1. Problems of Big Software

Prof. Dr. rer. nat. habil. Uwe Aßmann
Institut für Software- und Multimediatechnik
Lehrstuhl Softwaretechnologie
Fakultät für Informatik
TU Dresden
2011-0.1, 10.10.11

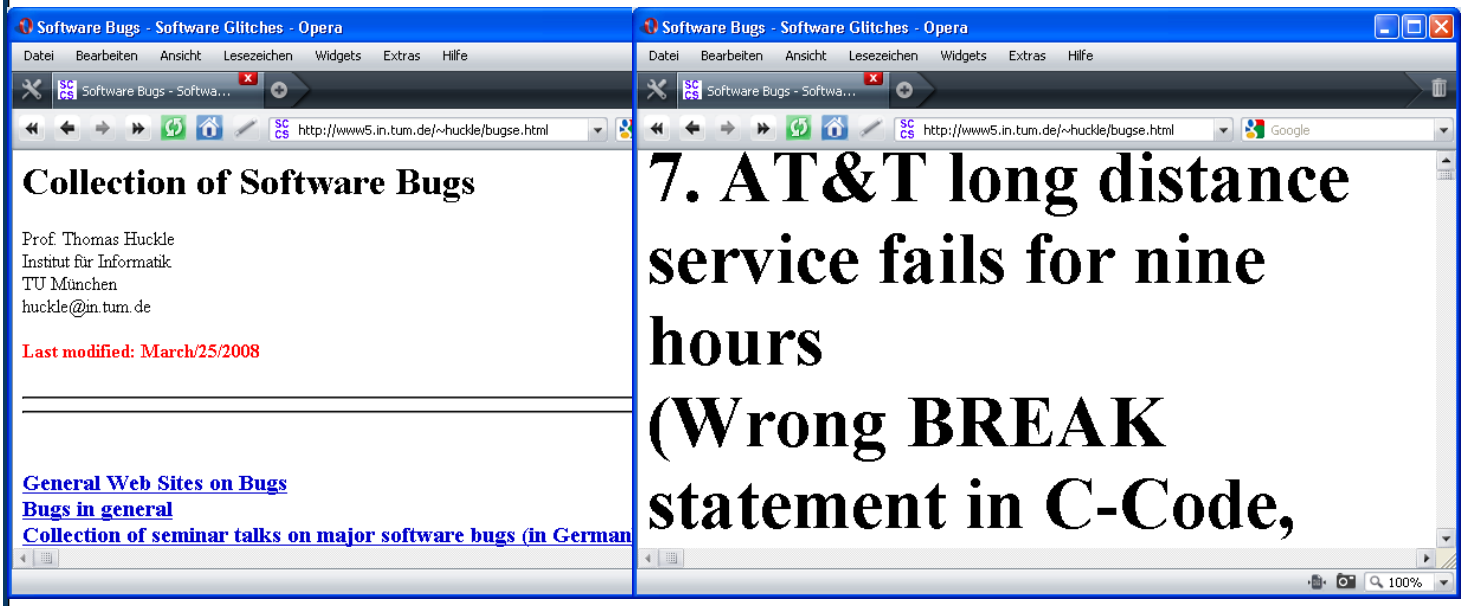
Obligatorisches Lesen

- **Balzert sagt nicht so viel aus**
- **Ghezzi Chapter 1 *oder***
- **Pfleeger Chapter 1; Chap 8.1**

- **http://homepages.cs.ncl.ac.uk/brian.randell/NATO/**
  The first International Conference on Software Engineering (ICSE) 1968.

- **S. Garfunkel: Die schönsten Software-Fehler**
  http://www.wired.com/news/technology/bugs/0,2924,69355,00.html
- **Risks.org: www.risks.org Die Seite für Softwarefehler**

- **Zusammenstellung von Prof. Thomas Huckle**
- **http://www5.in.tum.de/~huckle/bugse.html**



- **Peter G. Neumann http://www.risks.org**
  Das *Risk Digest* sammelt voller Akribie Softwarefehler

Mercedes console display with conflicting information
<Henry Baker <hbaker1@pipeline.com>>
Fri, 14 Dec 2007 10:48:39 -0800

The console display says "check engine" & "no malfunction" at the same time! Dueling messages!

It is supposed to say "check engine" & "1 malfunction", if "check engine" is the only malfunction being reported.

- **"Software-Krise":**
  - Fehler in Computersystemen sind fast immer Softwarefehler.
  - Software wird nicht termingerecht und/oder zu höheren Kosten als geschätzt fertiggestellt.
  - Software entspricht oft nicht den Anforderungen ihrer Benutzer.
- **Begriff der Software-Krise existiert seit 1968 bis heute !**
  - 70er Jahre:
    - Mangelhafte Beherrschung der Basistechnologie
  - 90er Jahre und Millennium:
    - Große (software-)technologische Fortschritte
    - Mangelhafte Beherrschung des Wachstumstempos und des Anpassungsdrucks

We undoubtedly produce software by backward techniques.
D. McIlroy, ICSE 1968

Was heißt hier "groß"?

Klasse	Anzahl der Codezeilen	Personenjahre zur Entwicklung
Sehr klein	Bis 1000	Bis 0.2
Klein	1000 - 10000	0.2 - 2
Mittel	10000 - 100000	2 - 20
Groß	100000 – 1. Mio	20 - 200
Sehr Groß	Über 1. Mio	Über 200

Riesige Systeme

- **Telefonvermittlungssoftware EWSD (Version 8.1):**
  - 12,5 Mio. Code-Zeilen
  - ca. 6000 Personenjahre
- **ERP-Software SAP R/3 (Version 4.0)**
  - ca. 50 Mio. Code-Zeilen
- **Gesamtumfang der verwendeten Software (Anfang 2000):**
  - Credit Suisse 25 Mio. Code-Zeilen
  - Chase Manhattan Bank: 200 Mio. Code-Zeilen
  - Citicorp Bank: 400 Mio. Code-Zeilen
  - AT&T: 500 Mio. Code-Zeilen
  - General Motors: 2 Mrd. Code-Zeilen

Abkürzungen:
EWSD = Elektronisches Wählsystem Digital (Siemens-Produkt)
ERP = Enterprise Resource Planning
SAP: Deutscher Software-Konzern

- **Top Players: IBM, Microsoft, HP, Hitachi, Computer Associates, Google, Oracle, SAP**
- **2/3 standard software : 1/3 individual software (with growing rate)**
- **Life Cycle of Software**
  - Average: 5 – 15y
  - max > 35 y (control software, certified systems, data bases)
    - Programmers die out
  - Development time: 1 – 3y

- **Contrary to Grosch's Law, hardware speed doubles every 2 years, but software productivity increases only about < 5%/y**
- **Costs**
  - acad. Prototype / acad. Product / Product = 1 : 3 : 3
  - Commercialization is rather difficult
- **Relation of development and maintenance 40:60 up to 20:80**
  - Development and maintenance are done by different departments
- **Costs: Extreme Requirements**
  - **Certification**: show the software and its development process to a certification agency (TÜV, etc.)
  - Insurance: certified software must be executable after 40 years
  - Ex.: German pension rules of the 50s must be processed today
    - Nobody knows the details anymore
    - Solution: write an interpreter for the old assembler
    - This has happened twice..

Cost Example: The Year 2000 Problem

- **COBOL programmers saved space and stored only the last two digits of the year**
  - In the 70s, programs should only live 20 years
- **In 2000, catastrophes were prophesied**
  - Power plants?
  - Pension insurances (birth dates)
- **From 1996 on, the industry panicked**
  - Spent enormous amounts to update software
- **New systems got installed**
  - SAP R/3 with date data type
- **Rewriting didn't work**
  - Programmers didn't trust the rewrites
  - Solution: sliding window technique

Cost Example: The Euro Introduction

- **End of 2001, many countries introduced the Euro**
- **Too bad: on paper, the Euro was introduced 2 years before**
  - Some companies had to maintain double booking for 2 years
  - At least for some months in 2002
  - Double booking was very costly: accounts had to be printed in two currencies
- **How to test the transition?**
  - In May 2001, the Dresdner bank ran a test
  - Which failed,.. And produced many wrong money transfers!
- **Many people worked day and night...**

Cost Example: Telecommunication

- **Telecommunication: Failure < 1 h./40 y., working rate 99.999%**
  - One second failure may cost $5Mio
- **Telecommunication software product line**
  - 20-30 000 Module of 1000 loc (lines of code)
  - Single product has 2-8000 modules
- **Necessary: 5000 persons/7years.**
- **Costs ca. 7 billion €.**
- **Size of world market 50 billion €**
- **How many suppliers can exist?**

Human Problems

- **Programmers are not educated well**
  - To develop
  - To communicate
- **Software construction is a social process**
  - It's hard to organize people
- **Software stays, the people go**
  - Software evolves, many versions
- **Projects run out of time**
  - How to control?
- **Programmer Productivity – Rules of Thumb**
  - System software: 1000-2000 loc/y
  - System like Software: 5000 loc/y
  - Application software: 5-10000 loc/y
  - Master's thesis: 10-20000 loc/thesis
- **Individual differences up to factor 5**
  - Has not changed in the last 30 years
- **Differences by programming language and reuse mechanisms**

Softwaretechnologie (Software-Engineering)
Softwareingenieurswesen
Softwaretechnik: Einzeltechnik aus der Lehre der Softwaretechnologie

software engineering: Die Entdeckung und Anwendung solider Ingenieur-Prinzipien mit dem Ziel, auf wirtschaftliche Weise Software zu bekommen, die zuverlässig ist und auf realen Rechnern läuft.

(F.L. Bauer, NATO-Konferenz Software-Engineering 1968)

- **NATO Conference on Software Engineering in Garmisch-Patenkirchen. Oct 7-10, 1968**
- **"The whole trouble comes from the fact that there is so much tinkering with software. It is not made in a clean fabrication process. What we need is Software Engineering." Friedrich L. Bauer, 1968**
- **Hence the conference was called "on Software Engineering" [in Thayer&McGettrick IEEE Press]**
- **→ "Software Crisis"**
- **"Component Software"**

E. Dijkstra

K. Samuelson (Stack)

D. McIlroy "Mass-produced Software Components"

W. van der Poel

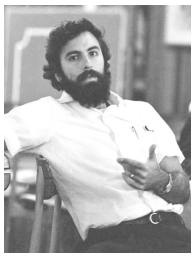
B. Randell

D. Gries

T. Hoare

3rd from right: G. Goos

A. Perlis



J. Feldman

C. Strachey

N. Wirth

P. Brinch Hansen

Different Forms of Software – A Classification

- **Artefact: (lat. artificially made)** Code or text or graphics that is made for software (documentation, specification, code, models, etc.)
- **Program:** Sources with object files, libraries
- **Model:** Partial program, abstracting from many details, cannot directly be executed, used during development
- **Software:** Program with user and developer documentation, requirement specification, design descriptions, implementation description, well-elaborated test suite
- **Product:** Mature software. Good, simple, and pedagogic documentation. Simple Installation. Support guaranteed
  - Companies like products
- **Product line (product family):** A group of products, having a common framework and product-specific extensions.
  - Note: every product is sold independently
- **Framework:** A software skeleton for many or all products in a product line

Lehman's Classes of Programs

- **Specification programs (S-programs)**
  - A formal problem specification exists, describing problem and solution
  - The specification allows for checking the solution on validity (formal checks or formal proofs)
- **Problem solving programs (P-programs)**
  - Can be formalized and checked
  - Have requirements for usability and appropriate
- **Embedded programs (E-programs)**
  - Embedded in a social context
  - The specification is a social process; the functionality depends on the involved people
  - No correctness proofs possible

- **First, you will be a designer and programmer in a team**
  - You will need design skills most urgently for your own and small-size projects
  - In the software process, design flaws are most costly
- **Afterwards, you will be project leader**
  - Without good knowledge in design, you will not be a good developer nor project leader
- **And then manager**
  - But neither a good manager
  - Basic Microsoft strategy: every manager must be able to program
- **.. but some gamble instead [Gates]...**

- **Some become entrepreneurs**
- **What is an entrepreneur?**
  - [Prof. R. Würth: Lecture notes on entrepreneurship http://www.iep.uni-karlsruhe.de/seite_260.php]

> Ein Unternehmer ist ein Problemlöser.
> Insbesondere sind ein Unternehmer und ein Kapitalist zweierlei. Der Kapitalist sieht den Gewinn im Mittelpunkt, aber der Unternehmer findet seine Befriedigung nur im Lösen von Problemen seiner Kunden und seiner Mitarbeiter. Damit kann er zwar auch Geld verdienen, im Wesentlichen lebt er aber nur einen grundlegenden Zug des Menschen aus: für Probleme befriedigende Lösungen zu finden.

What did we learn?

- **Big software creates big problems**
- **Some software has extreme requirements**
- **Sound engineering is necessary**

The End

- **Some german slides are courtesy to Prof. H. Hussmann.**