



# Software Costing Strategy

D. Hall



# Content

Why do we need a software costing strategy?

What is the software costing strategy?

Cost collection for software cost estimates

Modelling software costs using COCOMO II

Questions and Comment

# Why do we need a software costing strategy?



- One problem the large science experiments face is that software is an out-of-control expense
- They budget 25% or so for software and end up paying a lot more
- The extra software costs are often hidden in other parts of the project – the instrument control system software may be hidden in the instrument budget



# What is the software costing strategy?

Gather metrics about past size–effort–costs for developing software in (i) radio astronomy – (ii) physics – (iii) science generally

Estimate the sizes and kinds of codes to be acquired or developed; and the integration effort likely to be required

Use both (1) COCOMO II [an open source parametric software cost estimation tool]; and (2) expert judgement together to convert estimates of sizes to estimates of required efforts, times and costs



# What are the basic principles?

- ▶ Need a credible basis upon which to apply for funding for software construction for the SKA
- ▶ Software cost estimating is an ongoing and iterative process
- ▶ Confidence levels attributed to cost estimates for software depend on:
  - “Unprecedented-ness” of the problem space
  - Quality of the substantiating historical evidence
  - Maturity of the solution design



## Hardware costing can use SKACost:

- ▶ High Performance Computer (HPC) itself – the production boxes
- ▶ Additional hardware compute infrastructure:
  - Development, Testing, Staging
- ▶ Data storage facilities:
  - Disk, Tape Archive
- ▶ Data centre building including required spare space; protection systems
- ▶ Data centre power supply, backup and power cabling
- ▶ Systems to manage required redundancies in data centre facilities
- ▶ Data centre heating, ventilating, air conditioning, power management
- ▶ Cabling pathways for data centre cabling
- ▶ Data centre data cabling and cabling management systems
- ▶ Data centre accommodation for people
- ▶ Commodity computing equipment
- ▶ Radio frequency interference protection systems if the data centre is to be located anywhere near radio astronomy receiver facilities



# Software costing ~aligns with overall SKA costing principles:

- ▶ Methodologies and Definitions
  - Index of inflation
  - Currency conversions
  - Labour rates
- ▶ How we will treat historical cost data
  - Plan and process for collection of metrics of past experiences
  - Assessment of historical evidence
- ▶ COCOMO II
  - What it is
  - How it will be used
- ▶ Responsibilities with respect to costing software



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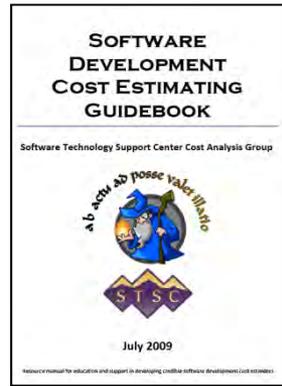
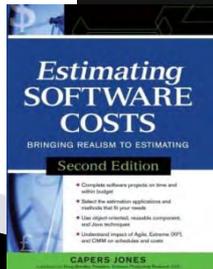
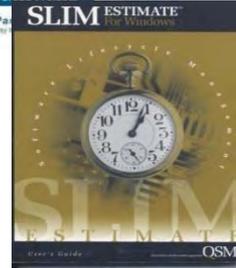
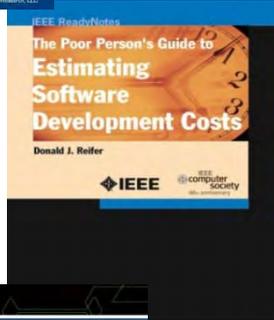
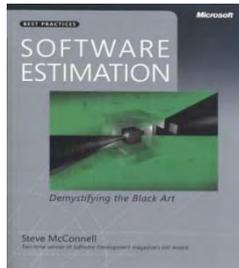
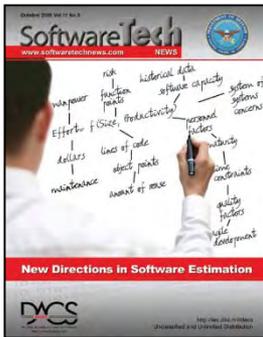
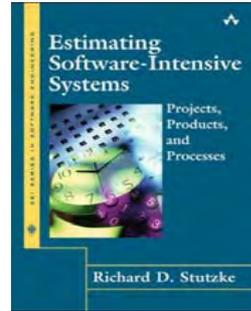
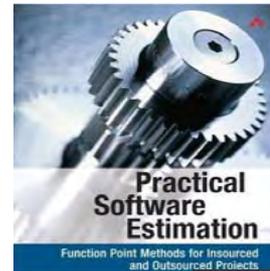
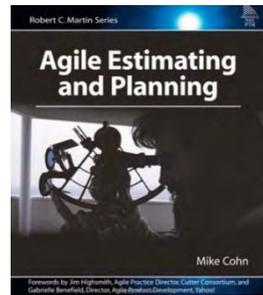
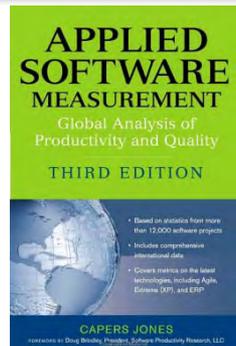
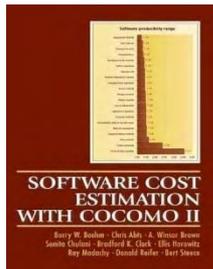
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# Collecting evidence:

Gather metrics about past size–effort–costs for developing software in (i) radio astronomy – (ii) physics – (iii) science generally



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# Constructive Cost Model: an open source model for estimating software development costs – has inspired many other tools

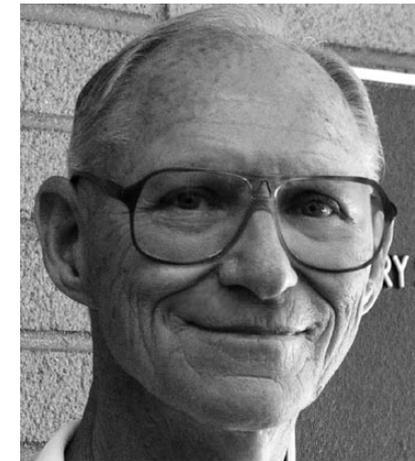


## SE Tools Taxonomy - Cost Estimating Tools

Description: Develop system pricing considering design complexity, domain knowledge, historical cost information, and cost objectives.

### IMPIG Taxonomy - Cost Estimating

Tool Name	Vendor	Description	Hardware Supported	Operating Systems	Uniform Resource Locator	Last Updated
ACE IT	Air Force and Army Joint Program	Automated Cost Estimating Integrated Tools. An estimating system containing tools to assist in conducting cost analysis activities such as cost estimates, what-if studies, cost proposal evaluations, risk and uncertainty analysis	x86	Win16 DOS	<a href="http://www.aceit.com/">http://www.aceit.com/</a>	01-May-99
AMCOS	U.S. Army Cost and Economic Analysis Center (USACEAC)	Army Military Civilian Cost System. Manpower estimation tool. Used for estimating: costs of manning new weapon systems over its life cycle, cost trade-offs of alternative weapon systems, cost of adding new positions to the force structure.	x86	DOS Win16	<a href="http://www.asafm.army.mil/amcos/amcoswely/demo/frame.htm">http://www.asafm.army.mil/amcos/amcoswely/demo/frame.htm</a>	26-Jan-99
CASA	U.S. Army Logistics Center	Cost Analysis and Strategy Assessment. Derived from Honeywell's Total Resource and Cost Evaluation (TRACE) Logistics Support and Life Cycle Cost Models. User for LCC estimates, trade-off analysis, repair level analysis, production rate and quantity			<a href="http://www.logpars.army.mil/casa.htm">http://www.logpars.army.mil/casa.htm</a>	28-Jan-98
COCOMO	University of Southern California	Constructive COSt Model for effort, cost and schedule estimation of incremental software development. COCOMO model published in Software Engineering Economics by Dr. Barry Boehm. The Intermediate COCOMO model, USC COCOMO, is available free	PPC x86 SPARC	Win16 MacOS Unix	<a href="http://sunset.usc.edu/COCOMOII/Cocomo.html">http://sunset.usc.edu/COCOMOII/Cocomo.html</a>	19-Feb-98
COCOMO II	University of Southern California	An update of COCOMO 1981 to address software development practice's in the 1990's and 2000's. Tailorable mix of models. The Application Composition Model uses Object Point count for the early prototyping phase to resolve high risks issues			<a href="http://sunset.usc.edu/COCOMOII/Cocomo.html">http://sunset.usc.edu/COCOMOII/Cocomo.html</a>	24-Apr-98
CoCoPro	ICONIX Software Engineering	Implements Boehm's Constructive Cost Model (CoCoMo) technique for estimating costs of software projects. It supports the intermediate CoCoMo model, and allows automatic calibration of the model to a cost history database.	x86 PPC	Win32 MacOS	<a href="http://www.iconixsw.com/Spec_Sheets/ToolsSummary.html">http://www.iconixsw.com/Spec_Sheets/ToolsSummary.html</a>	01-Nov-98
COOLSoft	Wright Williams & Kelly	A hybrid model using intermediate and detailed COCOMO. Allows for the reuse of existing code, development of new code, the purchase and integration of third party code, and hardware integration. The output is effort, calendar schedule, support costs	x86 PPC 68k	MacOS Win16	<a href="http://www.wwk.com/coolsoft.html">http://www.wwk.com/coolsoft.html</a>	28-Jan-98
Cost Xpert	Marotz, Inc.	Cost Estimation				01-May-99
CostBenefit Analysis Tool	Legacy Systems Research	Cost-benefit analysis software suitable for environmental and exploration investment activities at any stage of a project/decision for go/no go, choosing alternatives, proposal evaluation, acquisition strategy, long range plans.	x86 Alpha	Win16 Win32	<a href="http://www.costbenefit.com/">http://www.costbenefit.com/</a>	25-Jun-97
Costar V5	Softstar Systems	Supports all COCOMO models. Version 5 includes COCOMO II models. V4 is the version available on RTIS LAN under Project Management Apps.			<a href="http://www.SoftstarSystems.com">http://www.SoftstarSystems.com</a>	28-Jan-98
ENRV	U.S. Air Force Cost Analysis Agency	Revised Intermediate COCOMO and Enhanced REVIC Advisor. Differences are: equation coefficients are revised base on calibration using DOD projects, provides a single weighted "average" distribution for effort and schedule and the ability for user to vary				28-Jan-98
Foresight	Price Systems	Cost Estimation	x86		<a href="http://www.buys.com/p_products/foresight.htm">http://www.buys.com/p_products/foresight.htm</a>	01-Feb-99





COCOMO is an open source model for estimating costs of software **development**

Estimate the sizes and kinds of codes to be acquired or **developed**; and the integration effort likely to be required

Use both (1) COCOMO II [an open source parametric software cost estimation tool]; and (2) expert judgement together to convert estimates of sizes to estimates of required efforts, times and costs



Example:  $PM$  = Person Months of Effort

$$PM = A \times Size^E \times \prod_{i=1}^n EM_i$$



Formal models - or/and  
Expert judgement?



## Formal models or/and Expert judgement?

- In spite of massive effort and promotion, available empirical evidence shows that formal estimation models aren't in much use ...
- ... projects officially applying a formal estimation model actually use the model as a disguise for expert estimation
- All meaningful estimation models require judgment to produce the input to the models
- ... the relation between effort and size in software development contexts isn't stable
- In situations involving high cost and schedule uncertainty, it's a good idea to draw upon as many sources of insight as possible



## Formal models or/and Expert judgement

- ... software development situations frequently contain highly specific, highly important information ...
- ... expert judgment can have great advantages in situations with highly specific information that's not mechanically integrated, or integrated at all, in a model
- [BB]: "I used to think that closed-loop feedback and recalibration would enable organizations and models to become increasingly perfect estimators.
- But I don't any more
- The software field continues to reinvent and re-baseline itself too rapidly to enable this to happen"



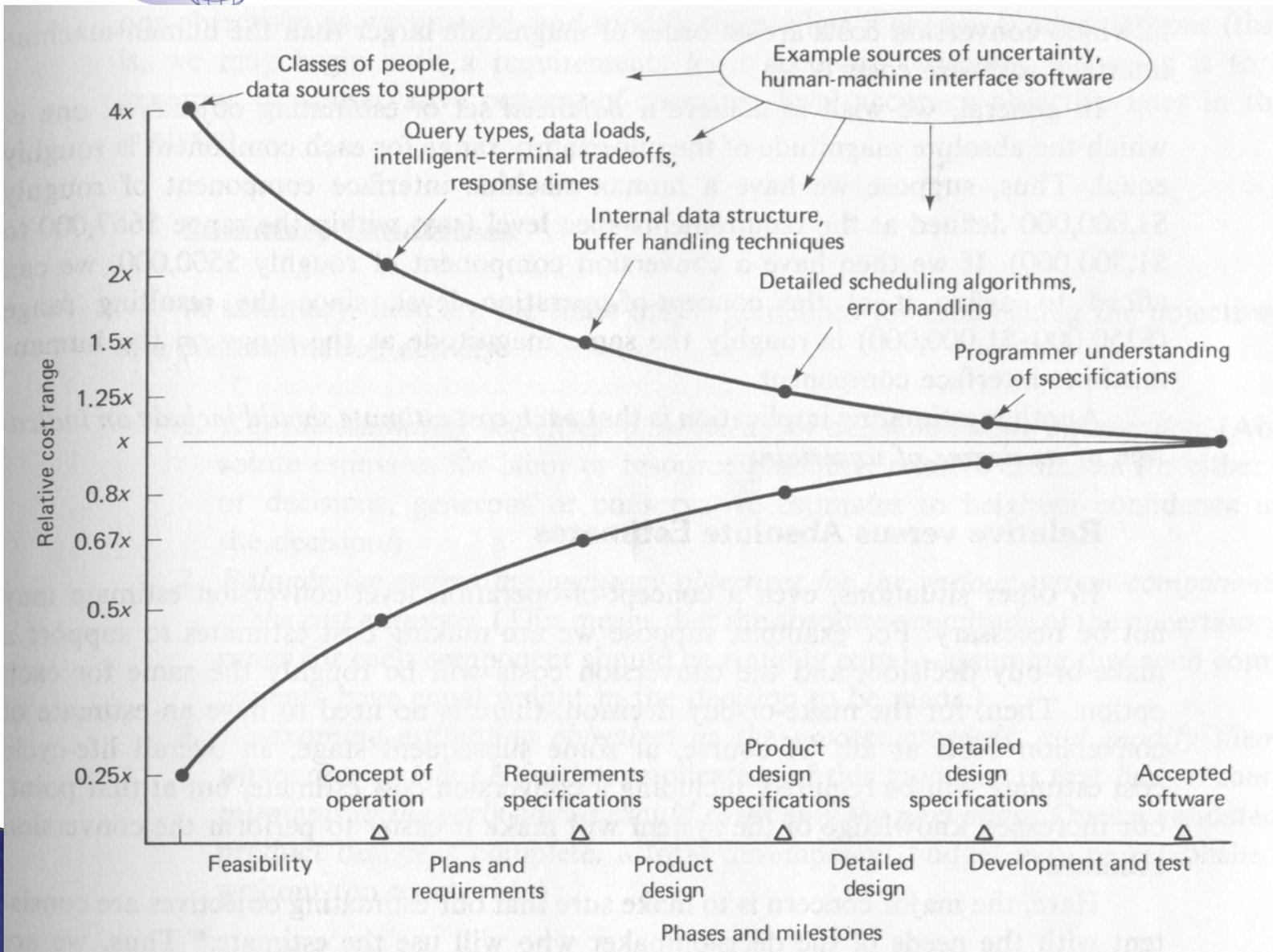
Formal models or/**AND** Expert judgement!

- A major advantage of a parametric model is that it doesn't modify its estimates when customers, managers, or marketers apply pressure
- Using a calibrated parametric model enables negotiation ... rather than a contest of wills between self-described experts
- ... the usual practice is to discard [cost models] as having served their purpose and to avoid future embarrassment when the estimates are overrun
- So, use incremental development and *timeboxing* – also known as *cost and schedule as an independent variable*
- Simple models typically perform just as well as more advanced models ...

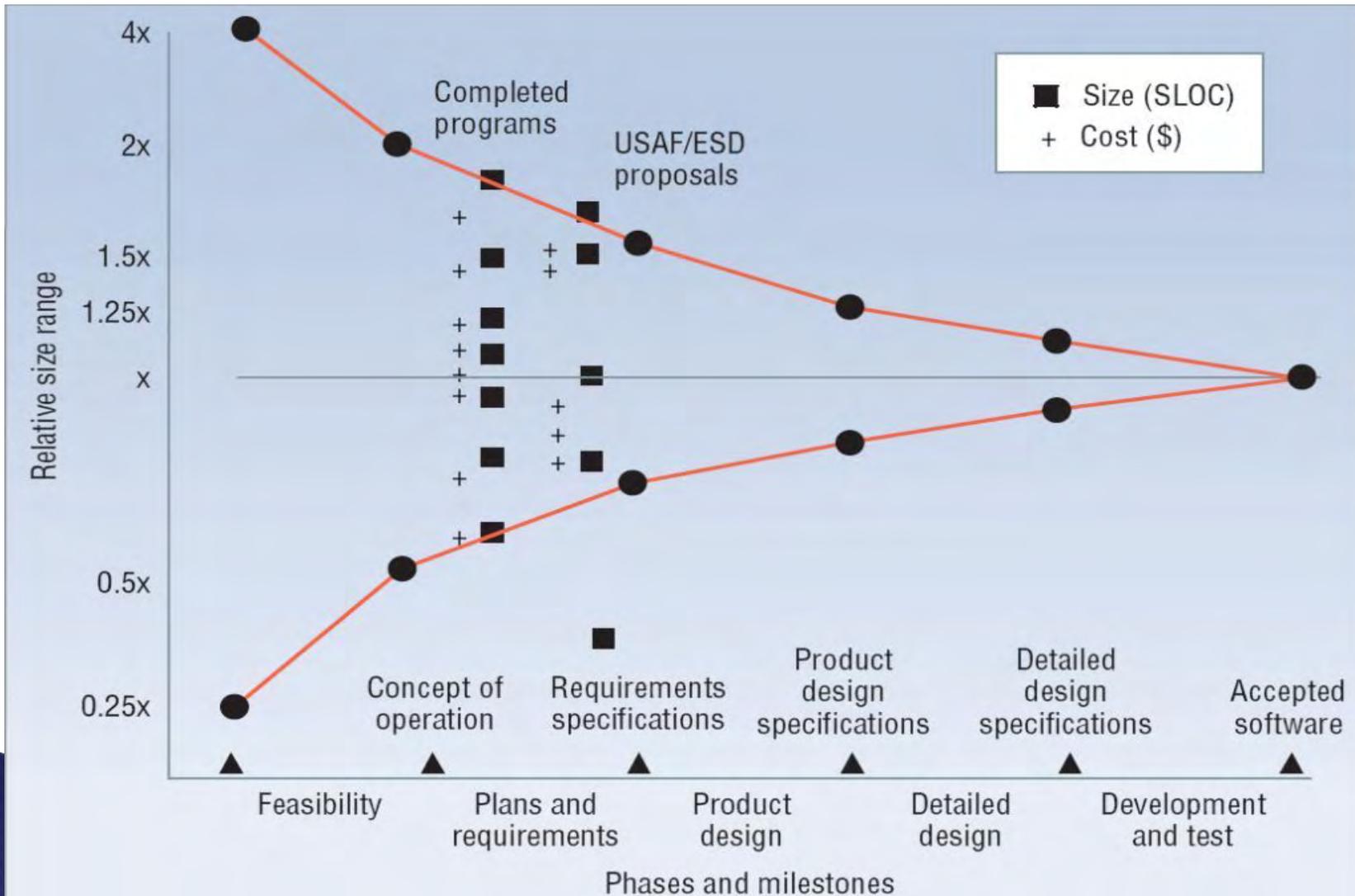


# Estimation uncertainties

# The Boehm-McConnell “cone of uncertainty”



# The Boehm-McConnell “cone of uncertainty”



## Next steps?

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