Realities of (Scientific Software) Engineering

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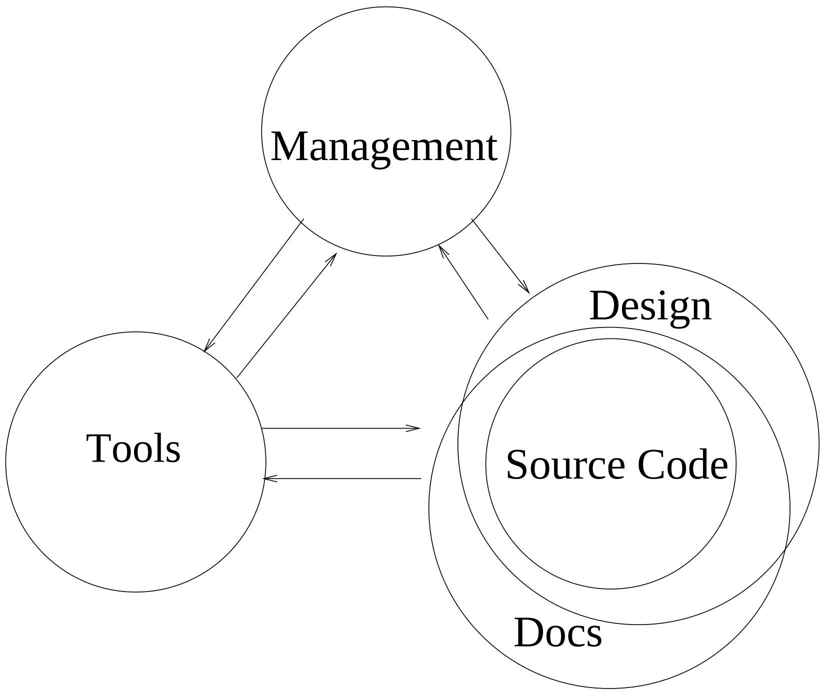
Methodology in General

- Meta + Hodos + Logia
- A regular and systematic way of accomplishing something
- Algorithms for humans
- One brings theory into practise using a methodology
- If theory and practise fail: methodology
- The human equation: intelligence, discipline, sociology, psychology

Software Engineering

Issues in this talk:

- What's (different in Scientific) Software Engineering?
- What mistakes did we make and what solutions do we use?
- First mistake: Software Engineering $\equiv$ Programming



Management: Goals (1/2)

- 2nd mistake: Normal Software Engineering in a Research group
- The General Mission Statement:

  "Make Software That Makes Profit"

  → Efficient Engineering Process

  → Marketability

  → Timing

  → Competition

  → Money and investments

  → <u>Continuity</u>

Management: Goals (2/2)

- Our Mission Statement

  "Invent New Stuff, Proof that it works, Teach it"

  → Almost the same implications, plus...

  → No innovations, real inventions

  → General relevance, genericity

  → Explainability and simplicity

  → No profit ≡ No motivation for investments

- Conclusions:

  More work with less money and less time

  → Do less and more efficient!

  → Invest in more efficiency

Management: People (1/2)

- Roles/Actors in the general Software Engineering process:

  Managers: General, Sales, Technical, Floor

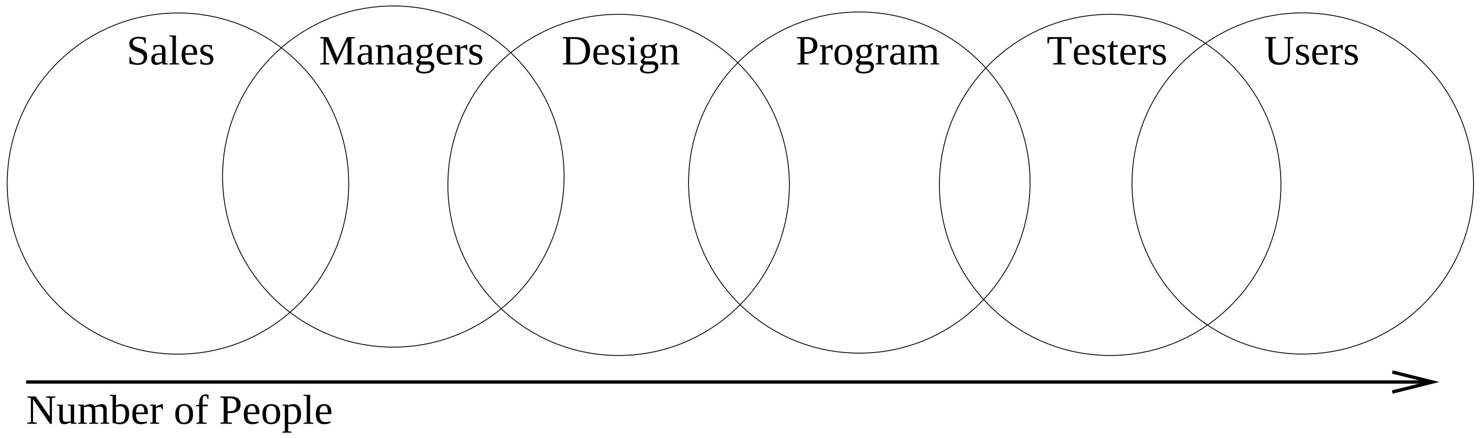
  Sales persons

  Designers: Architectural, Functional

  Programmers

  Testers

  Users



Management: People (2/2)

- Reality: We do not have many people

- But we do have the same roles to act!
- Highly educated thinkers and speakers
- Conclusion: be aware of your role in the engineering process at any time, and be aware of the role of others

Management: conflicting interests

- Time: Papers versus Software

  Long term continuity versus short term results

  Usability versus new functionality

- Judgement

  Individual versus group

  Short term versus long term

  Internal versus external

- Shared conflicts

  Shared software $\equiv$ shared papers

  $\rightarrow$ Software supports papers

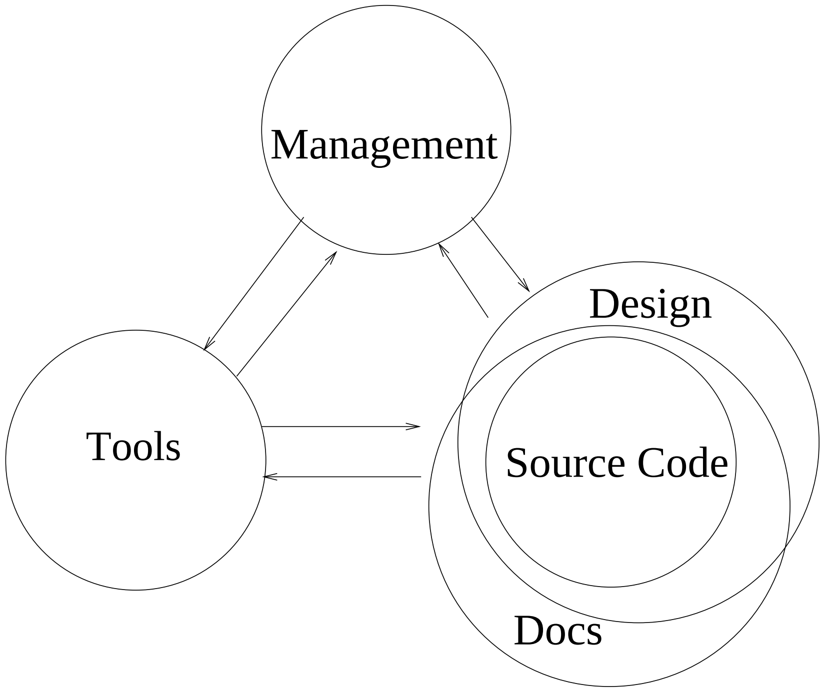
  $\rightarrow$ Papers support software

Management: Conclusions

- We need to be aware of our methodology
- Everybody is always involved in everything

  → Software and papers
- We have to deliver high(er) quality of software
- We have to be satisfied with less quantity
- We need to invest

Source Code



Source Code and the Laws of Murphy

- There's always something stupid wrong: bugs are never interesting
- It's always somebody else's fault or it was a long time ago for you
- Everything is related to everything
- Everything is always similar, but not quite equal
- Everything always changes

  Requirements, Functionality, Context, People
- The documentation is always out of date

  And the source code comments too
- Nothing works when you actually need it

Source code: How to ask for trouble (and we did!)

- One programming language: everything in Lisp/C/C++
- A simple architecture: one program does everything

  A simple architecture does not mean a simple design
- A simple programming interface: everything is an ATerm
- A simple source tree: everything in the same source tree
- Simple code reuse: copy & paste
- Efficiency first: obfuscated code
- No dependencies: no reuse
- Everybody specializes: nobody knows anything
- Release the software only when its finished
- Change the formalism and the architecture simultaneously

Source code: solutions

1. Standardization
2. Architecture
3. Abstraction
4. Automation
5. Testing
6. Knowledge spreading

Each of the above is a costly investment, with high rewards

Source code: solution 1 - standardization

- We use CVS: there is one repository
- All tools have versions
- LGPL license
- Everything is represented as AsFix, or an ATerm
- Programming style: e.g. layout, nomenclature, length of procedures
- Interfaces: commandline, ToolBus, configure scripts

  For example; every tool has '-h' and '-V' and '-v' options.
- Keep most of the system stable, while improving other parts

Source code: solution 2 - architecture

- “A style and method of design and construction”
- ToolBus: separating computation from communication
- Separate source code packages:

  logical separation of functionality

  hierarchical layers of dependency

  units of reuse
- Example: ’asfsdf-meta’ uses ’sglr’ which uses ’pt-support’

  ’sglr’ can be used without ’asfsdf-meta’ (e.g. in ’elan-meta’)

  ’pt-support’ can be used without ’sglr’ (e.g. in ’asf-compiler’)

Source code: solution 3 - abstraction

- Create packages for every component
- Create a commandline/ToolBus tool for every basic functionality
- Create API's for every data structure
- Create procedures for every computation
- Abstraction implies:

  documentation

  reusability

  replacability
- Choice of abstractions

  Arbitrary, logical or enforced by an interface

  Stratification

Source code: solution 4 - automation

- gmake, automake, autoconf: generate makefiles and configure scripts
- getopt: command line parsing
- ApiGen: generates abstract data types
- SDF: parser generation
- ASF: transformation tools
- autobuild: repetitive commandline work and reporting
- dbs (daily build system):

  cvs checkout, configure, build, check, install, distcheck
- autobundle:

  automated source tree composition and downloading

  documents dependencies between packages

Source code: solution 5 - tests

- Write automated test procedures and programs
- Functionality/Unit testing

  Higher confidence in correctness

  Documents functionality or fixed bugs
- Regression/Component testing

  Higher confidence in overal functionality
- Integration testing

  Testing the communication between components

Source code: solution 6 - knowledge spreading

- Pair programming
- ChangeLog/CVS messages: all small changes explained by short descriptions
- Presentations/Mailing lists/Papers
- Refactoring: by changing something a little bit, you get to know it

  Everything that is wrong or ugly

  Delete it, change it or reimplement it

  It will bother you later anyway

Measurable Results

- Much, much less code is left
- Less boring work
- Less bugs
- Self-documenting (for the programmer, not the user)
- Changes/Replacements/bugfixes are made very quickly
- Papers on the new tools

Conclusion

- I have told you a lot
- Awareness of the process and the technique
- Made many errors, fixed them one step at a time
- Set of solutions that require investments:

  Teamwork

  Standards

  Tools

  Refactorings

  Tests