



Relative importance of traceability

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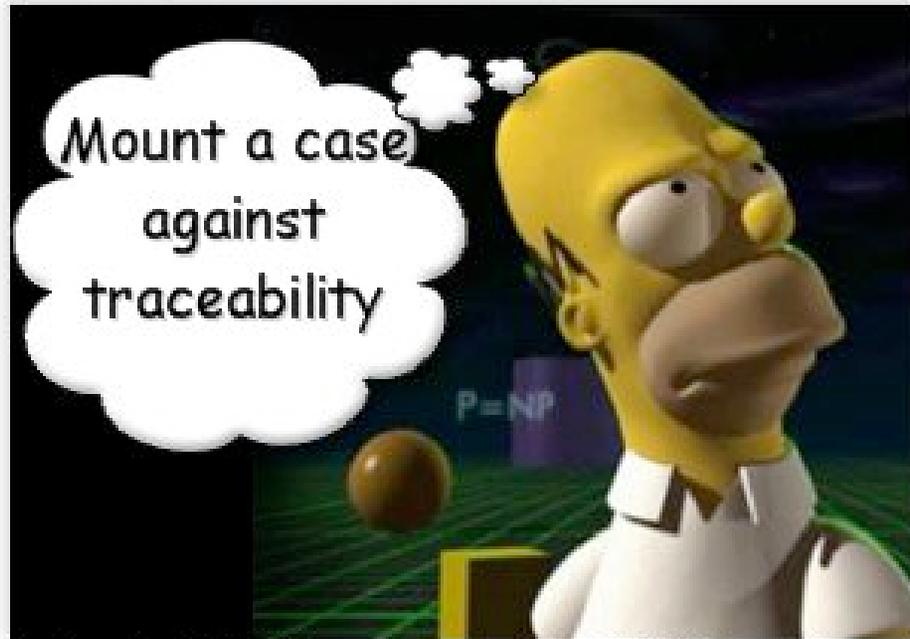
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Presentation to an RE'06 panel on Traceability

JANE HAYES TO TIMM



September 12, 2006

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JANE HAYES TO TIMM

TIMM TO JANE

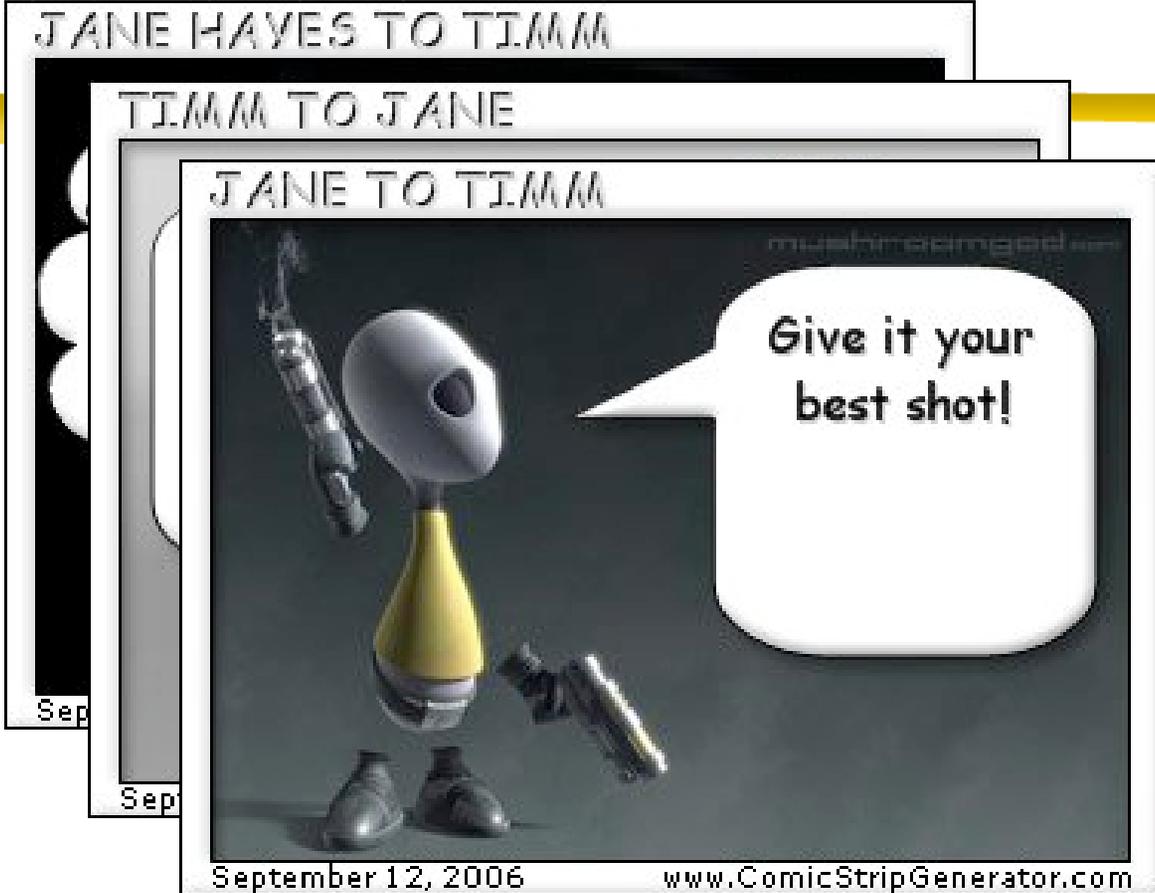
But that's
like arguing
against
oxygen



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O.k. lets argue the relative merits of traceability vs other techniques



- ➔ NASA Software Independent Verification & Validation facility
- ➔ NASA's software police
- ➔ Adapted the IEEE 1012 standard for Software V&V
 - 45 tasks, selected by..
 - Error probability and severity of each software elements
 - What tasks are most expensive and most frequent?



Caveat Emptor



- ➔ Only based on the NASA IV&V work practices
 - NASA IV&V does more static code work than anything else
- ➔ Only based on current NASA practices
 - And that will change as the CONSTELLATION project progresses
- ➔ Assumes the costing structures of NASA
 - May generalize at least to the rest of the aerospace industry
- ➔ Unaware of a similar data source

wbs	factor	CO11	CO12	CO13	CO14	CO15	EP11	EP12	EP13	EP14	EP15
1.1	Management and Planning of IV&V	X	X	X	X	X	X	X	X	X	X
1.2	Issue and Risk Tracking		X	X	X	X		X	X	X	X
1.3	Final Report Generation		X	X	X	X		X	X	X	X
1.4	IV&V Tool Support		X	X	X	X		X	X	X	X
1.5	Management & Technical Review Support	X	X	X	X	X	X	X	X	X	X
1.6	Criticality Analysis	X	X	X	X	X	X	X	X	X	X

probability

severity

2.1	Reuse Analysis*			X	X	X					
2.2	Software Architecture Assessment			X	X	X					
2.3	System Requirements										
2.4	Concept Documents										
2.5	SW/User Requirements Allocation										
2.6	Traceability										

3.1	Traceability Analysis -
3.2	Software Requirements
3.3	Interface Analysis
3.4	System Test
3.5	Acceptance Test
3.6	Timing and Scheduling

wbs	factor	CO11	CO12	CO13	CO14	CO15	EP11	EP12	EP13	EP14	EP15
4.1	Traceability Analysis - Design							X	X	X	X
4.2	Software Design Evaluation				X	X				X	X
4.3	Interface Analysis - Design					X				X	X
4.4	Software FQT Plan Analysis		X	X	X	X					
4.5	Software Integration Test Plan Analysis									X	X
4.6	Database Analysis								X	X	X
4.7	Component Test Plan Analysis										X

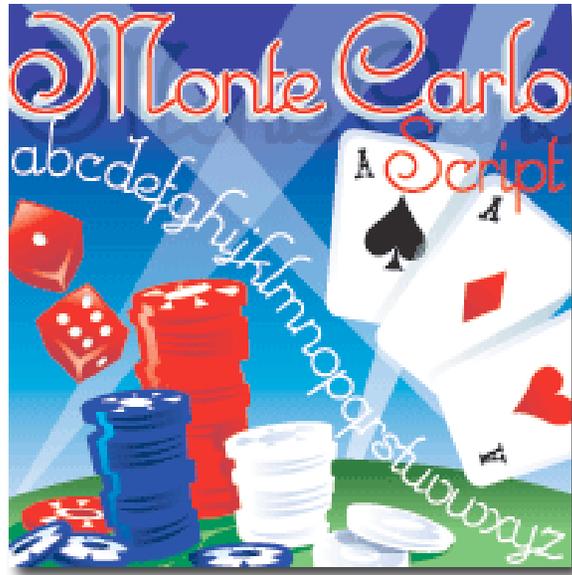
5.1	Traceability Analysis - Code					X		X	X	X	X
5.2	Source Code and Documentation Evaluation				X	X			X	X	X
5.3	Interface Analysis - Code				X	X			X	X	X
5.4	System Test Case Analysis				X	X					
5.5	Software FQT Case Analysis				X	X					
5.6	SW Integration Test Case Analysis										X
5.7	Acceptance Test Case Analysis					X					
5.8	SW Integration Test Procedure Analysis										X
5.9	SW Integration Test Results Analysis									X	X
5.1	Component Test Case Analysis										X
5.11	System Test Procedure Analysis									Z	
5.12	Software FQT Procedure Analysis									Z	

6.1	Traceability Analysis - Test		X	X	X	X					X
6.2	Regression Test Analysis									Z	Z
6.3	Simulation Analysis									Z	
6.4	System Test Results Analysis				X	X					
6.5	Software FQT Results Analysis				X	X					

7.1	Operating Procedure Evaluation									Z	
7.2	Anomaly Evaluation									Z	
7.3	Migration Assessment									Z	
7.4	Retirement Assessment									Z	

Wbs=
SILAP (software
elements)

Monte Carlo SILAP



- ➔ Generate 500 software elements
 - at the same frequency as those seen at NASA
- ➔ Pass to each to SILAP
 - Compute {probability,severity} for each
- ➔ Cache the frequency (F) with which the 1012 tasks are selected
 - Multiply those frequencies (F) by the cost (C) of each task



Predicted normalized frequencies (F) of IEEE 1012 tasks seen @ ivv.nasa

only 23 out of 46 have F > 0

Traceability Analysis - Requirements	7,	*****
Traceability Analysis - Test	7,	*****
Software FQT Plan Analysis,	7,	*****
Component Test Case Analysis,	6,	*****
Traceability Analysis - Code,	6,	*****
Traceability Analysis - Design,	6,	*****
Reuse Analysis*,	5,	*****
Software Requirements Evaluation,	4,	****
System Requirements Review,	4,	****
Interface Analysis - Code,	4,	****
Source Code and Documentation Evaluation,	4,	****
Interface Analysis - Requirements,	4,	****
System Test Plan Analysis,	4,	****
Software Architecture Assessment,	4,	****
Database Analysis,	2,	**
Software Design Evaluation,	2,	**
Software FQT Results Analysis,	2,	**
System Test Results Analysis,	2,	**
Software FQT Case Analysis,	2,	**
System Test Case Analysis,	2,	**
Traceability Analysis,	1,	*
SW/User Requirements Allocation Analysis,	1,	*
Concept Document Evaluation,	1,	*

← Sums to 100

Normalized costs (C) of IEEE 1012 tasks seen @ IVV.Nasa

only 25
out of 46
have C > 0

Simulation Analysis,	22,	*****
Source Code and Documentation Evaluation,	11,	*****
Interface Analysis - Code,	5,	*****
SW Integration Test Results Analysis,	4,	****
Software Requirements Evaluation,	4,	****
Software Design Evaluation,	4,	****
Software FQT Results Analysis,	3,	***
Traceability Analysis - Code,	3,	***
Software FQT Plan Analysis,	3,	***
Regression Test Analysis,	3,	***
Traceability Analysis - Design,	2,	**
Traceability Analysis - Test,	2,	**
System Test Results Analysis,	2,	**
Interface Analysis - Design,	2,	**
Software FQT Case Analysis,	2,	**
Software Integration Test Plan Analysis,	1,	*
Traceability Analysis - Requirements,	1,	*
Interface Analysis - Requirements,	1,	*
Software Architecture Assessment,	1,	*
System Test Procedure Analysis,	1,	*
Acceptance Test Case Analysis,	1,	*
System Requirements Review,	1,	*
System Test Plan Analysis,	1,	*
System Test Case Analysis,	1,	*
Reuse Analysis*,	1,	*

Sums to 100

Normalized (frequency * costs) of IEEE 1012 tasks @ ivv.nasa

only 18 out of 46 have $F \cdot C > 0$

Traceability: in the top 9 of 46

Source Code and Documentation Evaluation,	20,	*****
Interface Analysis - Code,	9,	*****
Traceability Analysis - Code,	9,	*****
Software FQT Plan Analysis,	8,	*****
Traceability Analysis - Design,	7,	*****
Software Requirements Evaluation,	7,	*****
Traceability Analysis - Test,	6,	*****
Software Design Evaluation,	4,	****
Traceability Analysis - Requirements,	4,	****
Reuse Analysis*,	3,	***
Software FQT Results Analysis,	2,	**
Simulation Analysis,	2,	**
System Test Plan Analysis,	2,	**
Interface Analysis - Requirements,	2,	**
System Requirements Review,	2,	**
Software Architecture Assessment,	2,	**
System Test Results Analysis,	1,	*
Software FQT Case Analysis,	1,	*

Top 50%

To do:

- 1) Focus on code & design traceability
- 2) Reactive the missing 28 tasks
- 3) Assess tasks by F,C & effectiveness

Requirements traceability: ranks fourth

Sums to 100