := sNumber;
155   while bEngine do // Preemption control
156     begin
157       if iState = rRule[iTime].iState then // State Logic Control
158         begin
159           rRule[iTime].pTrueRule; // True Cohesive Behavior
160           True_Trace(iTime); // True Trace and Debug
161           iTime := rRule[iTime].iTrueRule; // True Next Time Logic
162         end else
163         begin
164           rRule[iTime].pFalseRule; // False Cohesive Behavior
165           False_Trace(iTime); // False Trace and Debug
166           iTime := rRule[iTime].iFalseRule; // False Next Time Logic
167         end;
168       end;
169       formCalc.editDisplay.Text := sBuildNumber; // Single Point Display Update
170     end;

```



www.VSMerlot.com

# The Logic

```

160 // Rules Static True Next True False Next False Trace
161 // State Behavior Rule Behavior Rule Behavior Rule Trace
162 pBRT(rOpr1, iNeg44, Negate, (0) rOpr1+, Clr_Buf, (1) rOpr1+, 100);
163 pBRT(rOpr1+, iDigit, Any_Number, (0) rOpr1+, Ignore, (1) rOpr1+, 101);
164 pBRT(rOpr1+, iDot59, One_Period, (0) rOpr1+, Ignore, (1) rOpr1+, 102);
165 pBRT(rOpr1+, iDigit, Any_Number, (0) rOpr1+, Ignore, (1) rOpr1+, 103);
166 // Clear
167 pBRT(rOpr1+, iClEnt, Clear_Entry, (0) rOpr1, Ignore, (1) rOpr1+, 104);
168 pBRT(rOpr1+, iClear, Clear, (0) rOpr1, Ignore, (1) rOpr1+, 105);
169 pBRT(rOpr1+, iPush, Push_Dis, (1) rOpr0, Push_Dis, (1) rOpr0, 106);
170 // operations
171 pBRT(rOpr8, iAdd43, Addition, (1) rOpr2, Ignore, (1) rOpr8+, 500);
172 pBRT(rOpr8+1, iSub44, Subtraction, (1) rOpr2, Ignore, (1) rOpr8+2, 501);
173 pBRT(rOpr8+2, iMul42, Multiply, (1) rOpr2, Ignore, (1) rOpr8+3, 502);
174 pBRT(rOpr8+3, iDiv47, Division, (1) rOpr2, Ignore, (1) rOpr8+4, 503);
175 // next number
176 pBRT(rOpr2, iOff, Engine_Off, (0) rOpr2+, Ignore, (0) rErr, 700);
177 pBRT(rOpr2+, iNeg44, Negate, (0) rOpr2+, Ignore, (1) rOpr2+, 701);
178 pBRT(rOpr2+, iDigit, Any_Number, (0) rOpr2+, Ignore, (1) rOpr2+, 702);
179 pBRT(rOpr2+, iDot59, One_Period, (0) rOpr2+, Ignore, (1) rOpr2+, 703);
180 pBRT(rOpr2+, iDigit, Any_Number, (0) rOpr2+, Ignore, (1) rOpr2+, 704);
181 // Clear
182 pBRT(rOpr2+, iClEnt, Clear_Entry, (0) rOpr2+, Ignore, (1) rOpr2+, 705);
183 pBRT(rOpr2+, iClear, Clear, (0) rOpr1, Ignore, (1) rOpr2+, 706);
184 pBRT(rOpr2+, iSave, Save_Dis, (0) rResu, Save_Dis, (1) rResu, 707);
185 // equals
186 pBRT(rResu, iPer37, Percent, (0) rOpr1, Ignore, (1) rResu+, 900);
187 pBRT(rResu+, iEqual, Equals, (0) rOpr1, SetChain, (1) rResu+, 901);
188 pBRT(rResu+, iChain, Operate, (0) rOpr1+, Error, (0) rErr, 902);
189 pBRT(rErr, iErr86, Error, (0) rOpr1, Unknown, (0) rOpr1, 993);
190 end;

```



www.VSMerlot.com

# Create Steps / Behaviors in Model



Step	Start	End	State	Behavior	Next	Trace
1	0	1	0	Any_Number	0	101
2	1	2	0	Any_Number	0	101
3	2	3	0	Any_Number	0	101
4	3	4	0	Any_Number	0	101
5	4	5	0	Any_Number	0	101
6	5	6	0	Any_Number	0	101
7	6	7	0	Any_Number	0	101
8	7	8	0	Any_Number	0	101
9	8	9	0	Any_Number	0	101
10	9	10	0	Any_Number	0	101
11	10	11	0	Any_Number	0	101
12	11	12	0	Any_Number	0	101
13	12	13	0	Any_Number	0	101
14	13	14	0	Any_Number	0	101
15	14	15	0	Any_Number	0	101
16	15	16	0	Any_Number	0	101
17	16	17	0	Any_Number	0	101
18	17	18	0	Any_Number	0	101
19	18	19	0	Any_Number	0	101
20	19	20	0	Any_Number	0	101
21	20	21	0	Any_Number	0	101
22	21	22	0	Any_Number	0	101
23	22	23	0	Any_Number	0	101
24	23	24	0	Any_Number	0	101
25	24	25	0	Any_Number	0	101
26	25	26	0	Any_Number	0	101
27	26	27	0	Any_Number	0	101
28	27	28	0	Any_Number	0	101
29	28	29	0	Any_Number	0	101
30	29	30	0	Any_Number	0	101
31	30	31	0	Any_Number	0	101
32	31	32	0	Any_Number	0	101
33	32	33	0	Any_Number	0	101
34	33	34	0	Any_Number	0	101
35	34	35	0	Any_Number	0	101
36	35	36	0	Any_Number	0	101
37	36	37	0	Any_Number	0	101
38	37	38	0	Any_Number	0	101
39	38	39	0	Any_Number	0	101
40	39	40	0	Any_Number	0	101
41	40	41	0	Any_Number	0	101
42	41	42	0	Any_Number	0	101
43	42	43	0	Any_Number	0	101
44	43	44	0	Any_Number	0	101
45	44	45	0	Any_Number	0	101
46	45	46	0	Any_Number	0	101
47	46	47	0	Any_Number	0	101
48	47	48	0	Any_Number	0	101
49	48	49	0	Any_Number	0	101
50	49	50	0	Any_Number	0	101
51	50	51	0	Any_Number	0	101
52	51	52	0	Any_Number	0	101
53	52	53	0	Any_Number	0	101
54	53	54	0	Any_Number	0	101
55	54	55	0	Any_Number	0	101
56	55	56	0	Any_Number	0	101
57	56	57	0	Any_Number	0	101
58	57	58	0	Any_Number	0	101
59	58	59	0	Any_Number	0	101
60	59	60	0	Any_Number	0	101
61	60	61	0	Any_Number	0	101
62	61	62	0	Any_Number	0	101
63	62	63	0	Any_Number	0	101
64	63	64	0	Any_Number	0	101
65	64	65	0	Any_Number	0	101
66	65	66	0	Any_Number	0	101
67	66	67	0	Any_Number	0	101
68	67	68	0	Any_Number	0	101
69	68	69	0	Any_Number	0	101
70	69	70	0	Any_Number	0	101
71	70	71	0	Any_Number	0	101
72	71	72	0	Any_Number	0	101
73	72	73	0	Any_Number	0	101
74	73	74	0	Any_Number	0	101
75	74	75	0	Any_Number	0	101
76	75	76	0	Any_Number	0	101
77	76	77	0	Any_Number	0	101
78	77	78	0	Any_Number	0	101
79	78	79	0	Any_Number	0	101
80	79	80	0	Any_Number	0	101
81	80	81	0	Any_Number	0	101
82	81	82	0	Any_Number	0	101
83	82	83	0	Any_Number	0	101
84	83	84	0	Any_Number	0	101
85	84	85	0	Any_Number	0	101
86	85	86	0	Any_Number	0	101
87	86	87	0	Any_Number	0	101
88	87	88	0	Any_Number	0	101
89	88	89	0	Any_Number	0	101
90	89	90	0	Any_Number	0	101
91	90	91	0	Any_Number	0	101
92	91	92	0	Any_Number	0	101
93	92	93	0	Any_Number	0	101
94	93	94	0	Any_Number	0	101
95	94	95	0	Any_Number	0	101
96	95	96	0	Any_Number	0	101
97	96	97	0	Any_Number	0	101
98	97	98	0	Any_Number	0	101
99	98	99	0	Any_Number	0	101
100	99	100	0	Any_Number	0	101



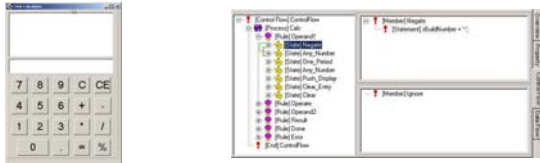
www.VSMerlot.com

# Everything in Sync



Step	Start	End	State	Behavior	Next	Trace
1	0	1	0	Any_Number	0	101
2	1	2	0	Any_Number	0	101
3	2	3	0	Any_Number	0	101
4	3	4	0	Any_Number	0	101
5	4	5	0	Any_Number	0	101
6	5	6	0	Any_Number	0	101
7	6	7	0	Any_Number	0	101
8	7	8	0	Any_Number	0	101
9	8	9	0	Any_Number	0	101
10	9	10	0	Any_Number	0	101
11	10	11	0	Any_Number	0	101
12	11	12	0	Any_Number	0	101
13	12	13	0	Any_Number	0	101
14	13	14	0	Any_Number	0	101
15	14	15	0	Any_Number	0	101
16	15	16	0	Any_Number	0	101
17	16	17	0	Any_Number	0	101
18	17	18	0	Any_Number	0	101
19	18	19	0	Any_Number	0	101
20	19	20	0	Any_Number	0	101
21	20	21	0	Any_Number	0	101
22	21	22	0	Any_Number	0	101
23	22	23	0	Any_Number	0	101
24	23	24	0	Any_Number	0	101
25	24	25	0	Any_Number	0	101
26	25	26	0	Any_Number	0	101
27	26	27	0	Any_Number	0	101
28	27	28	0	Any_Number	0	101
29	28	29	0	Any_Number	0	101
30	29	30	0	Any_Number	0	101
31	30	31	0	Any_Number	0	101
32	31	32	0	Any_Number	0	101
33	32	33	0	Any_Number	0	101
34	33	34	0	Any_Number	0	101
35	34	35	0	Any_Number	0	101
36	35	36	0	Any_Number	0	101
37	36	37	0	Any_Number	0	101
38	37	38	0	Any_Number	0	101
39	38	39	0	Any_Number	0	101
40	39	40	0	Any_Number	0	101
41	40	41	0	Any_Number	0	101
42	41	42	0	Any_Number	0	101
43	42	43	0	Any_Number	0	101
44	43	44	0	Any_Number	0	101
45	44	45	0	Any_Number	0	101
46	45	46	0	Any_Number	0	101
47	46	47	0	Any_Number	0	101
48	47	48	0	Any_Number	0	101
49	48	49	0	Any_Number	0	101
50	49	50	0	Any_Number	0	101
51	50	51	0	Any_Number	0	101
52	51	52	0	Any_Number	0	101
53	52	53	0	Any_Number	0	101
54	53	54	0	Any_Number	0	101
55	54	55	0	Any_Number	0	101
56	55	56	0	Any_Number	0	101
57	56	57	0	Any_Number	0	101
58	57	58	0	Any_Number	0	101
59	58	59	0	Any_Number	0	101
60	59	60	0	Any_Number	0	101
61	60	61	0	Any_Number	0	101
62	61	62	0	Any_Number	0	101
63	62	63	0	Any_Number	0	101
64	63	64	0	Any_Number	0	101
65	64	65</				

# Application, Model, Logic



Control-Flow Logic



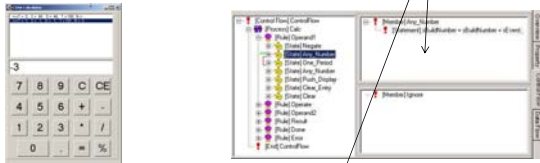
www.VSMerlot.com

# Enter Operand (-3.14159)



www.VSMerlot.com

True Behavior



www.VSMerlot.com

False Behavior



One Period



www.VSMerlot.com

3.1

7 8 9 C CE  
4 5 6 + -  
1 2 3 \* /  
0 . = %

Control Flow ControlFlow  
Process Call  
Play Downoff  
State Negative  
State Any Number  
State One Percent  
State Any Number  
State Push\_Stack  
State One Entry  
State One  
Play Down  
Play DownG  
Play Forward  
Play Done  
Play Exit  
End ControlFlow

Member Any Number  
[Statement] dballNumber + dballNumber + d.ball

Member Ignore

www.VSMerlot.com

**Fractional Part**

## Until Not a Number

-3.14

7 8 9 C CE  
4 5 6 + -  
1 2 3 \* /  
0 . = %

Control Flow ControlFlow  
Process Call  
Play Downoff  
State Negative  
State Any Number  
State One Percent  
State Any Number  
State Push\_Stack  
State One Entry  
State One  
Play Down  
Play DownG  
Play Forward  
Play Done  
Play Exit  
End ControlFlow

Member Any Number  
[Statement] dballNumber + dballNumber + d.ball

Member Ignore

www.VSMerlot.com

3.141

7 8 9 C CE  
4 5 6 + -  
1 2 3 \* /  
0 . = %

Control Flow ControlFlow  
Process Call  
Play Downoff  
State Negative  
State Any Number  
State One Percent  
State Any Number  
State Push\_Stack  
State One Entry  
State One  
Play Down  
Play DownG  
Play Forward  
Play Done  
Play Exit  
End ControlFlow

Member Any Number  
[Statement] dballNumber + dballNumber + d.ball

Member Ignore

www.VSMerlot.com

-3.1415

7 8 9 C CE  
4 5 6 + -  
1 2 3 \* /  
0 . = %

Control Flow ControlFlow  
Process Call  
Play Downoff  
State Negative  
State Any Number  
State One Percent  
State Any Number  
State Push\_Stack  
State One Entry  
State One  
Play Down  
Play DownG  
Play Forward  
Play Done  
Play Exit  
End ControlFlow

Member Any Number  
[Statement] dballNumber + dballNumber + d.ball

Member Ignore

www.VSMerlot.com

Trace

Count	Step	Time	Eng	State	Dynamic	Behavior	Value
1	*P=0	100	OH	44	44	None	N=
2	*P=1	103	OH	1	1	Any Number	N=3
3	*P=1	101	Oh	1	59	Ignore	N=
4	*P=2	102	OH	59	59	One Poss	N=3
5	*P=3	103	OH	1	1	Any Number	N=3
6	*P=3	103	OH	1	1	Any Number	N=3,14
7	*P=3	103	OH	1	1	Any Number	N=3,141
8	*P=3	103	OH	1	1	Any Number	N=3,1415
9	*P=3	103	OH	1	1	Any Number	N=3,14159

Trace

www.VSMerlot.com

## Enter Operation ('-')

Operators

www.VSMerlot.com

www.VSMerlot.com

www.VSMerlot.com

www.VSMerlot.com

Trace Subtract

10	Q=3	103	Oct. 1;	44;	Ignore;	N=-
11	Q=4	104	Oct. 12;	44;	Ignore;	N=-
12	Q=5	105	Oct. 11;	44;	Ignore;	N=-
13	Q=6	106	Oct. 1;	44;	Push_Disp;	N=-
14	Q=7	500	Oct. 43;	44;	Ignore;	N=-
15	=P=8	501	Oct. 44;	1;	Substow;	N=-3.14159

www.VSMerlot.com

## Enter Operand (-2.14159)

www.VSMerlot.com

Negate


www.VSMerlot.com



www.VSMerlot.com



www.VSMerlot.com



Loop until not number

www.VSMerlot.com



www.VSMerlot.com



www.VSMerlot.com

www.VSMerlot.com

Trace

16	=F 12	700	OH	1	1	Engines Off	N=3.14159
17	=F 13	701	OH	44	44	Negate	N=
18	=F 14	702	OH	1	1	Any Number	N=2
19	Q= 14	702	OH	1	59	Ignoc.	N=
20	=F 15	703	OH	59	59	One Peak	N=2
21	=F 16	704	OH	1	1	Any Number	N=2.1
22	=F 16	704	OH	1	1	Any Number	N=2.14
23	=F 16	704	OH	1	1	Any Number	N=2.141
24	=F 16	704	OH	1	1	Any Number	N=2.1415
25	OH=16	704	OH	1	1	Any Number	N=2.14159

www.VSMerlot.com

Enter '='

'=' Not a Number

www.VSMerlot.com



## Not Clear Entry



www.VSMerlot.com

## Not Clear



www.VSMerlot.com

## Not Percent



www.VSMerlot.com

## Equals



www.VSMerlot.com

## Ready for Next Problem

Trace



26	CF=14705	On	1;	13;	Ignore;	N=
27	CF=18706	On	12;	13;	Ignore;	N=
28	CF=17707	On	1;	13;	Save sp	N=
29	CF=15900	On	11;	13;	Ignore;	N=
30	CF=201901	Off	13;	13;	Equal	N=1



www.VSMerlot.com

## Trace - Simple or Robust

- Numbers only
- OR
- Dynamic State
- Static State
- Engine State
- Behavior Name
- Etc.



www.VSMerlot.com

## Trace Can be Inherited

- True Trace Definition
  - Subordinate Call to True Trace
    - Subordinate Call to True Trace
      - Subordinate Call to True Trace
- False Trace Definition
  - Subordinate Call to False Trace
    - Subordinate Call to False Trace
      - Subordinate Call to False Trace



www.VSMerlot.com

## Trace Can Be:

- Enabled
  - Dynamic bind = call to Trace
- Disabled
  - Dynamic bind = call to ignore



www.VSMerlot.com

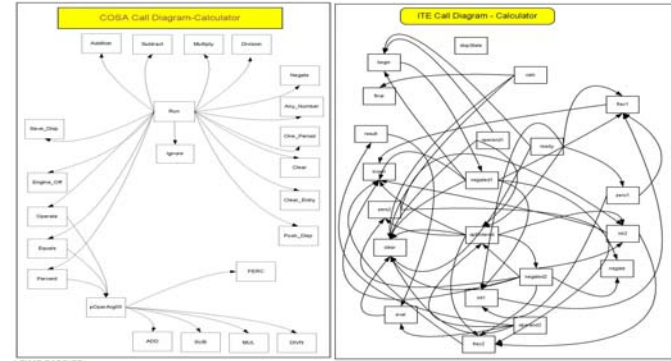
## Trace - All that you want

Count	Step	Trace	Eng	Static	Dynamic	Behavior	Value
1	+T= 0;	100	Off;	44;	44;	Negate;	N= -
2	+T= 1;	101	Off;	1;	1;	Any Number;	N= -3
3	Q= 1;	101	On;	1;	59;	Ignore;	N=
4	+T= 2;	102	Off;	59;	59;	One Perio d;	N= -3
5	+T= 3;	103	Off;	1;	1;	Any Number;	N= -3.14
6	+T= 3;	103	Off;	1;	1;	Any Number;	N= -3.14
7	+T= 3;	103	Off;	1;	1;	Any Number;	N= -3.141
8	+T= 3;	103	Off;	1;	1;	Any Number;	N= -3.1415
9	+T= 3;	103	Off;	1;	1;	Any Number;	N= -3.14159
10	Q= 3;	103	On;	1;	44;	Ignore;	N=
11	Q= 4;	104	On;	2;	44;	Ignore;	N=
12	Q= 5;	105	On;	11;	44;	Ignore;	N=
13	Q= 6;	106	On;	1;	44;	Push Disp;	N=
14	Q= 7;	500	On;	43;	44;	Ignore;	N=
15	+T= 8;	501	On;	44;	1;	Subtraction;	N= -3.14159
16	+T= 12;	700	Off;	1;	1;	Engine Off;	N= -3.14159
17	+T= 13;	701	Off;	44;	44;	Negate;	N= -
18	+T= 14;	702	Off;	1;	1;	Any Number;	N= -2
19	Q= 14;	702	Off;	1;	59;	Ignore;	N=
20	+T= 15;	703	Off;	59;	59;	One Perio d;	N= -2
21	+T= 16;	704	Off;	1;	1;	Any Number;	N= -2.1
22	+T= 16;	704	Off;	1;	1;	Any Number;	N= -2.14
23	+T= 16;	704	Off;	1;	1;	Any Number;	N= -2.141
24	+T= 16;	704	Off;	1;	1;	Any Number;	N= -2.1415
25	+T= 16;	704	Off;	1;	1;	Any Number;	N= -2.14159
26	Q= 16;	705	On;	1;	13;	Ignore;	N=
27	Q= 18;	706	On;	12;	13;	Ignore;	N=
28	Q= 17;	707	On;	1;	13;	Save Disp;	N=
29	Q= 19;	900	On;	11;	13;	Ignore;	N=
30	+T= 20;	901	Off;	13;	13;	Equals;	N= -1



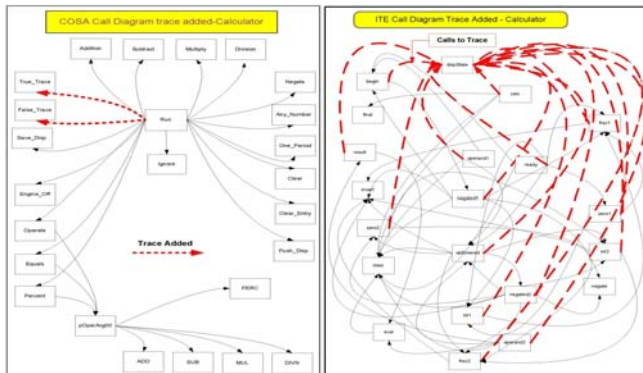
www.VSMerlot.com

## Compare



www.VSMerlot.com

## Now with Trace



www.VSMerlot.com

Was improving the quality of your software products a company goal?

Are you using an object-oriented design methodology because it promotes code reuse and reduces code maintenance and complexity?

Are you happy with the results? Or did you end up with *spaghetti objects*?

My new book provides a clear step-by-step of how to achieve the promise that object technology alone can't deliver.

But it requires change.



www.VSMerlot.com