Formal Methods in Software Engineering

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- ... the larger the project, the worse the picture ...

Some Development Catastrophes

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25% of all large systems are cancelled

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- extreme time pressure, with no realistic testing
- deficient management determined to push through

Critical Software Failures

US Telephone Network	[switching software failures, 1991]
Bank of New York	[90 minutes failure, Nov. 20 1985
	lost information on $ 32 b in transactions
	forced to borrow $ 23.6 b from the FR
	at a cost in interest of $ 5 m]
GM Detroit Automated Factory	[1 year working at half its capacity]
THERAC-25 Radiotherapy	[2 killed by overdose]

[*Digital Woes*, Wiener, L., 1993]

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But is Software Engineering (SE) ... Engineering?

Hardware *vs* Software Engineering

Reusable Components	“Flat” & Unrelated Tons of Code
Catalogue of specifications	... formal?
Refinement Methods	Why reuse, if it is easy to begin again?
Development stations	Debug = (Edit;Compile;Test)*
Standard Methodologies and Notation	Proliferation ...
Production and Maintenance: • Production Plans & Data Bases • Components’ Families — classification, equivalences, etc.	Cubic meters of • unreadable programs • unhelpful manuals

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> *There is a need for a software technology with a sound mathematical basis, coping with composition and refinement, in which a program would be unacceptable unless accompanied by a* guarantee *that it respects its* specified *behaviour.*

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Precise, **abstract** descriptions $\equiv$ **mathematical models**

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- Reason within the model
- Calculate a **solution** ($\equiv$ an **implementation**)

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- *Model-Oriented*: VDM, Z, B, RAISE, CAMILA, ...
- *Property-Oriented*: CLEAR, OBJ, ...

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Links:

`www.fmeurope.org` (includes an applications database)
`www.comlab.ox.ac.uk/archive/formal-methods` (huge FM Archive)
`shemesh.larc.nasa.gov/fm.html` (NASA FM Page; generalistic)

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> *'There is a big difference between good, sound reasons, ...*
> *... and reasons that sound good'* (Haldane)

Why Maths?

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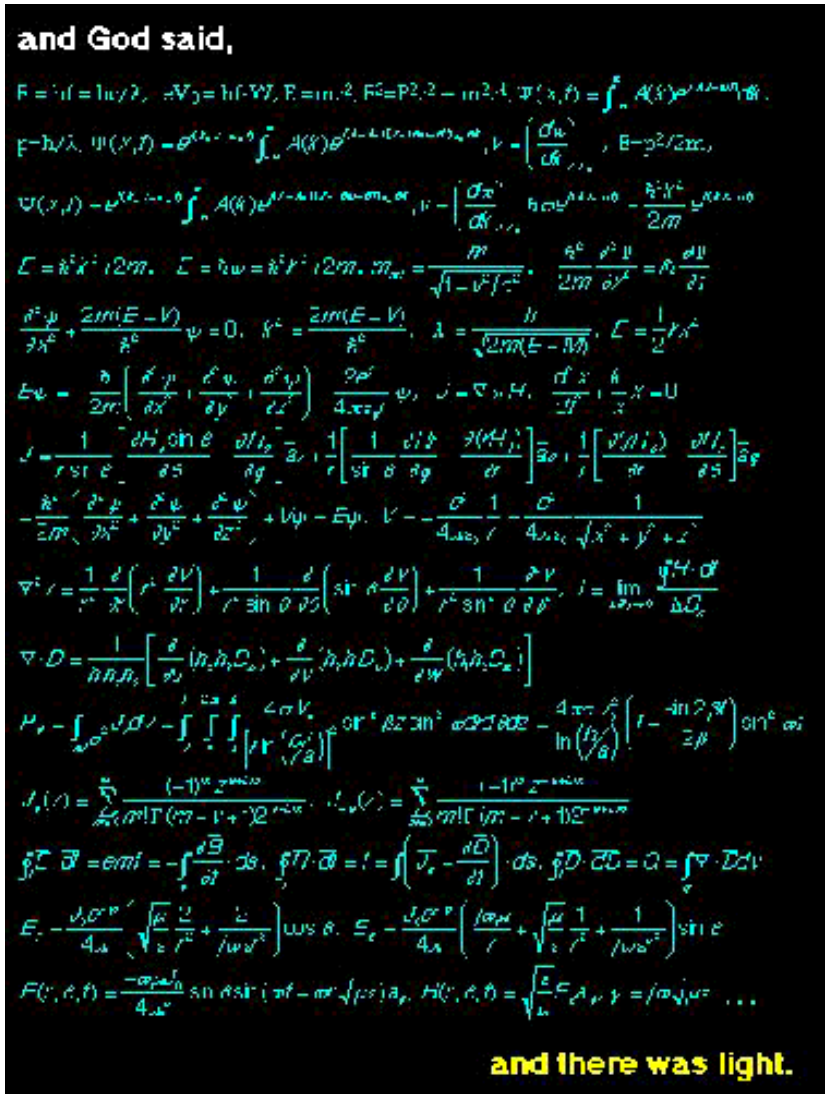

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There is a need for tools to validate software formal descriptions: *type checkers*, *syntax-oriented editors*, *theorem provers*, *proto-typing environments*...