

DebugLive.com presents:

# The Life and Times of Software Bugs

**Donis Marshall**



# Presenter

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- President, DebugLive.com
- Microsoft Press author
  - Most recent book – Solid Code
  - Best Seller – Programming Microsoft Visual C# 2005
- 30 years of computer programming experience ( first computer – abacus )

# Course contents

- Overview
- Part 1: Ten notable software bugs
- Part 2: Ten notable debugging tools
- Part 3: Steps to prevent a bug



# Overview

# Overview

- Everyone has software bugs.
- As the definition of a software company evolves, the prevalence and scope of these bugs increases dramatically.
- For this reason, software bugs can affect everyone – even those far removed from technology.
- Management that does not invest adequate resources in bug prevention, testing, and software support are gambling with the future of their company.

# Is this a software company?


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Life and Times of Bugs

# A Software Parable

## Software Problem Spoof - Halifax Comedy Festival

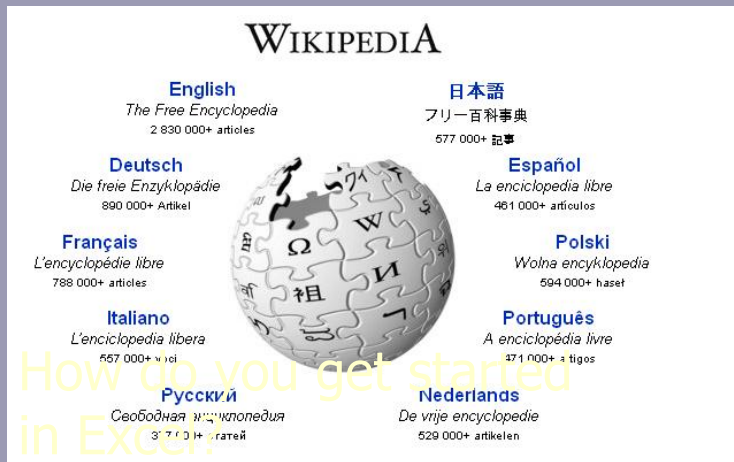


[http://www.youtube.com/watch?v=Lnu9XxF2\\_J8](http://www.youtube.com/watch?v=Lnu9XxF2_J8)

Life and Times of Bugs

# When you know there is a real problem (1)

If your software bug becomes a entry in Wikipedia.



Many of the following software bugs have that dubious distinction. This does not include the harm to the organization, forfeited revenue, and sometimes lost jobs (i.e., someone was fired).

# When you know there is a real problem (2)



If your software bug becomes a video on YouTube.

<http://www.youtube.com/watch?v=Qb1jB3d920E>

# Part 1

## **Notable Software Bugs**

# Notable Software Bug : 1



What does a Prius have in common with a software bug?

# Prius software bug

- Last year, Toyota recalled 160,000 of its Prius hybrid vehicles because the vehicle warning lights illuminated for no reason, and cars' gasoline engines stalling unexpectedly.
- **Problem:** the root of the Prius issue wasn't a hardware problem -- it was a programming error in the smart car's embedded code. *The Prius had a software bug.*
- **Result:** 160,000 Prius hybrid vehicles recalled to update the software with a patch. The financial cost for Toyota was enormous.



# Harvard Mark II Bug

- The Mark II was an electromechanical computer built at Harvard University and commissioned by the U. S. Navy.
- **Problem:** On September 9, 1947, a moth was found trapped in Panel F of the Mark II Aiken Relay Calculator. This caused errors in mathematical calculations. The moth was removed and later attached to a computer log, with this statement: "First actual case of bug being found."
- **Result:** Better bug control.

# Mark II



Life and Times of Bugs

# Notable Software Bug : 3



Some software bugs can kill you.

# Multidata Systems International Bug

- Therapy planning software from Multidata Systems International calculates radiation doses incorrectly.
- **Problem:** The software would not allow physicians to designate five protective areas from radiation. Workaround created by doctors unknowingly created the miscalculation.
- **Result:** 8 Patients died. 20 others seriously affected. The physicians that created the “work around” were indicted criminally for murder.

# Notable Software Bug : 4

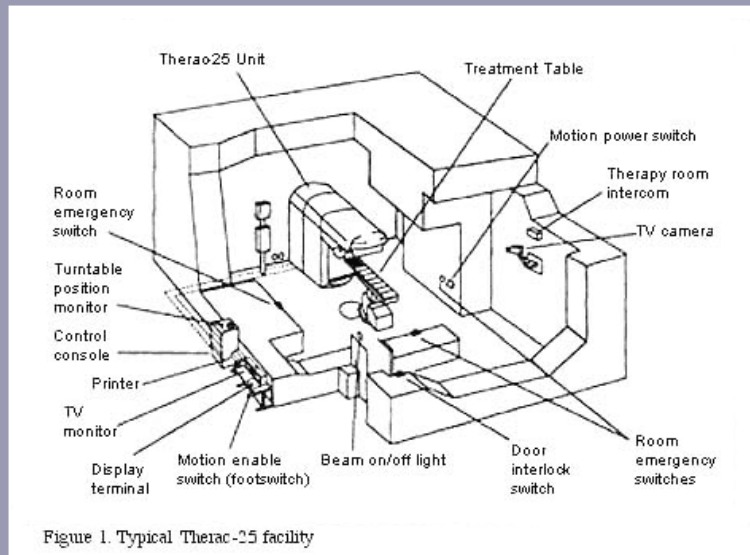


Sometimes life is stranger than fiction bug.

# Soviet Gasline bug

- This is the only bug to involve sabotage and the United States government at its best. Our tax dollars hard at work.
- **Problem:** The Soviet Union illicitly purchased a computer system for their pipeline system. Their reward: the CIA planted a software bug in the system. Unknowingly the software bug contained a bug itself, which resulted in a massive pipeline explosion.
- **Result:** No fatalities but greatly damaged the Russian economy.

# Notable Software Bug : 5



The potential of software bugs lurks in unexpected places.

# Therac Medical Accelerator Bug

- The Therac-25 is an automated radiation therapy machine, which delivered radiation dosage to patients.
- **Problem:** Because of an unknown race condition, someone could accidentally configure the Therac-25 to fire an electron beam in high-power mode but with the metal X-ray target out of position.
- **Result:** From June 1985 to January 1987, the Therac-25 delivered at least six overdoses of radiation, which killed or harmed patients.

# Notable Software Bug : 6



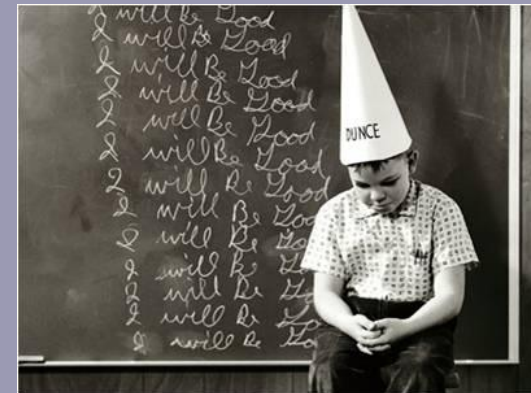
The \$ 475 million software bug.

# Pentium FDIV Bug - Problem

Intel Pentium chips were making floating point errors when dividing numbers within a certain range. For example, dividing  $4195835.0/3145727.0$  yields 1.33374 instead of 1.33382, an error of 0.006 percent.

# Pentium FDIV Bug – Result

- Second mistake (the first being the bug itself) was Intel's response to the problem.
- More than 4 million users were potentially affected by the problem.
- Intel initially agreed to replace only those chips where the user could demonstrate an actual problem or impact to themselves.
- The result was a publicity nightmare.



# Notable Software Bug : 7



Software bugs can even travel into space.

# Ariane 5 Flight 501 Bug

- The Ariane 5 rocket is an unmanned rocket for launching satellites into space. The rocket was the successor to the Ariane 4 rocket.
- **Problem:** The software operating environment from the Ariane 4 rocket is reused in Ariane 5 with insufficient testing. What was not understood is that the hardware of the Ariane 5 runs much faster than then its predecessor. This uncovers a flaw in the software system.
- **Result:** Shortly after launch, the rocket disintegrates. Total cost: \$8.5 billion dollars.

# Notable Software Bug : 8



An expensive  
Christmas present

# Comair/Delta Bug

- Comair, a Delta Airlines subsidiary, has a software system for scheduling flight crews – called the SBS System. The SBS System had been acquired from a subsidiary of Boeing.
- **Problem:** The catalyst of the problem is bad weather, which caused substantial airline crew reassignment. This overflows a field designed to hold a value less than 32,768.
- **Result:** Delta did not know where to get crewmembers for new and rescheduled flights. This caused the cancellation of thousands of flights only days before Christmas.

# Notable Software Bug : 9



Bugs in the  
telephone system

# AT&T 4ESS Switch

- 4ESS is a long distance switch used by AT&T to connect long distance phone calls.
- **Problem:** A bug in updated software for the AT&T's #4ESS long distance switches causes these computers to crash when they receive a specific message from an adjacent computer.
- **Result:** 114 computers crash and are rebooting every six seconds, leaving an estimated 60 thousand people without long distance service for nine hours.

# Notable Software Bug : 10

**child support agency**

Software bugs can affect everyone – in all walks of life

# Child Support Agency Bug

- Electronic Data System (EDS) contracted to provide a software system to the UK Child Support Agency.
- **Problem:** At the same time that EDS introduces the new system, another government agency restructures a peer system. Bugs were introduced as the result – more than five hundred bugs.
- **Result:** The two systems are incompatible. \$1.9 billion underpaid to people, \$7 billion in uncollected child support, and more. Direct cost: more than \$1 billion dollars.

# Part 2

## **Notable Software Tools**

# Microsoft Visual Studio

- Lightweight debugging
  - Should be the first tool to use when debugging
  - Remote debugging capability
  - Javascript debugging
  - SQL debugging
  - Mix-mode debugging
- Well-known user interface
- Well documented
- IDE including a compiler for a variety of languages
- Code analysis

# Windbg

- Advanced Kernel- and User-mode debugger downloaded from the Debugging Tools For Windows Package website from Microsoft.
- Benefits
  - Many advanced features
    - Deadlocks
    - .NET debugging
    - Small footprint relative to Visual Studio
    - Debugging extensions
- Disadvantages
  - Steep learning curve
  - Primarily a command-line tool

# Visual SoftIce

- Visual SoftIce is part of the DevPartner product suite from Compuware
- Benefits
  - If Windbg is an advanced debugger, Visual SoftIce is an advanced debugger on steroids.
    - Visual SoftIce offers several features, particularly for kernel mode debugging, that are unique.
  - Best debugging tool for device drivers and system programmers
- Disadvantages
  - Steep learning curve

# Total View Etnus

- Total View Etnus is a user mode debugger for the Linux and Macintosh environment. Of the recommended tools, this is the only debugger that target the Linux and Macintosh platform.
- Benefits:
  - Supports OpenMP and MPI debugging
  - Record and replay debugging
  - Memory Debugging

# FXCop / Code Analysis

- FxCop and Code Analysis are products available from Microsoft for .NET Programming. Both of these tools perform static analysis on .NET assemblies and confirm adherence to the .NET Framework Design Guidelines.
- FxCop is available as a separate tool apart from Visual Studio.
- Code Analysis is the productized version of FxCop that is deployed as a component of Visual Studio.
- Managed developers should use these products for proactive debugging of .NET assemblies.

# Application Verifier

- The Application Verifier is a desktop tool from Microsoft and a runtime verification tool for native applications. This is a helpful product to locate otherwise undiscovered bugs. This should be used as a part of the testing process.
- Benefits
  - Easy to use
  - Memory leaks
  - Critical section usage
  - Handle problems

# PageHeap

Pageheap is a utility for tracking memory. The utility notates every allocation and memory release. This is used to track memory utilization and leaks. You can specify the type of memory tracked: new, HeapAlloc, COM, and so on.

# ADPlus

- ADPlus is Autodump+ and included in the Debugging Tools for Windows package, which is from Microsoft. ADPlus is used for postmortem analysis and creating dumps and other files on a crash or hang condition. ADPlus automates CDB, which is the console debugger.
- Benefits
  - Configurable
  - Programmable
  - Clear text
  - ADPlus scripts already exists for many contexts

# SysInternals

- SysInternal is a Microsoft website. A variety of tools and utilities are published at this website, which are useful to developers. Many of the tools, such as DebugView, are helpful when debugging.

<http://technet.microsoft.com/en-us/sysinternals/default.aspx>

- Benefits
  - Free
  - Comprehensive
  - Unique

# DebugLive.com

- The first full-featured web-based usermode debugger for Windows applications. You can debug local or remote applications.
- Written from the perspective of support engineers and developers
- Benefits:
  - Remote features
  - Collaboration and enterprise debugging
  - Advanced debugger with easy to use user interface
  - Snapshot feature
  - Extensible
- Available June 2009

# Part 3

## **Debugging Tenets**

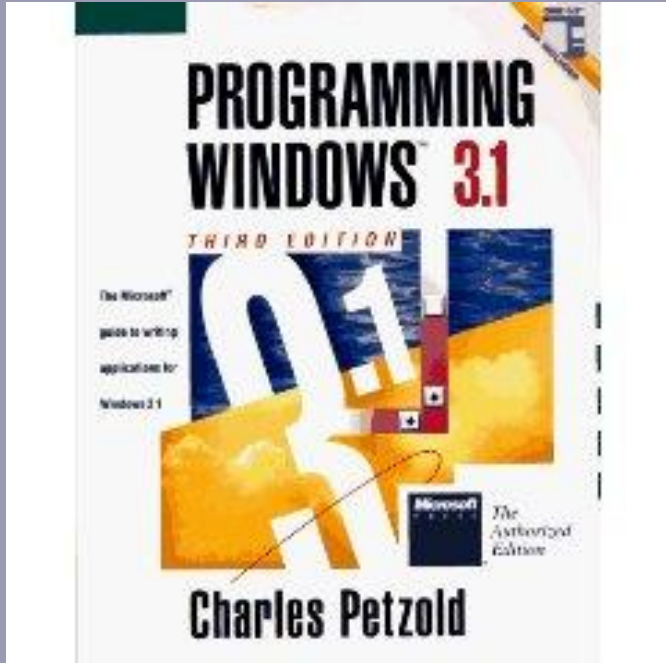
# The Perfect Software Application



**The perfect application does not exist.**

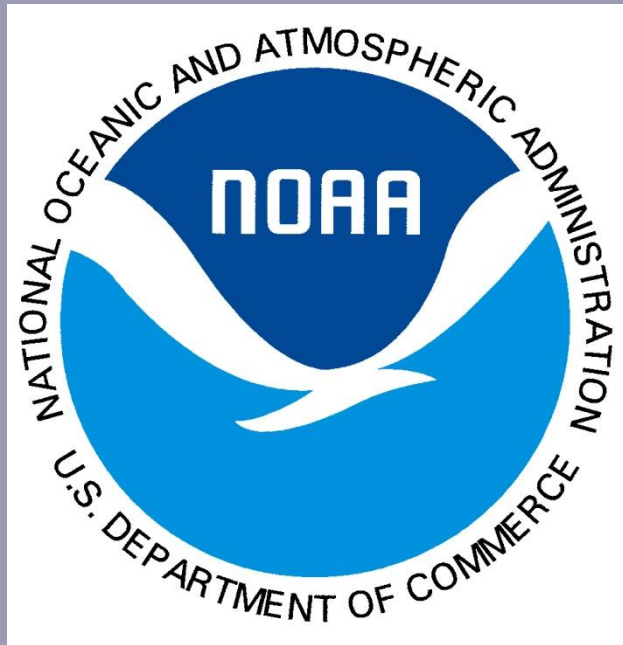
1. Beware of developers that say otherwise.
2. You must have an organized and efficient test and support organization in place.
3. Of course, effective bug tracking is essential.
4. Encourage developers to find and report bugs – do not punish them.

# Lack of Knowledge



- 15 years ago, one book (Programming Windows 3.1) encompassed everything a developer needed to know about Windows programming.
- Now a dozen books would not cover a small fraction of Windows programming.
- It is hard for a programmer to know “everything”.
- This lack of knowledge is a primary source of bugs.
- Promote specialization and education.

# Problem Domain

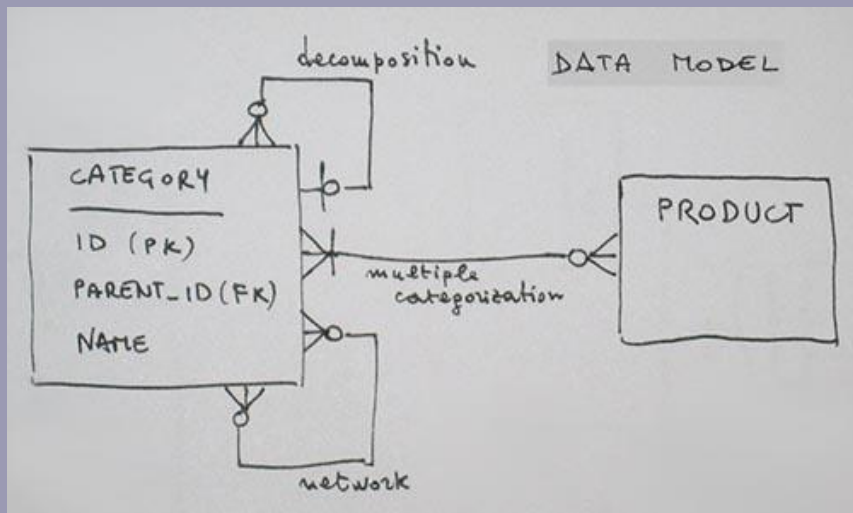


It is no longer sufficient to simply be a great programmer. You must know the problem domain. If not, this creates other kinds of bugs:

- Unmet expectations
- Fragile applications
- Scalability

A SME (subject matter expert) is often a solution. Set the expectation early that developers must know more than code.

# OOAD



- Object oriented programming without adherence to OOAD is akin to driving a car without wheels.
- Code first and think later approach is a recipe for disaster.
- It is essential that management recognize the importance and provide time for OOAD.

# Life without OOAD



Life and Times of Bugs

# Feature creep



Feature creep is:

- Main culprits of bugs in an application
- Demoralizes the project team
- Causes missed deadlines

Freeze product features at or before 75% completion of the project. If needed, cut features to maintain deadlines.

# Simplicity versus Complexity



Unneeded complexity causes:

- Feature creep
- Makes the application harder to debug
- Causes missed deadlines

Your mantra: complexity should be driven by requirements.

# Design and Architecture documents



Keep architecture and design documents available and current. When something goes wrong, these documents are invaluable.

- Reduces cost of debugging existing software problems
- Important knowledge (starting point) for new team members

In an informal survey, less than 50% of computer companies have these documents.

# Reasonable timelines

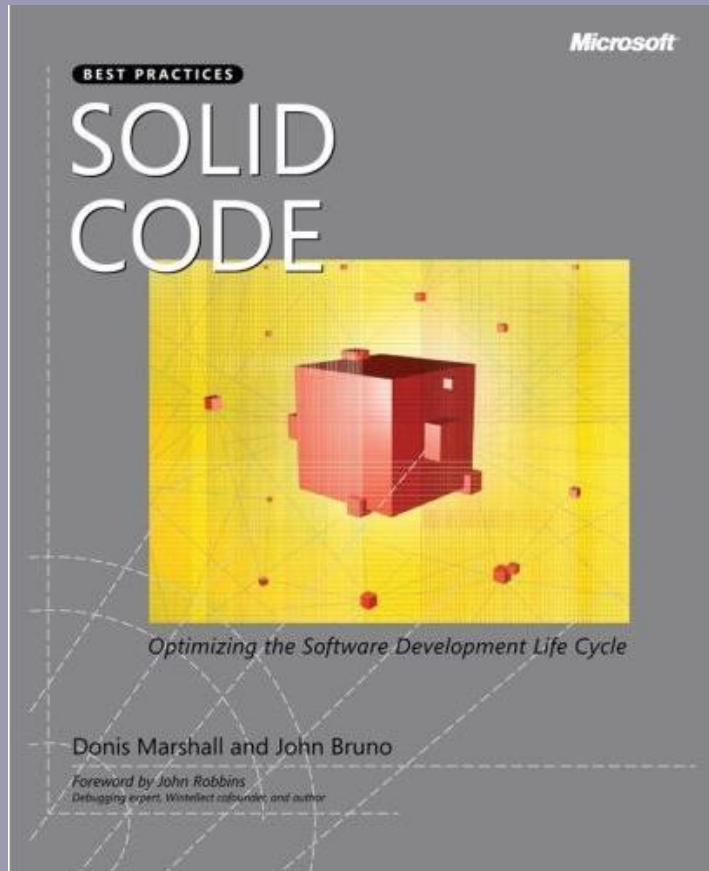


Set reasonable expectations when setting timelines. Be sure to set aside appropriate time for:

- Testing
- Timeline
- Decompose tasks
- Vacation

Remember: developers are prone to over confidence. Keep them real.

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Life and Times of Bugs

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