THE CHALLENGE OF OO TESTING

❑ THE FAIRY TALE OF THE EARLY BIRDS:
"Both testing and maintenance are simplified by an oo approach . . ."
[Rumbaugh 91]

❑ OPTIMISM ALL OVER:
". . . the use of oo design doesn’t change any basic testing principles; what does change is the granularity of the units tested."
[Booch 94]

❑ THE BIG DISCOVERY:
". . . we have uncovered a flaw in the general wisdom about oo languages - that “proven” (that is well-understood, well-tested, and well-used) classes can be reused as superclasses without retesting the inherited code."
[Perry 90]

❑ PESSIMISM FIGHTS BACK:
". . . it costs a lot more to test oo software than to test ordinary software - perhaps four or five times as much . . .

Inheritance, dynamic binding, and polymorphism create testing problems that might exact a testing cost so high that it obviates the advantages."
[Beizer 94]

SOME DIFFERENCES (I)

❑ increasing modularization
  -> decreasing module size
  -> more inter-module dependencies
    (if methods depend on methods of other classes)

❑ project is divided into oo work packages
  -> instead of function-oriented work packages
  -> functionality may depend on classes developed by co-workers
  -> increasing dependencies among co-workers
  -> dependencies require coordination
    -> coordination requires time = money
    -> coordination may result into misunderstanding
      -> misunderstanding results into errors

❑ functionality - collaboration among objects
  -> collaboration requires interfaces
  -> interfaces tend to be complex
  -> interfaces require coordination
    -> coordination <see above>

❑ general purpose classes
  -> reuse beyond the current project
  -> higher degree of potential applications
  -> public methods may be used by any method of any other class
  -> testing of all (currently) relevant states requires anticipation of user profile
**Some Differences (II)**

- Program structure does not reflect program functionality
  - Functionality is realized by a subset of methods
  - New instrumentation technique to check functional test coverage
  - User profile oriented instrumentation

- Object methods communicate by common object attributes
  - The object state produced by a former method (in a sequence) may influence the behavior of the latter method
  - The method behavior is influenced by method parameters AND object state
  - Exhaustive testing = all possible state transitions in all possible states

- Methods call often other methods of the same class
  - Procedural coupling among methods

- Object software is not only harder to test, there is even a richer set of potential errors
  - Dedicated object test techniques required

**State of the Art (Latest News from Case Studies)**

- Object software exhibits an higher fault rate

- Inaccurate classes in inheritance hierarchies
  - Three times more bound to be erroneous than classes without inheritance

- Concise code results into higher fault density

- Object analysis and design faults
  - Greater influence than faults in classical analysis and design techniques

- The real fault causes are harder to detect
  - Difficult debugging

- Insufficient object analysis/design/programming skills
  - Avoidable faults

- BUT: Reused classes produce generally less faults
  - Higher dependability seems to be possible
THE MOST IMPORTANT TROUBLEMAKERS

- **encapsulation**
  - restricts visibility of object states
  - restricts observability of intermediate test results
  - code adaption for test purposes, e.g. “friendly” methods
  - fault discovery more difficult

- **inheritance**
  - the oo goto statement
  - invisible dependencies between super/sub-classes
  - reduced code redundancy = increased code dependencies
  - erroneous functionality is inherited too
  - a subclass can’t be tested without its superclasses
  - abstract classes can’t be tested at all

- **polymorphism & dynamic binding**
  - static program structure /= dynamic behaviour
  - all possible bindings have to be tested
  - explosion of potential execution paths
  - explosion of potential errors

(CURRENT ?) CONCLUSIONS

- high dependability demands
  - avoid oo
  - “Currently, at the time of developing this standard, it is not clear whether object-oriented languages are to be preferred to other conventional ones.”
    - [Sneed 2002]
    - [IEC 61508-7, p. 169]

- to promote oo
  - developed skills in sophisticated oo testing techniques
  - testing costs may be much higher than developing costs

- lessons learnt
  - method test /= procedure test
  - class test /= module test

- oo testing
  - class test - a challenge
  - integration test - a challenge
  - system test - reuse of conventional test strategies
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