ESTIMATION CON COSMIC

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Alain Abran

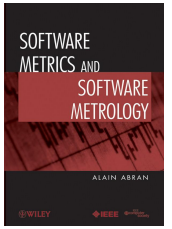
20 years

20 years

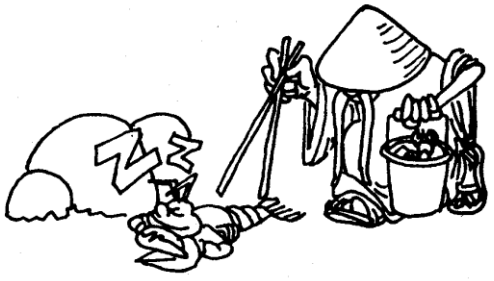
+ 35 PhD

- **Development**
- **Maintenance**
- **Process Improvement**

ISO: 19761, 9216, 25000, 15939, 14143, 19759



Hablo Español…. un poquito!



Agenda

1. Estimation: Craft or Engineering?
2. The phases in estimation
3. Economics concepts for estimation models
4. COSMIC Estimation models with data from industry
5. Conditions for credible estimation models

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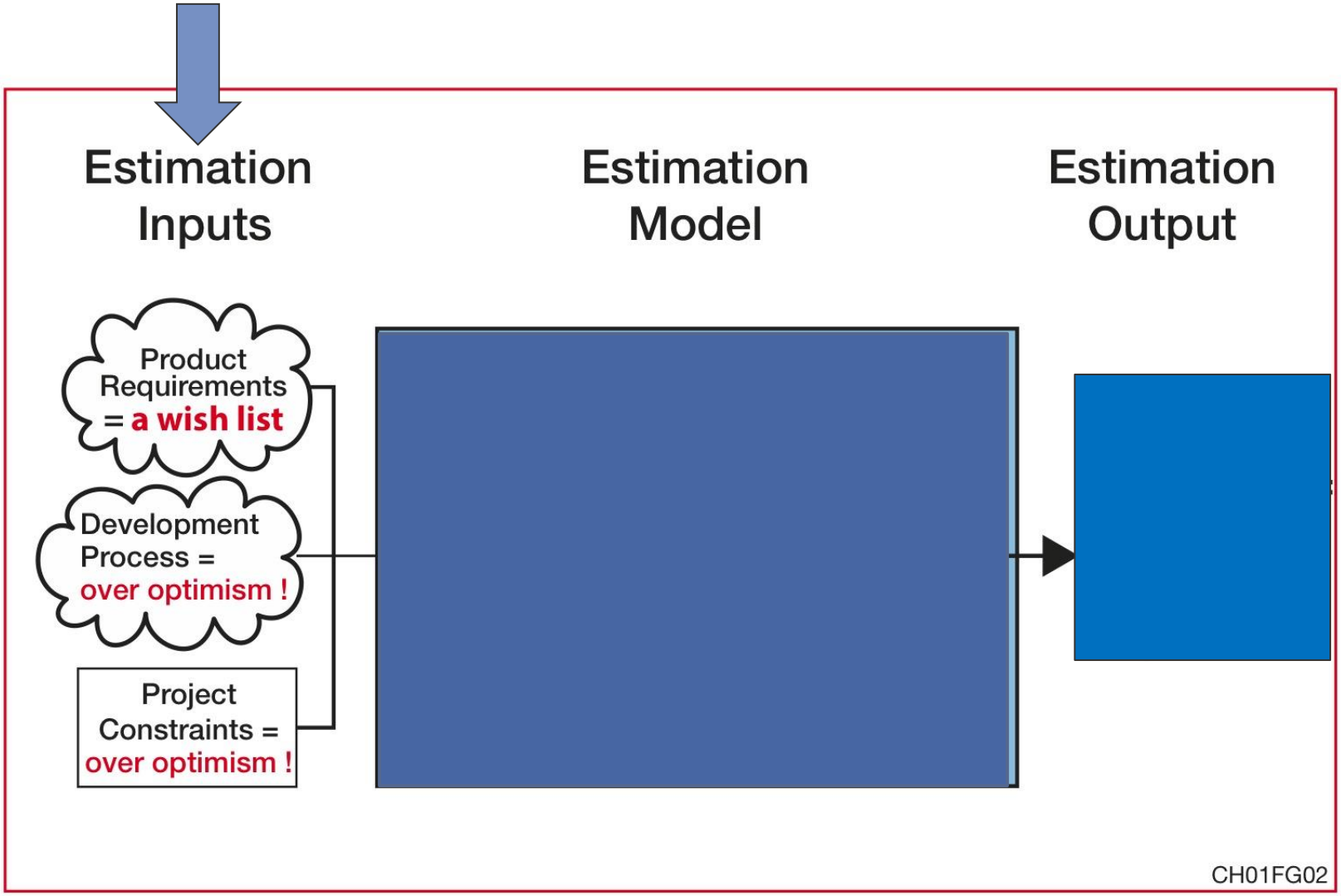
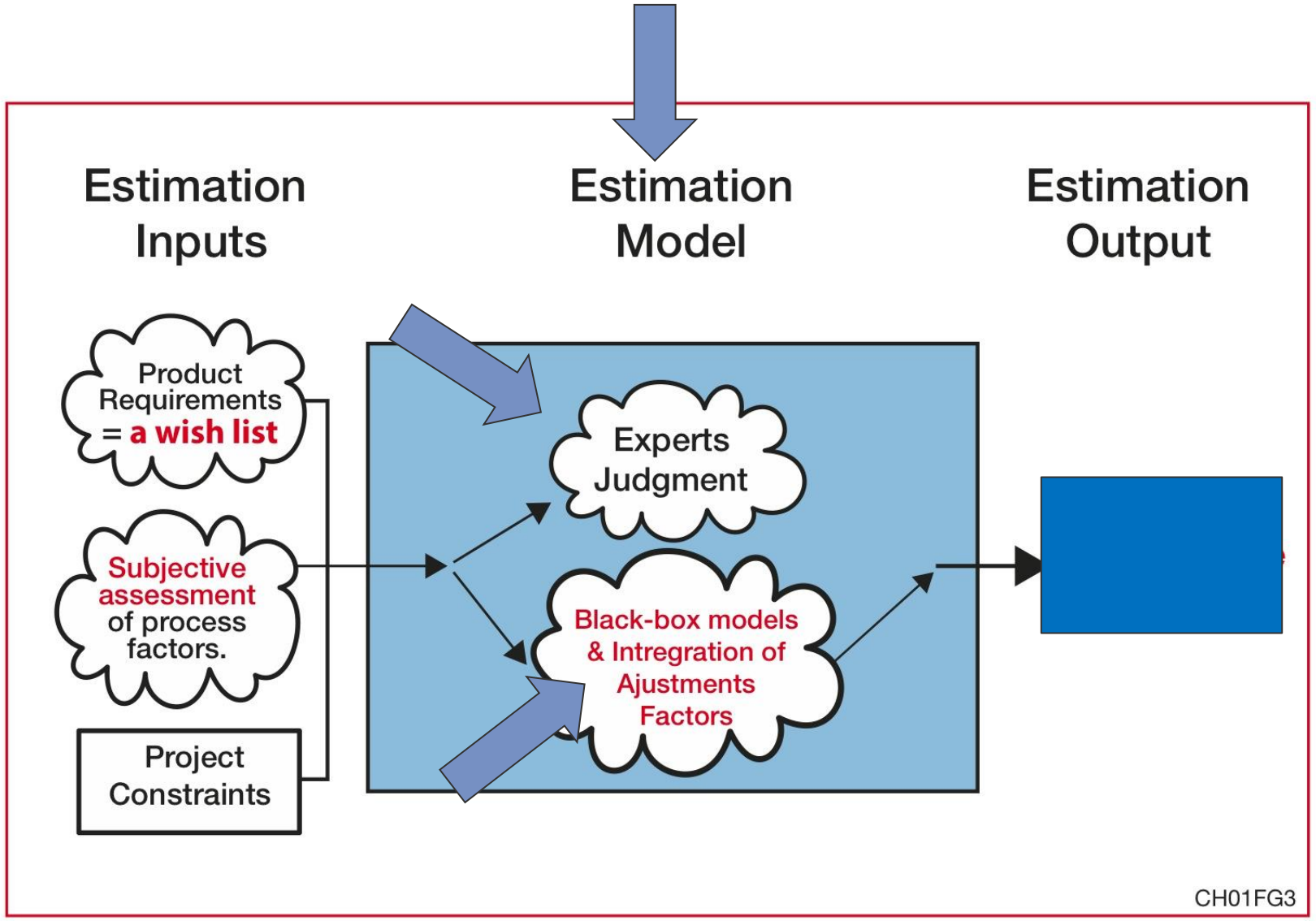
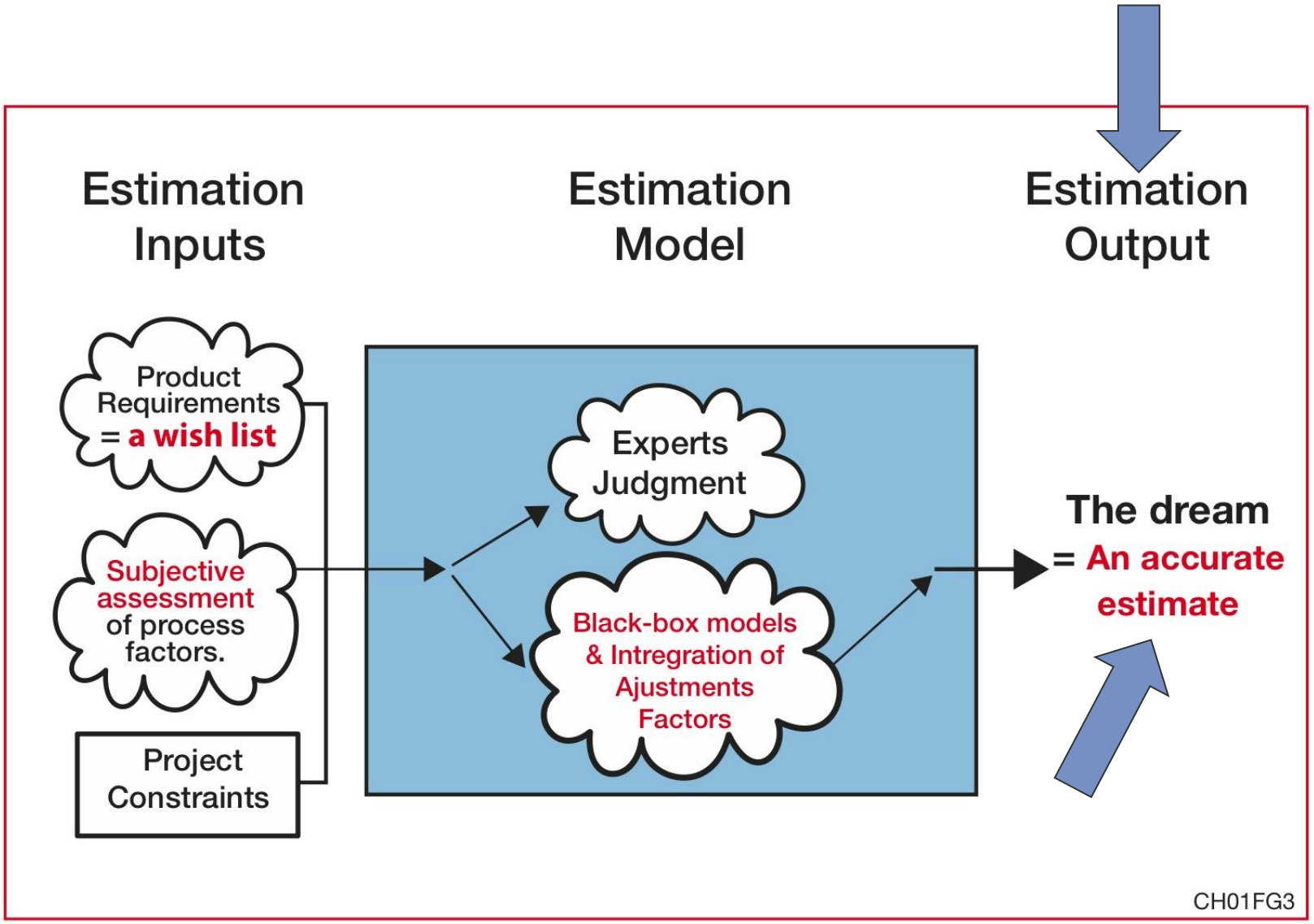
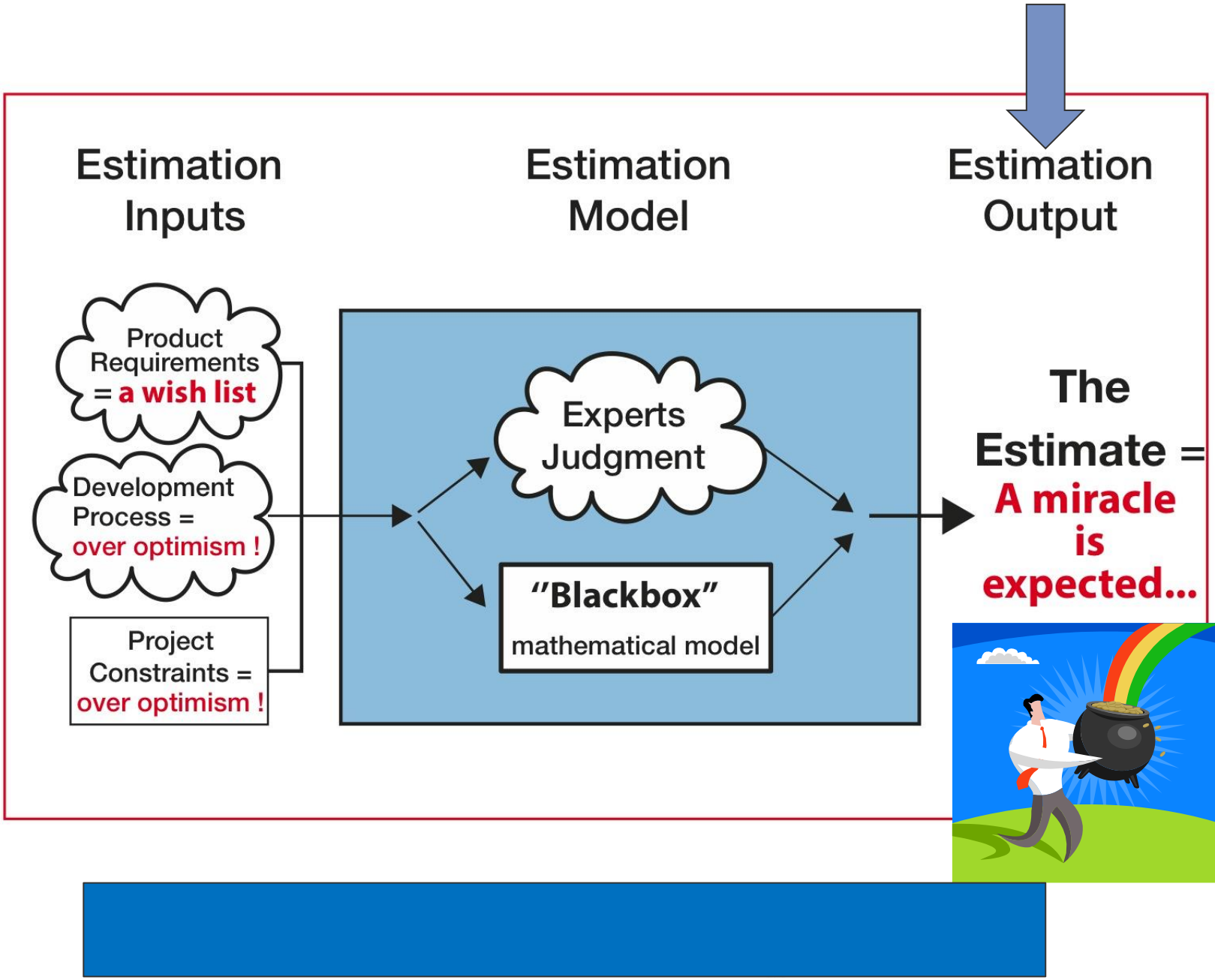








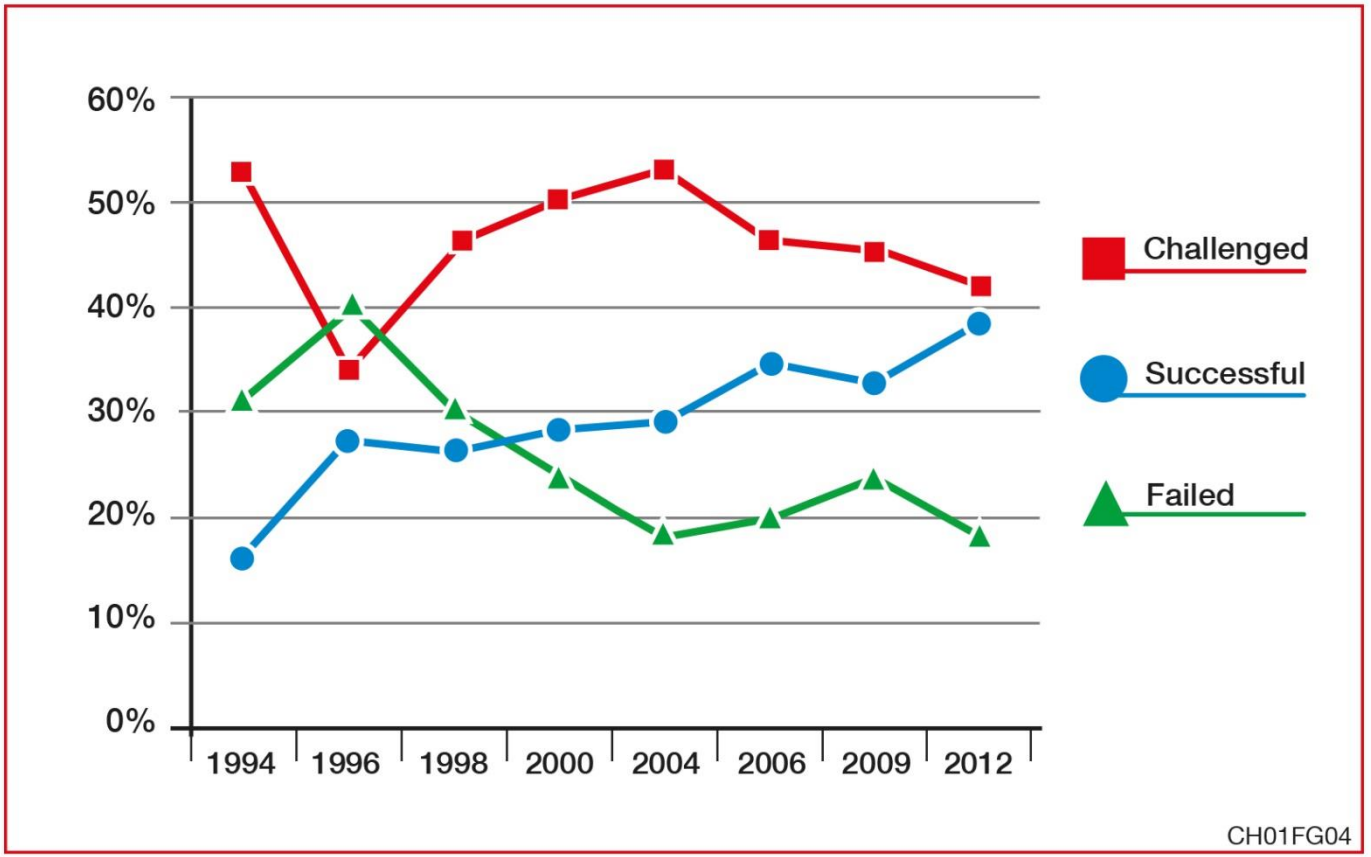
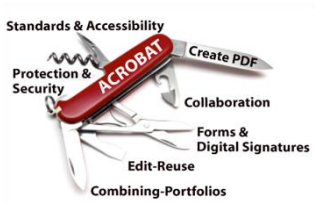
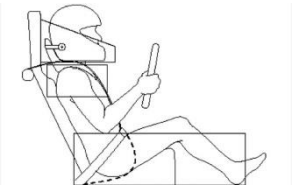


Figure 1.4 Project success trends according to the Standish Group. [Miranda 2010]

Softare Estimation Tools: Availability & Costs



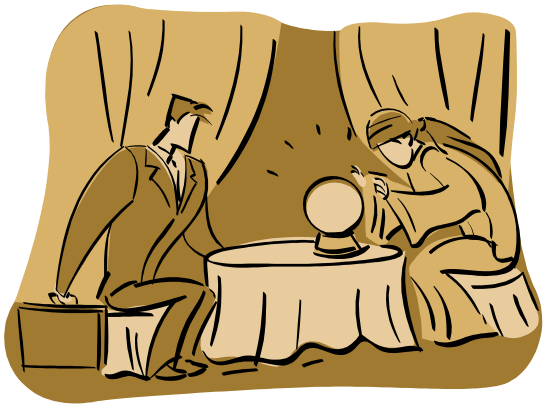
Consumers & Quality!



Consumer Reports

Estimation Tools & Quality?

(Software) Estimation



Or?

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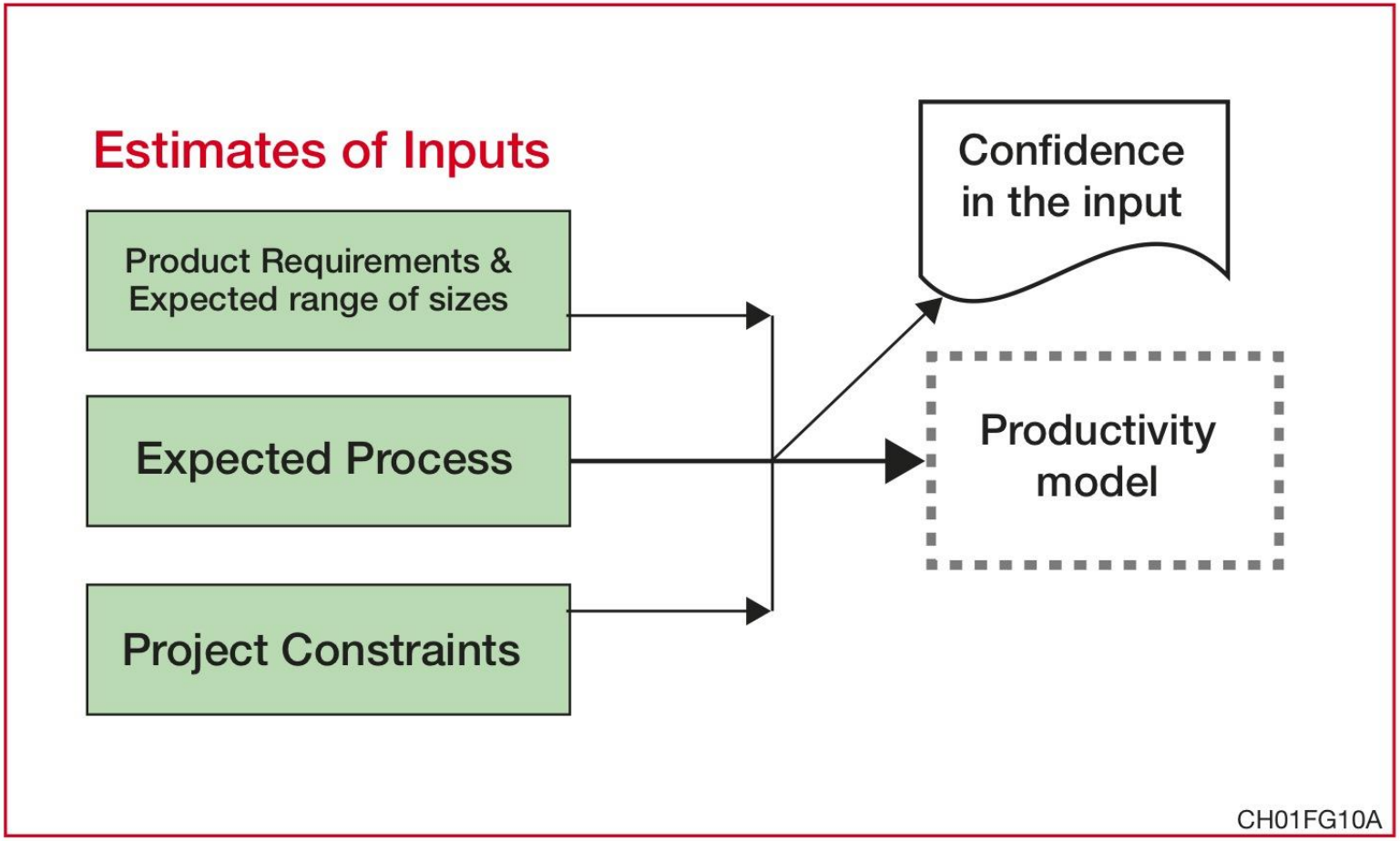


Figure 1.10 Phase A :
Collection of the Inputs for the Estimation Process.

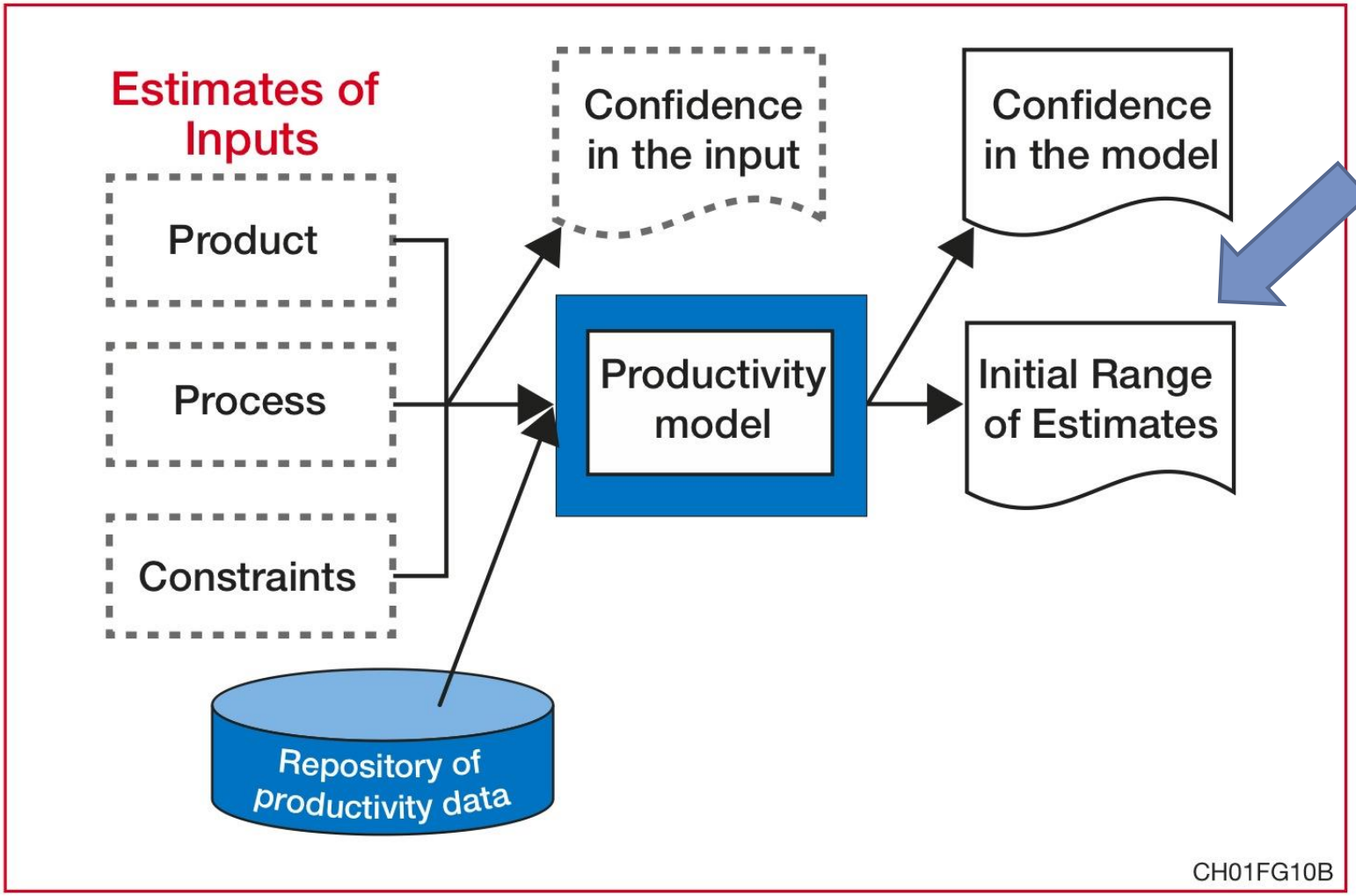


Figure 1.10 Phase B : Execution of the productivity model.

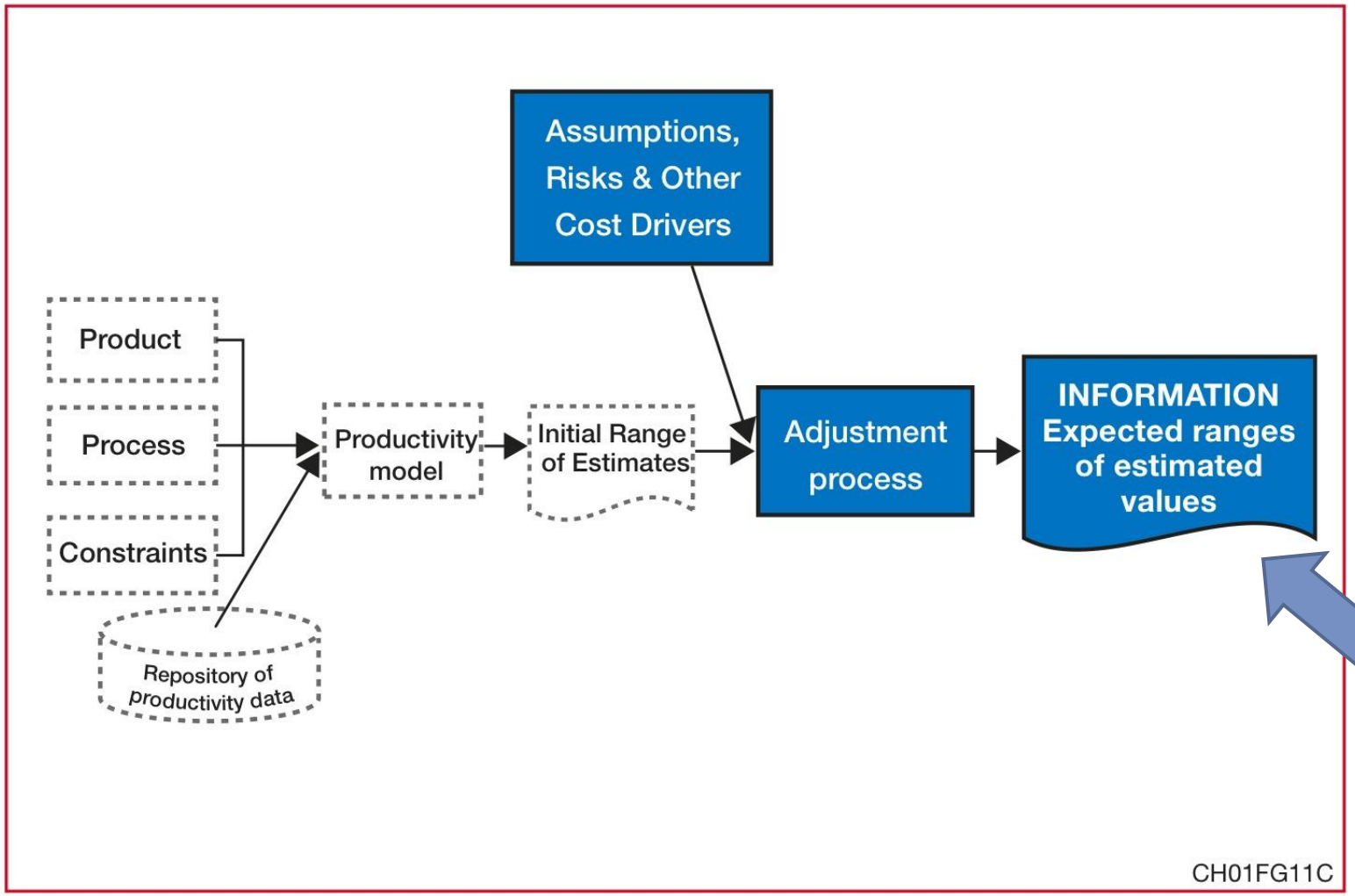


Figure 1.11 Phase C : The adjustment process.

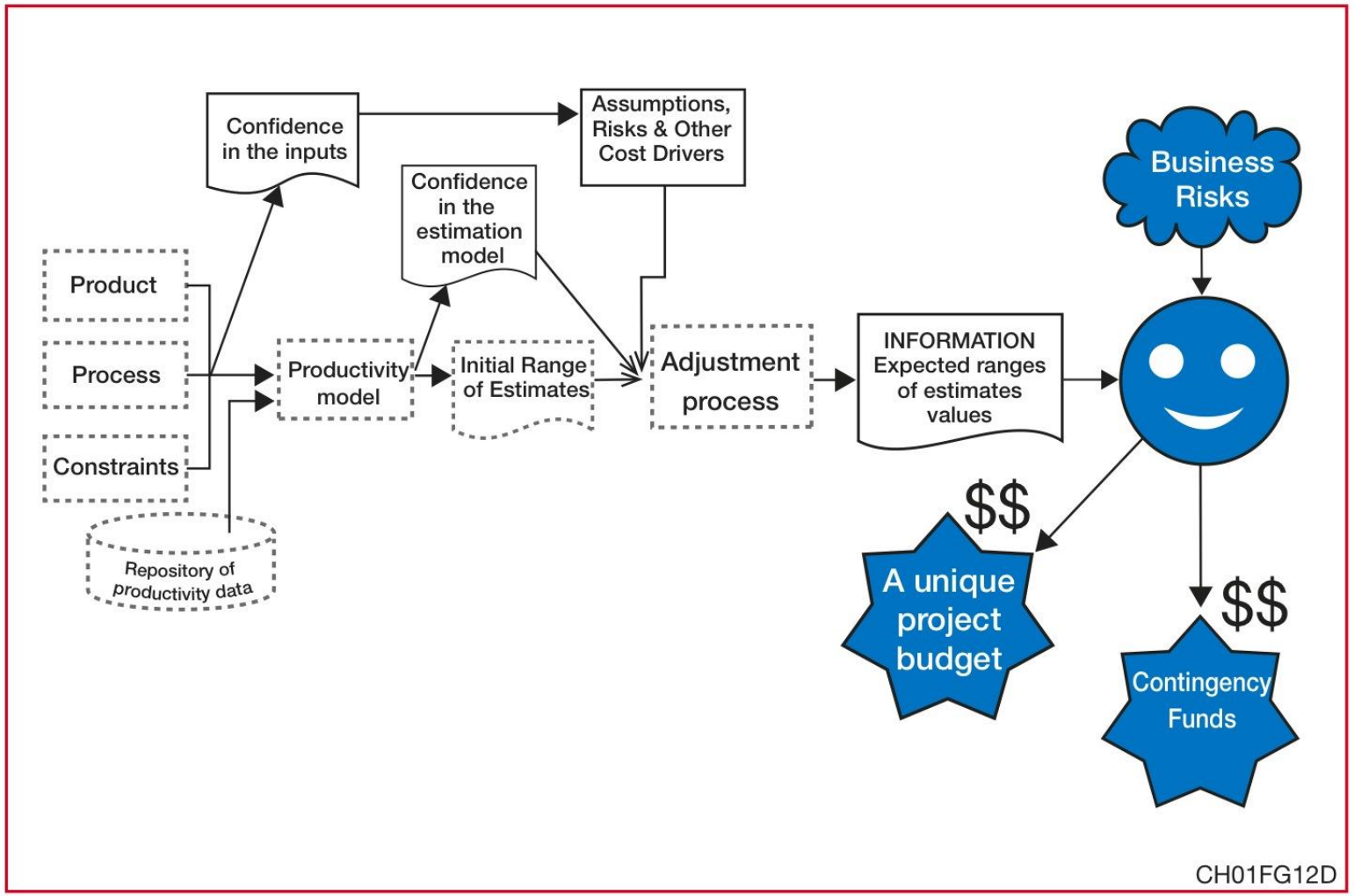


Figure 1.12 Phase D : Budgeting decision.

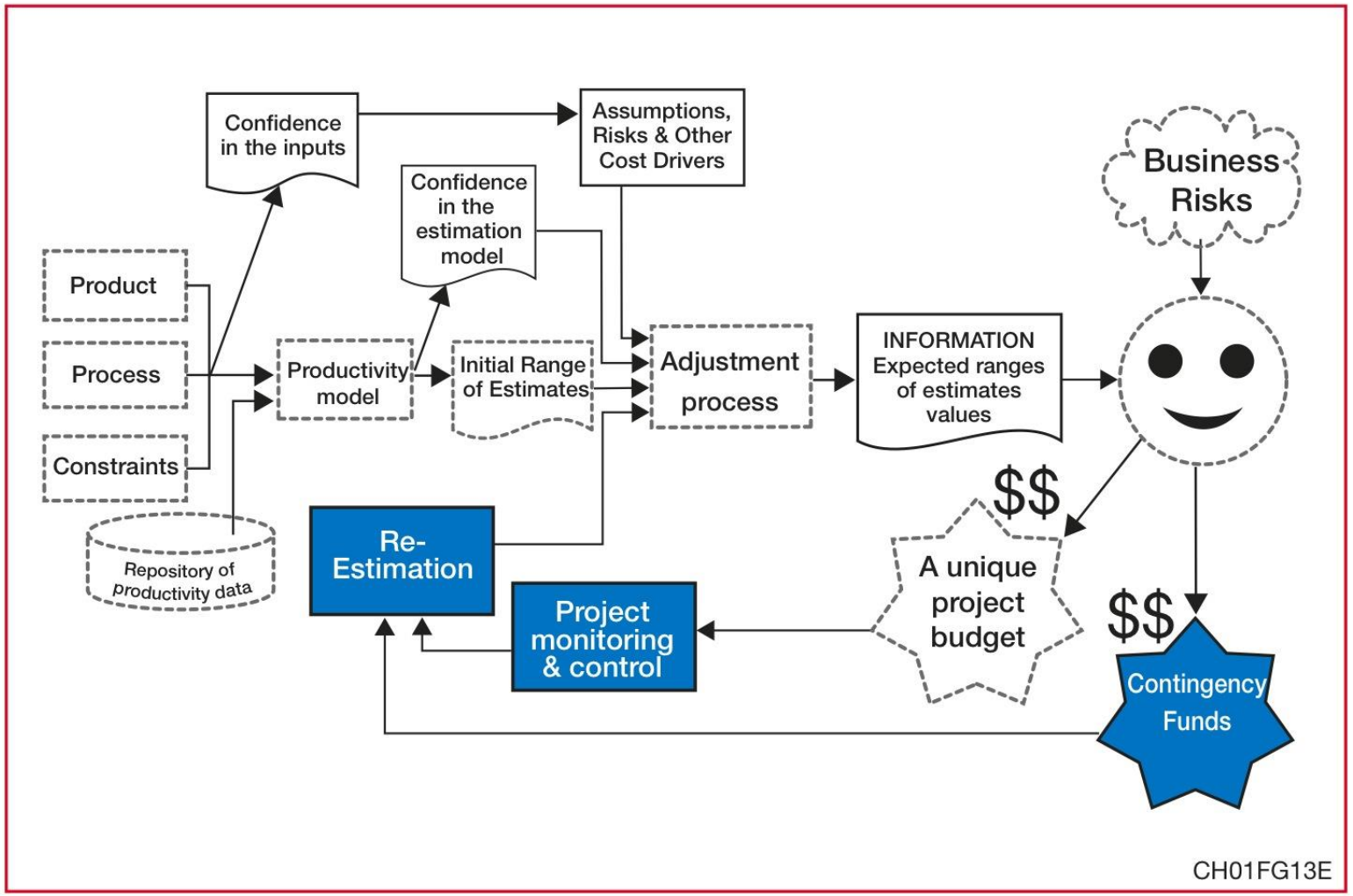


Figure 1.13 Phase E : Re-Estimation.

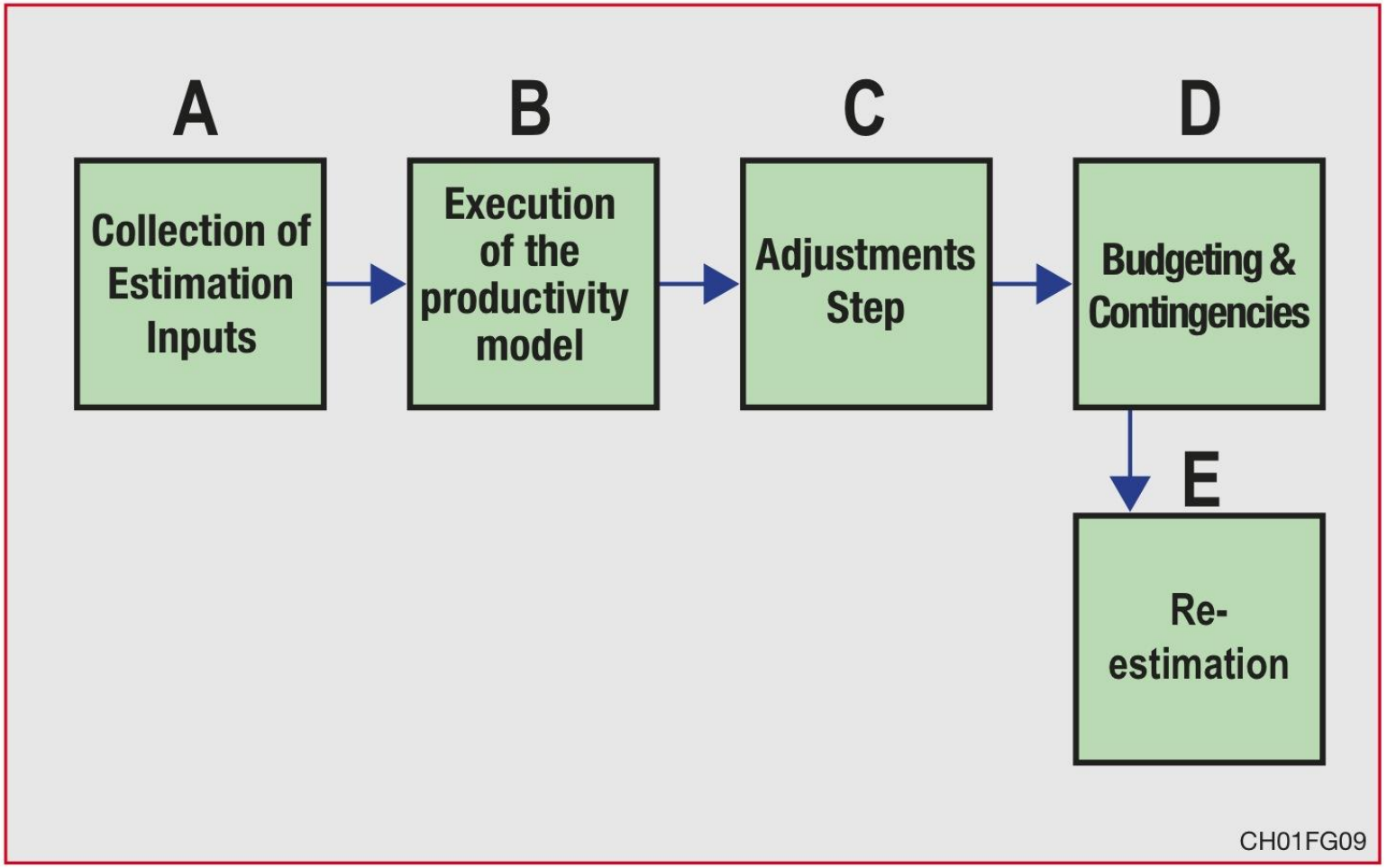


Figure 1.9 The Estimation Process.

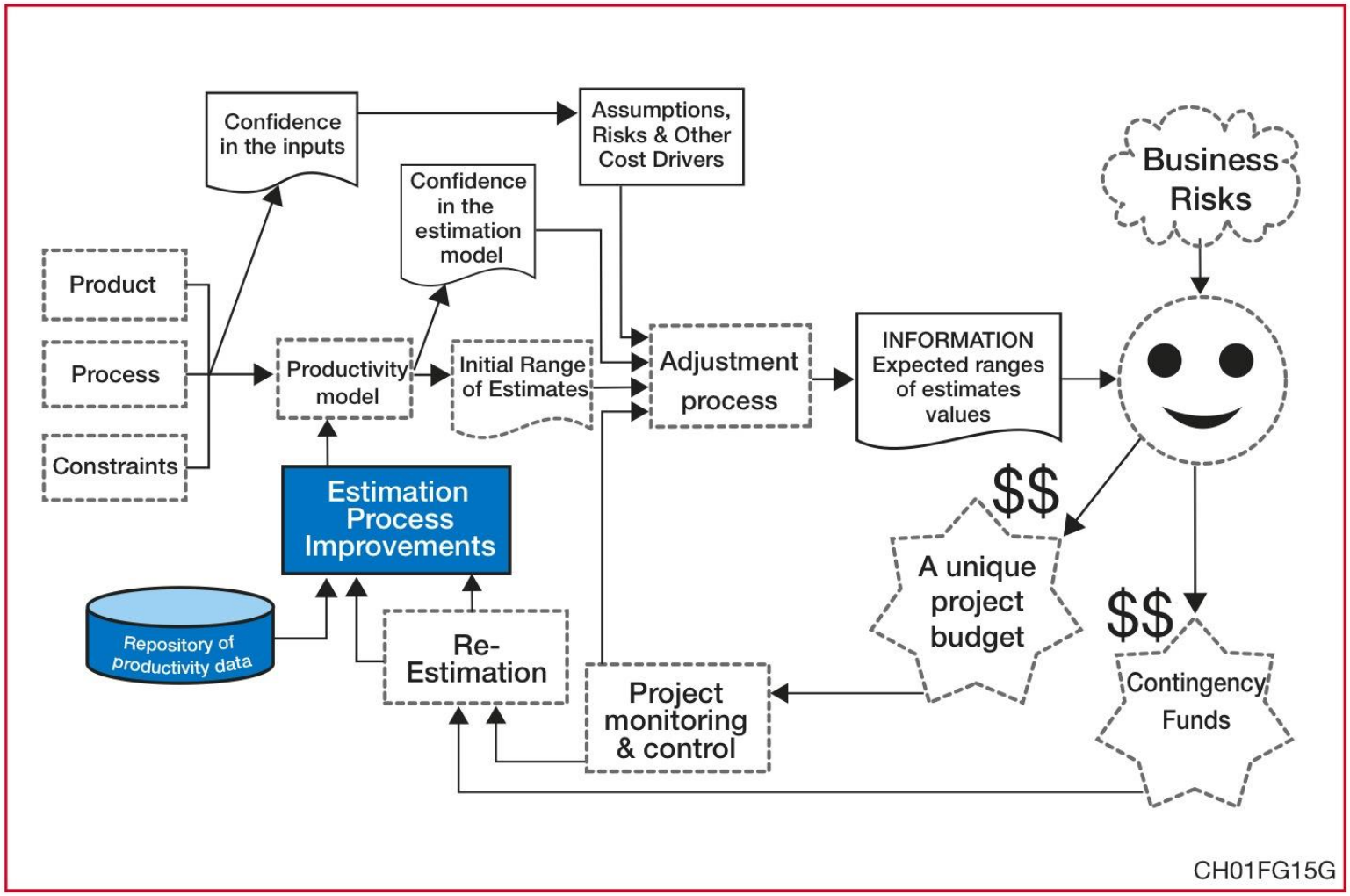


Figure 1.15 Phase G : Estimation Process Improvements.

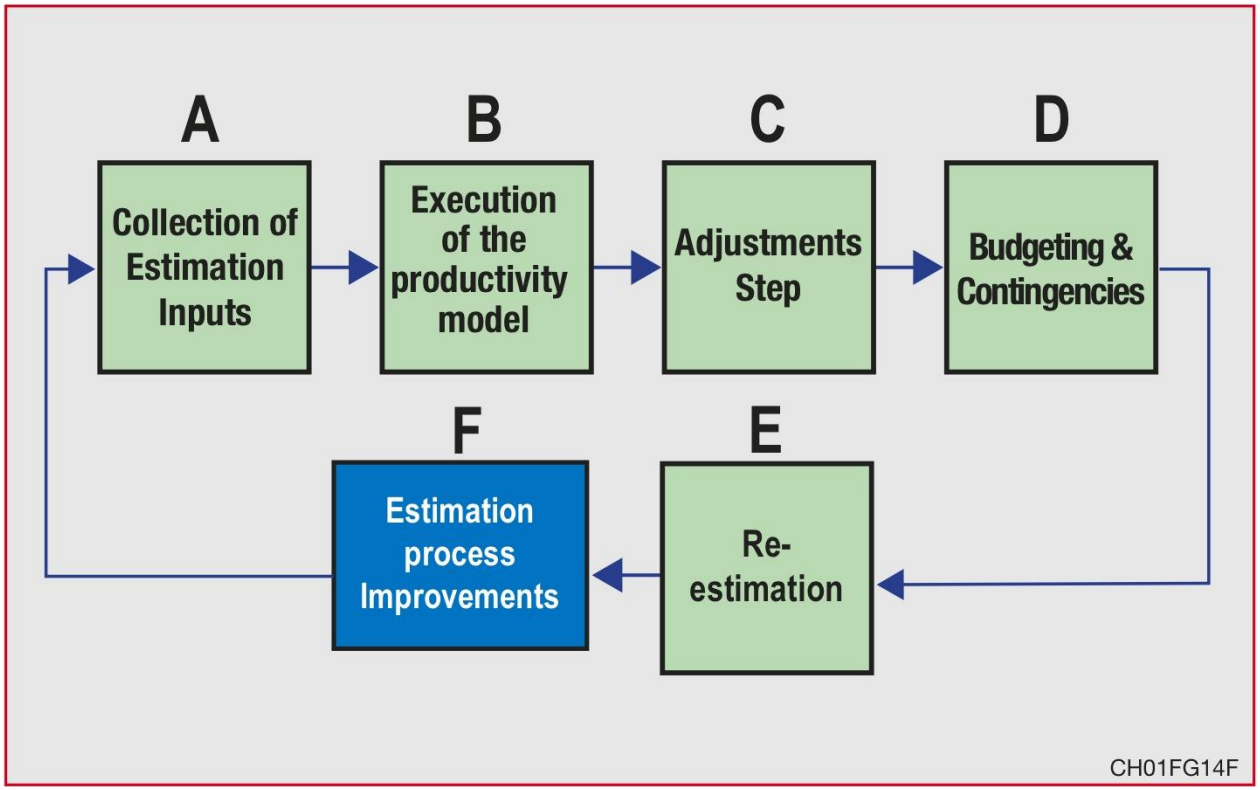
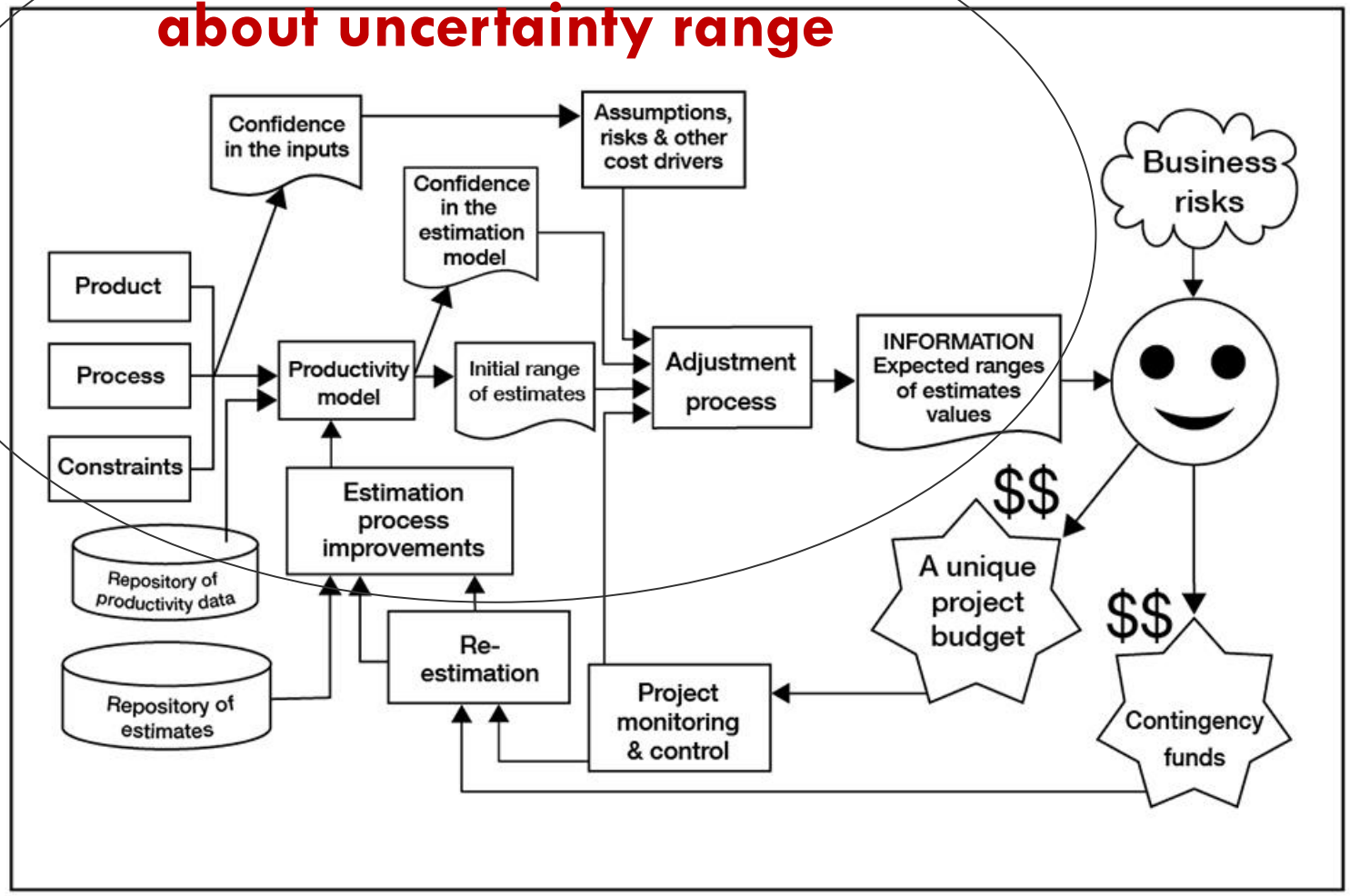
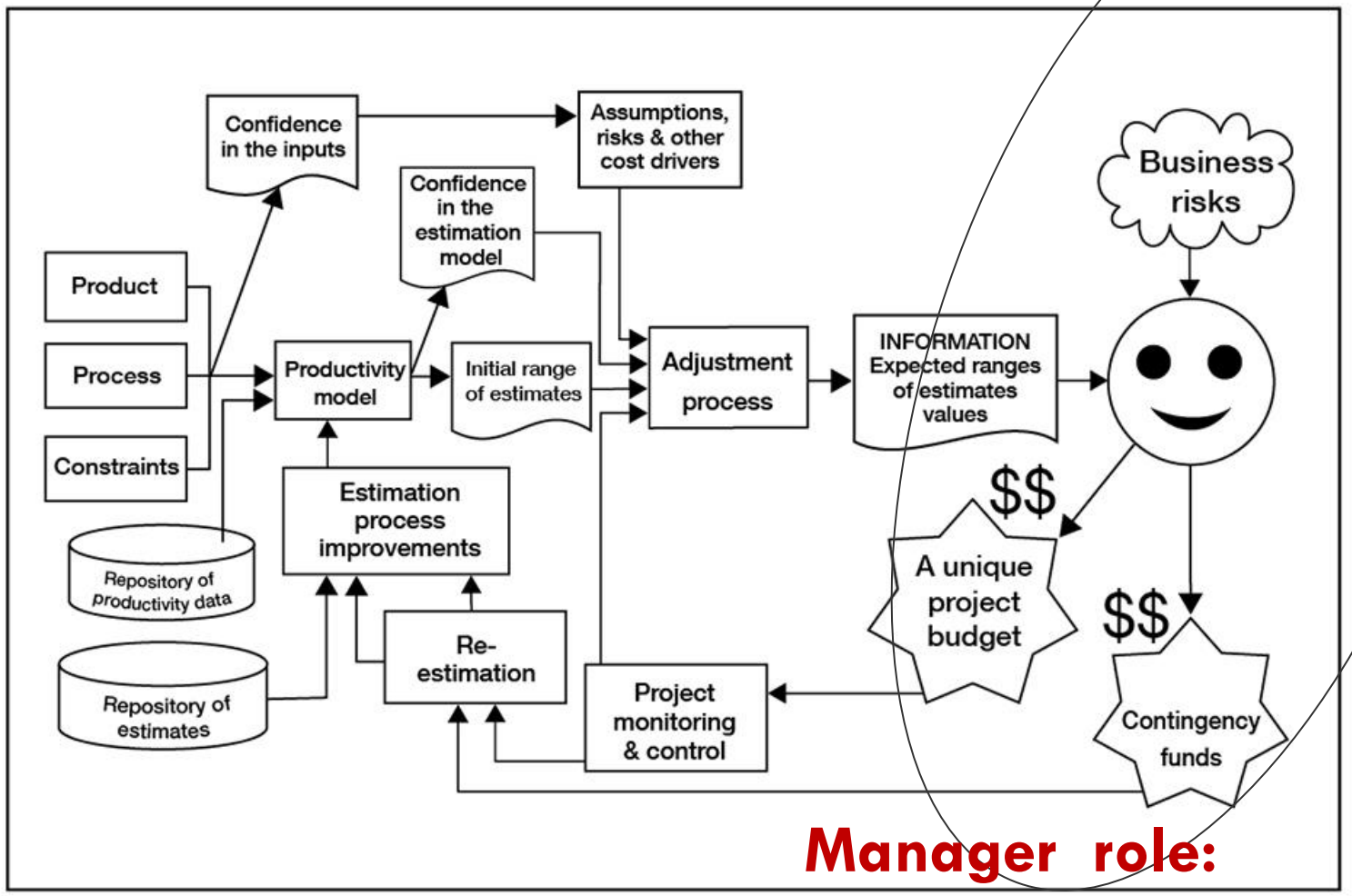


Figure 1.14 Phase F: Estimation Feedback Loop.

Estimator role: Provide information about uncertainty range

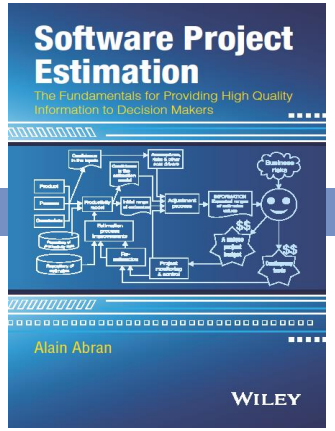




Manager role:

Pick a number & Manage Risk

Agenda



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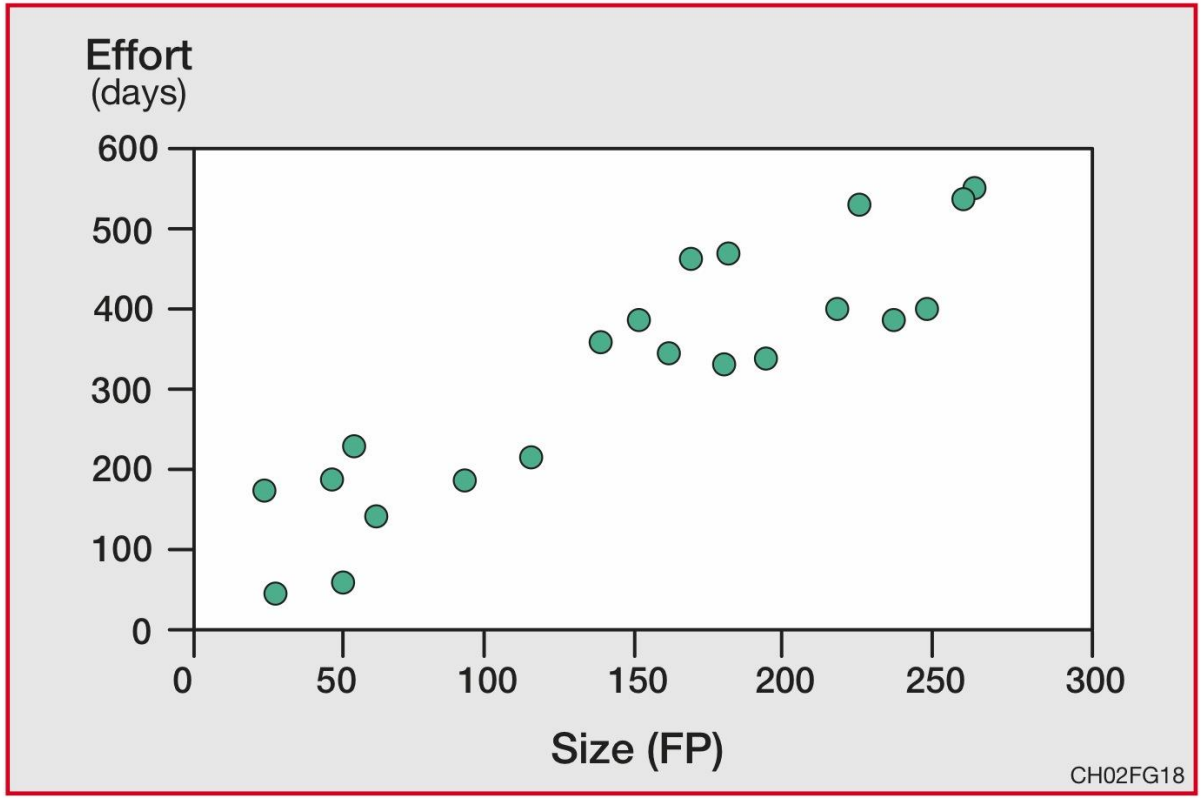


Figure 2.18 Homogeneous dataset of 21 projects (Abran 1994)

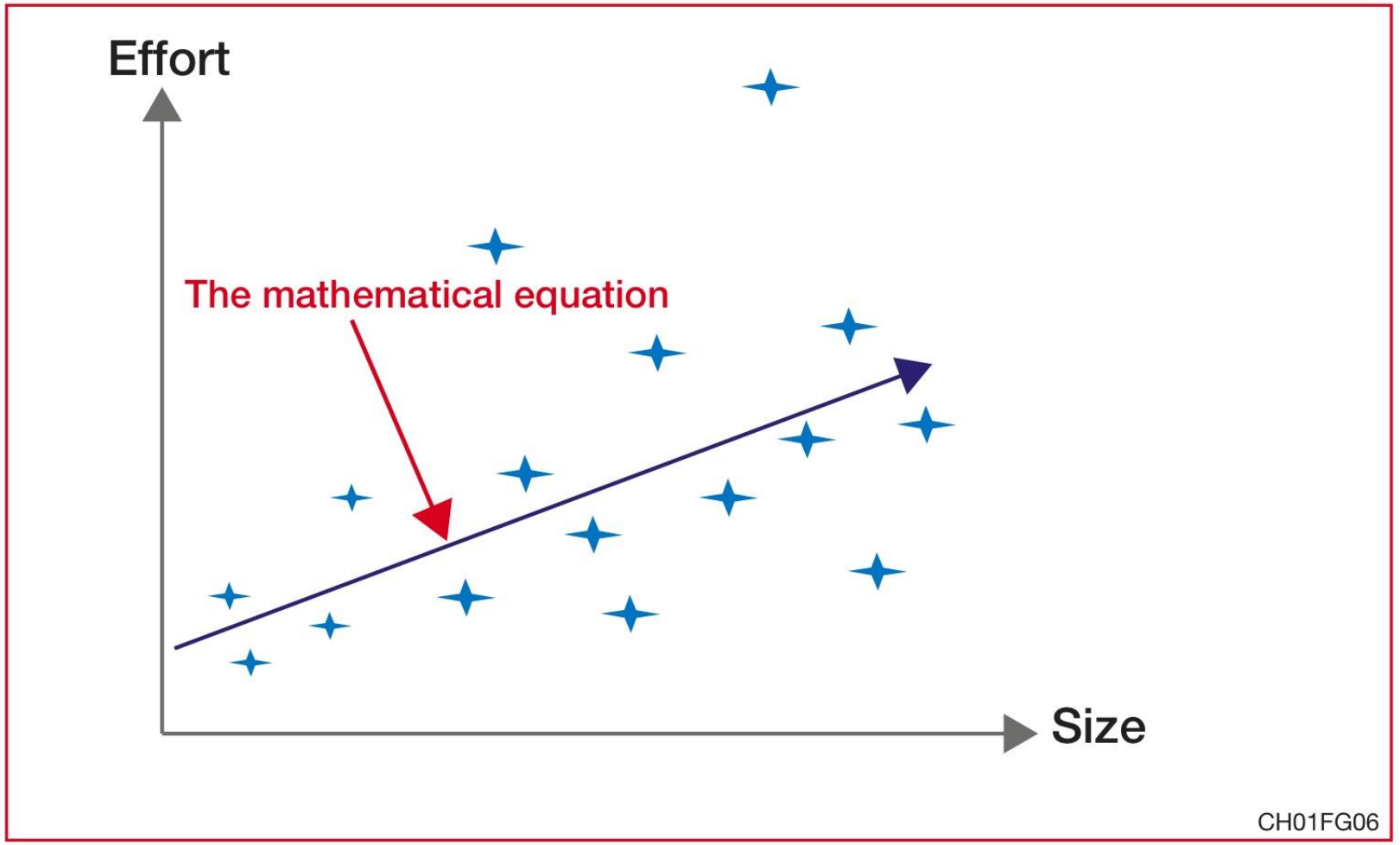


Figure 1.6 A productivity model with 1 independant variable.

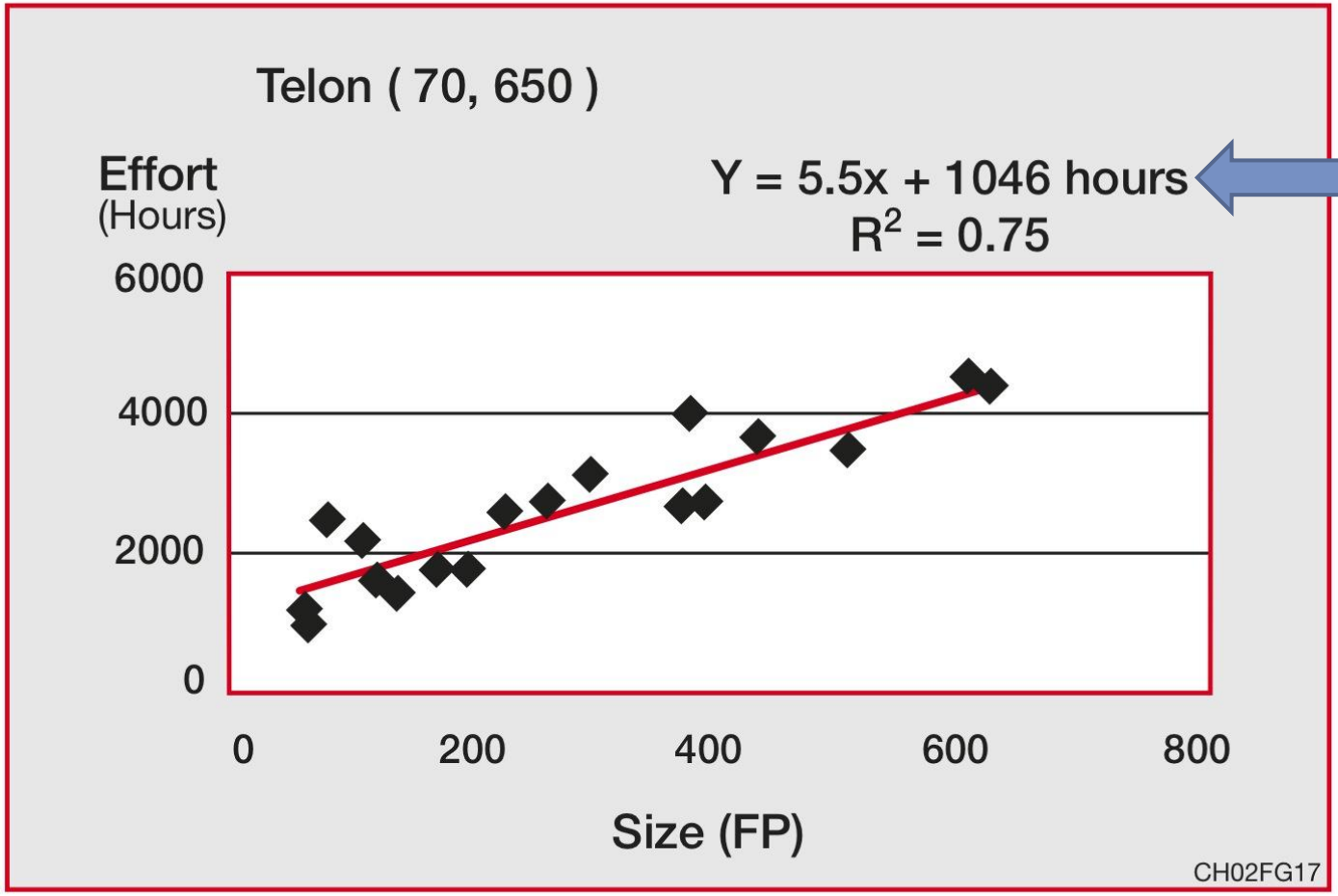


Figure 2.17 The TELON dataset in the ISBSG 1999 Release

(Abran, Ndiaye, Bourque, 2007)

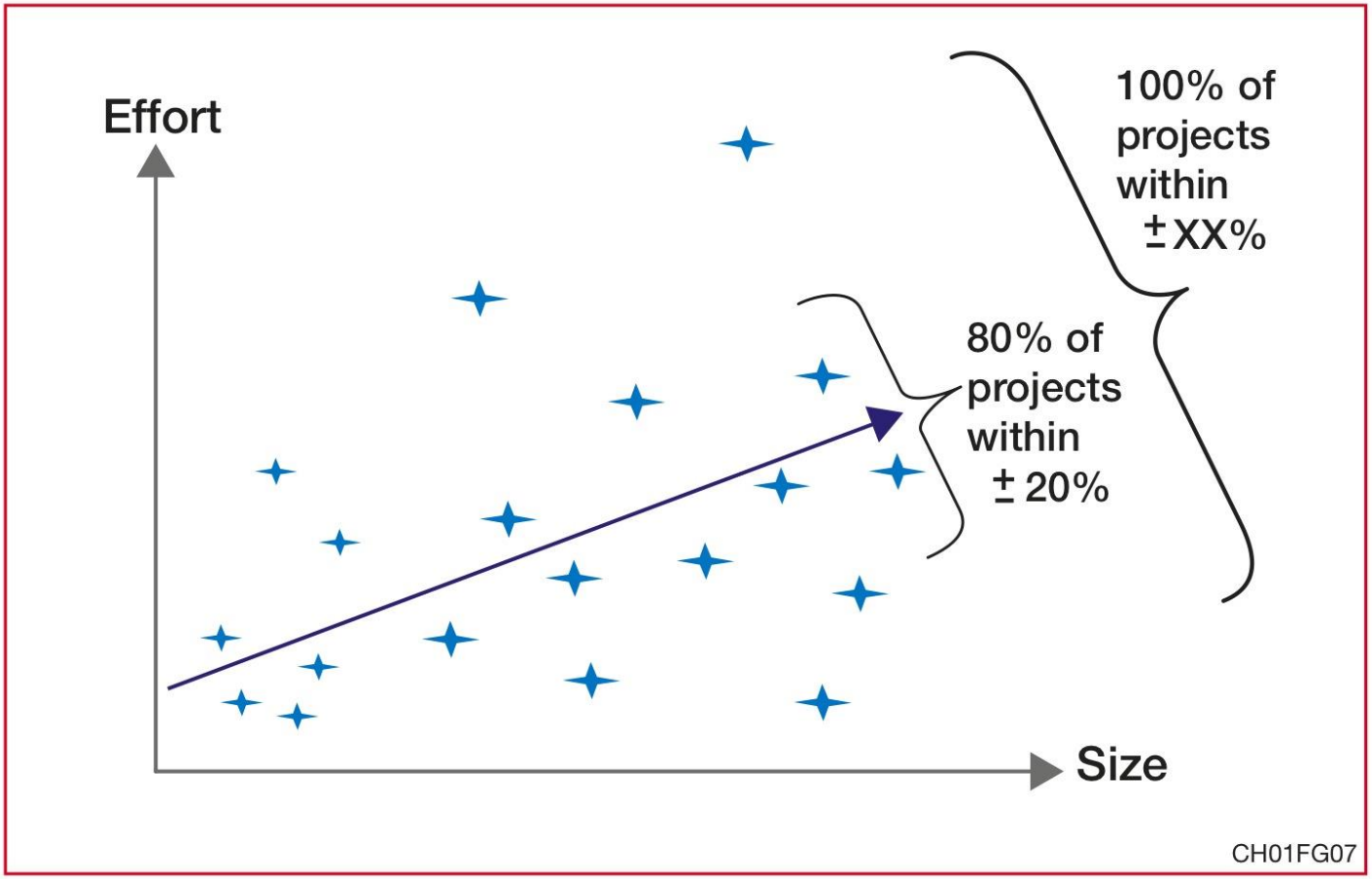


Figure 1.7 A productivity model accuracy.

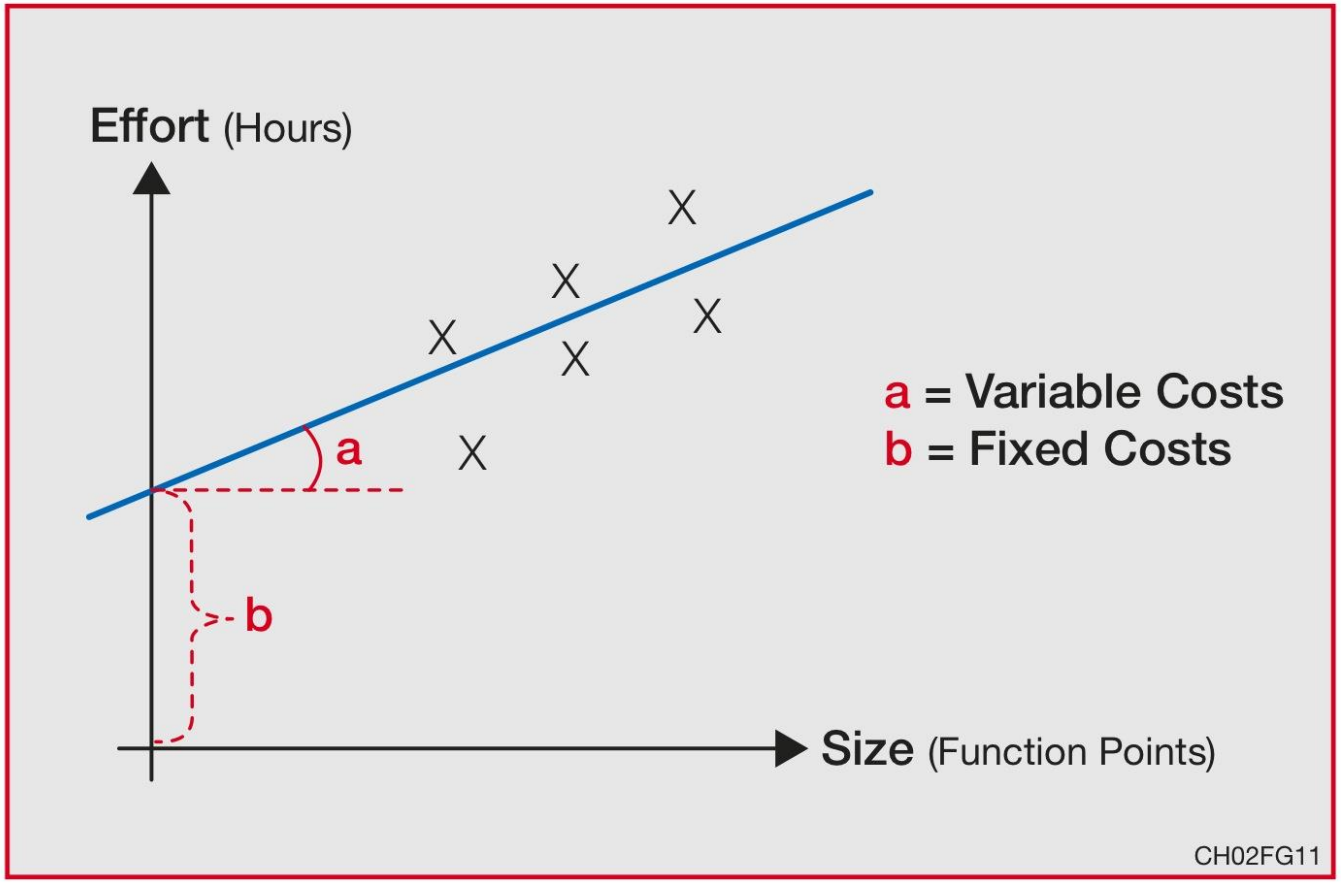
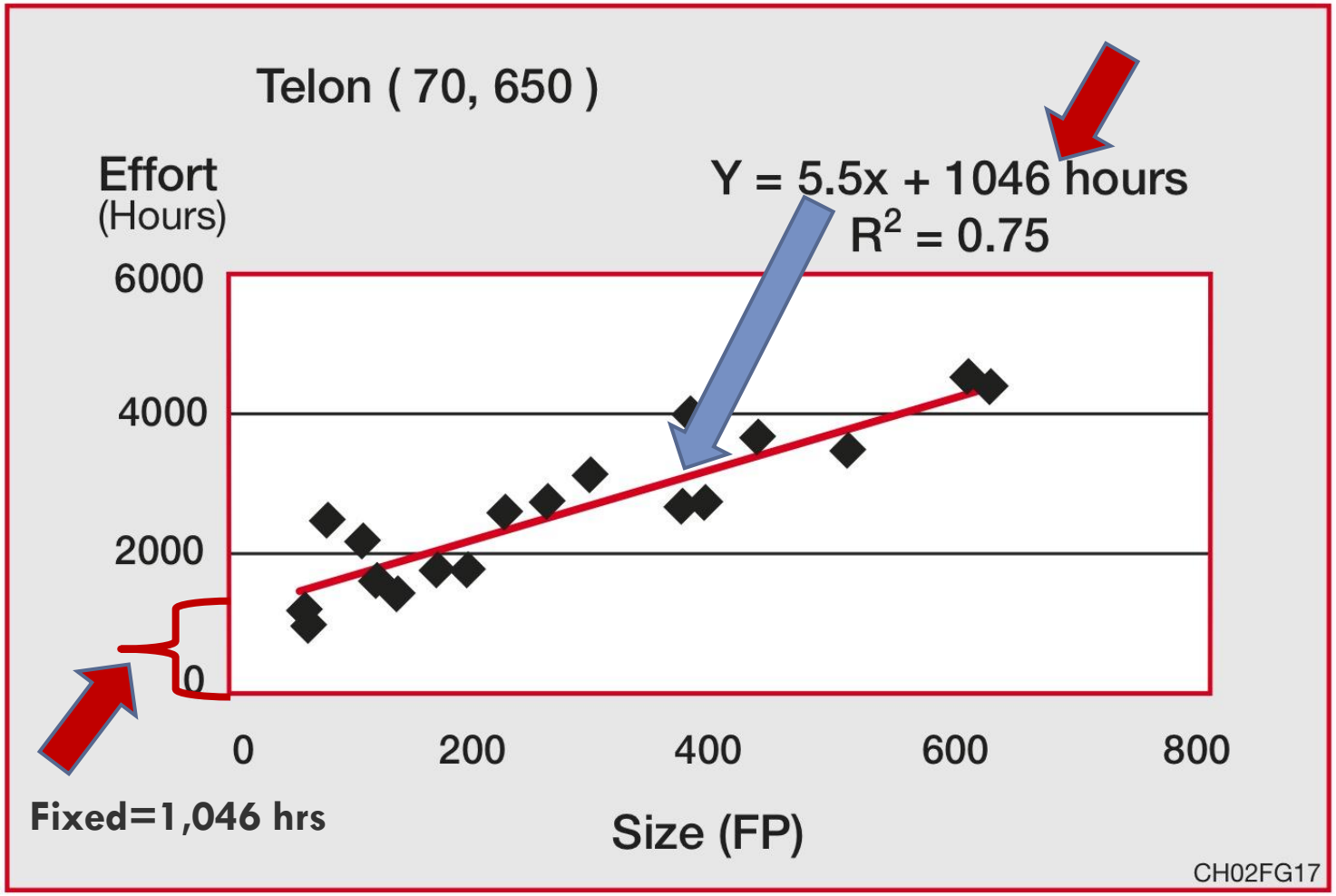


Figure 2.11 Model with a fixed and variale costs.



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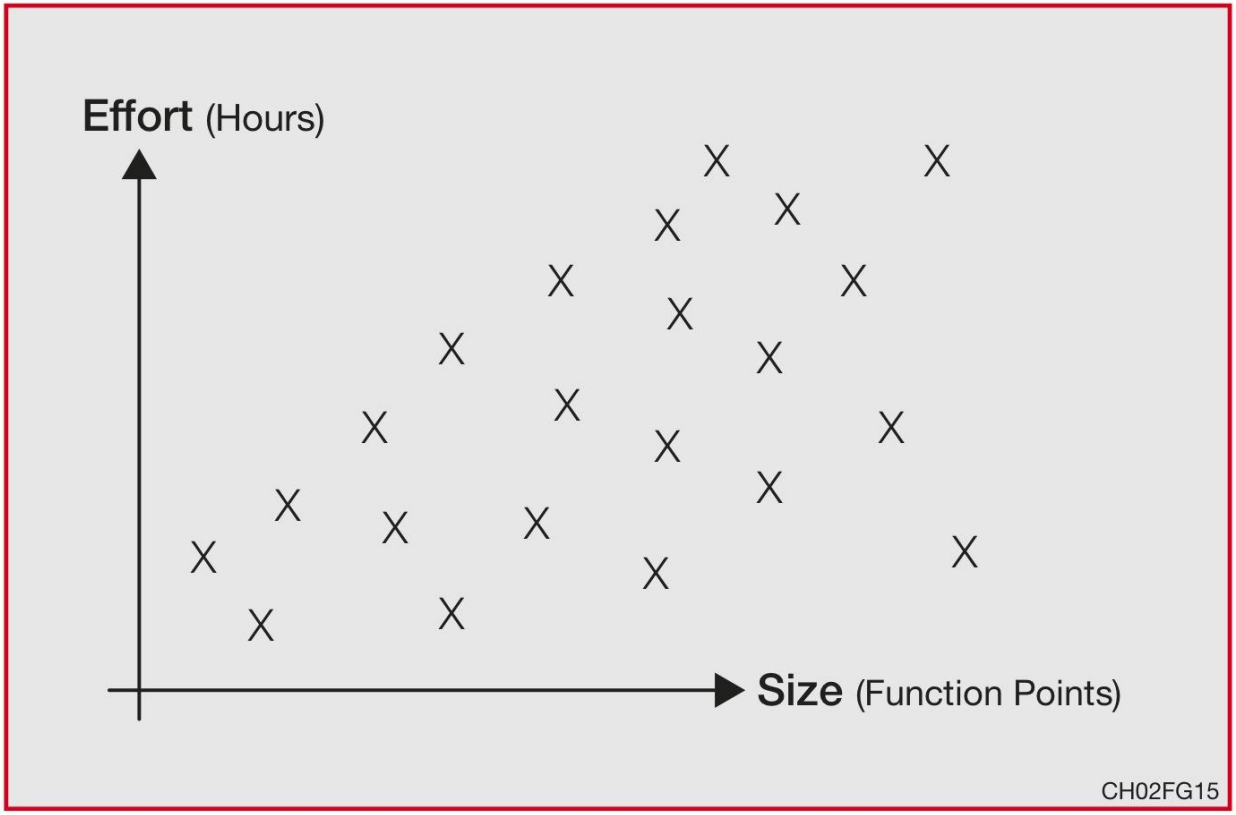

Figure 2.15 Wedge-shaped dataset in software engineering.

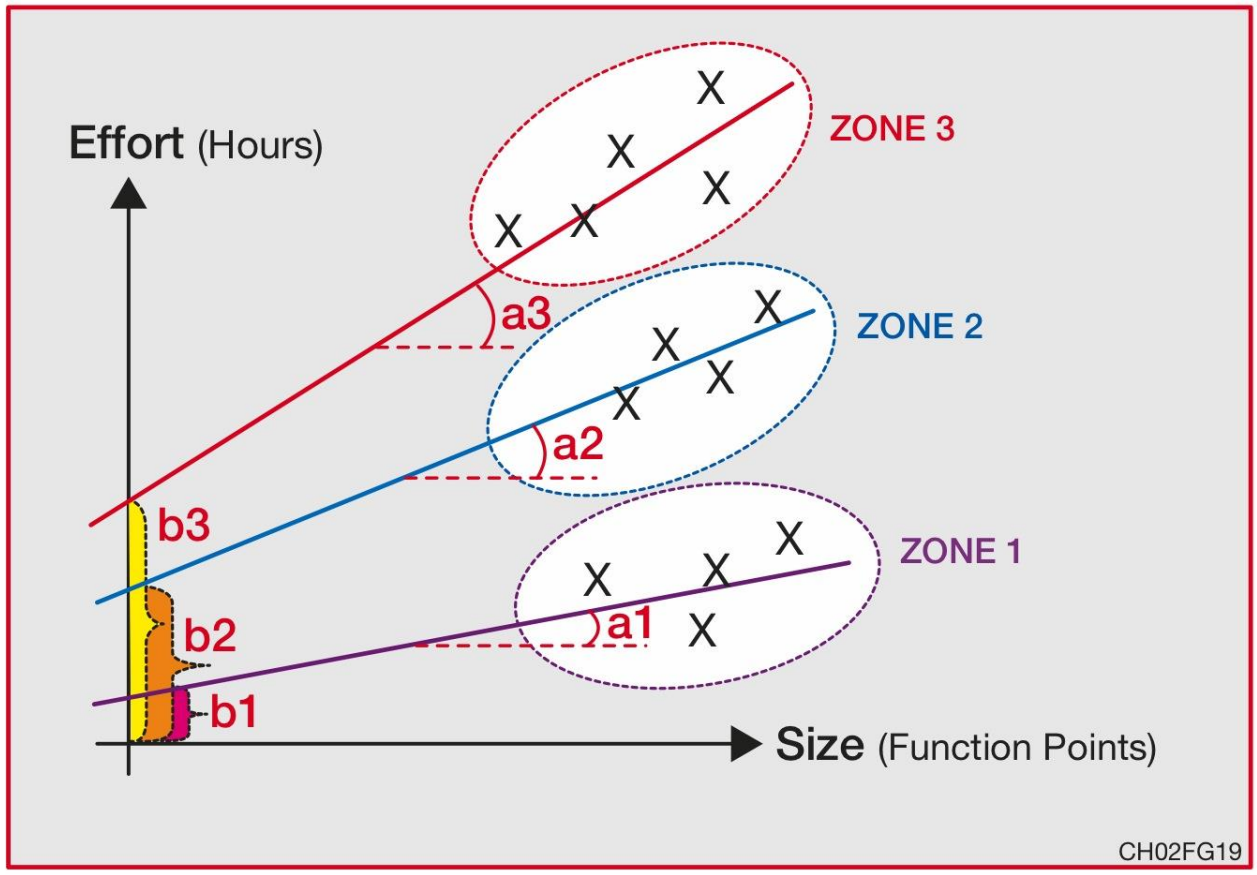

Figure 2.19 Wedge shape with 3 data subsets with economies/diseconomies of scale.

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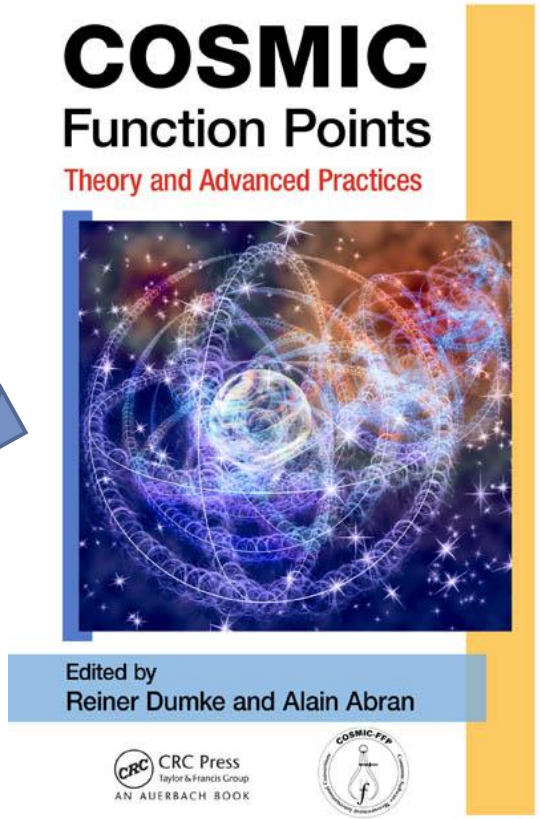
COSMIC data from Industry

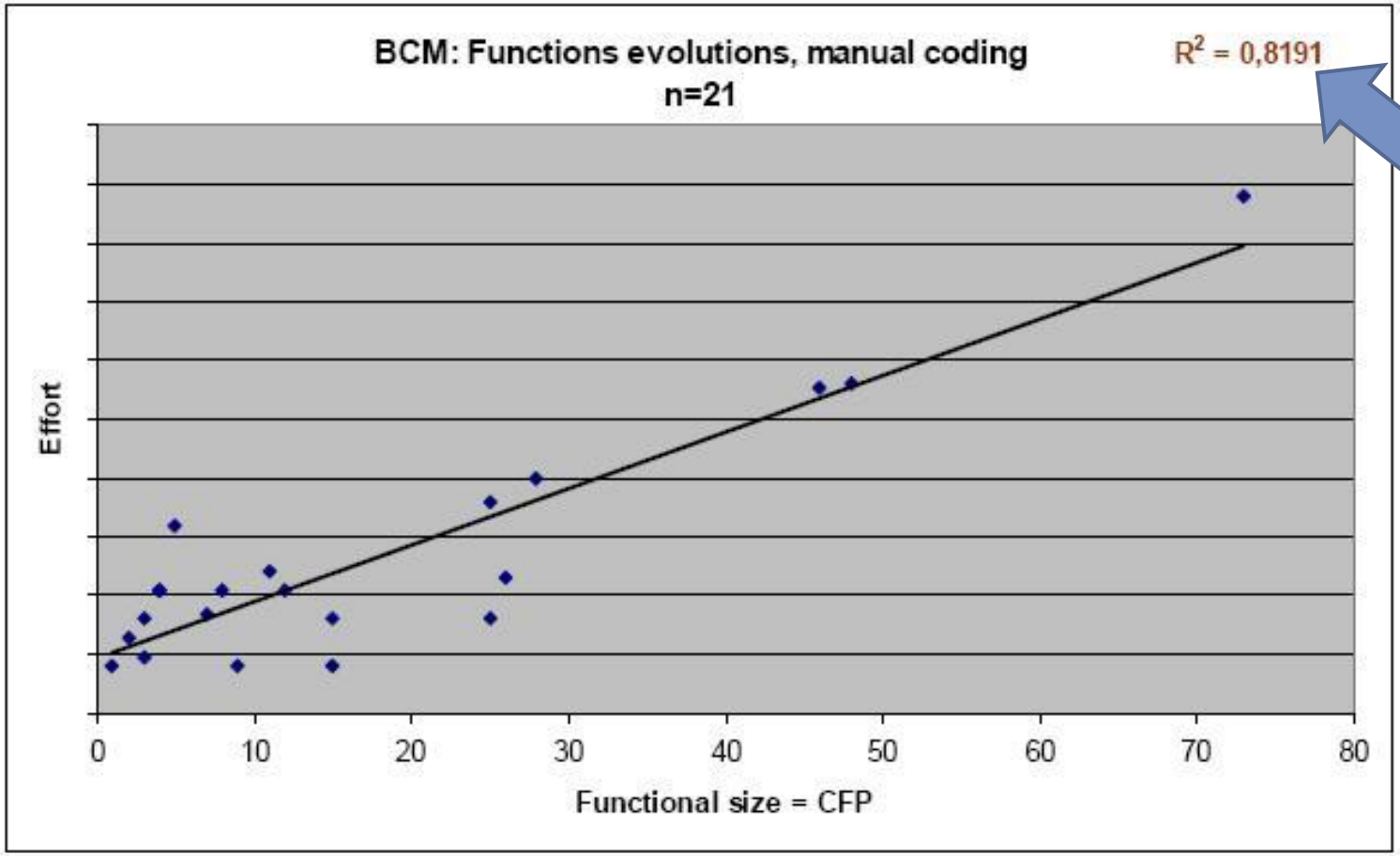
Practical experimentations with the COSMIC method in Automotive embedded software field

By: Sophie Stern

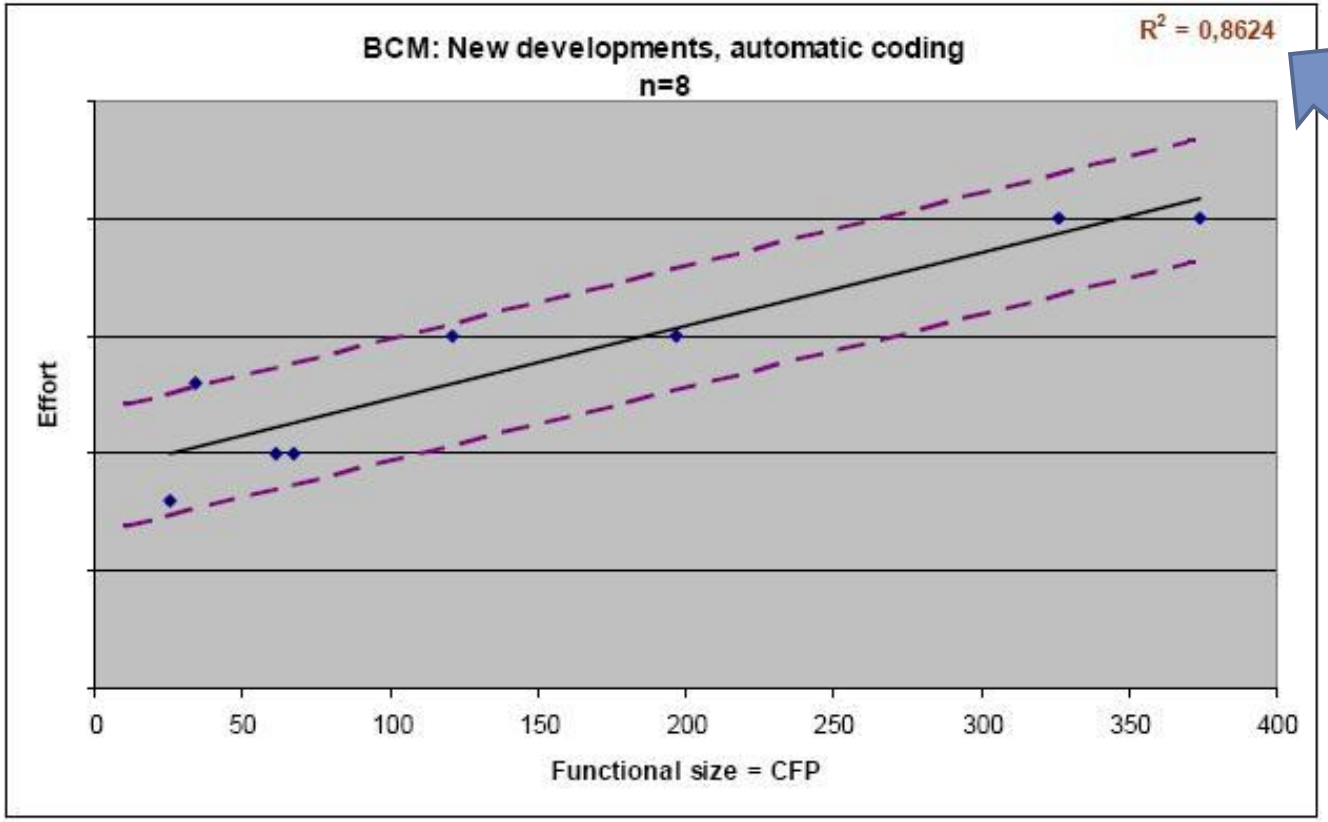
Renault



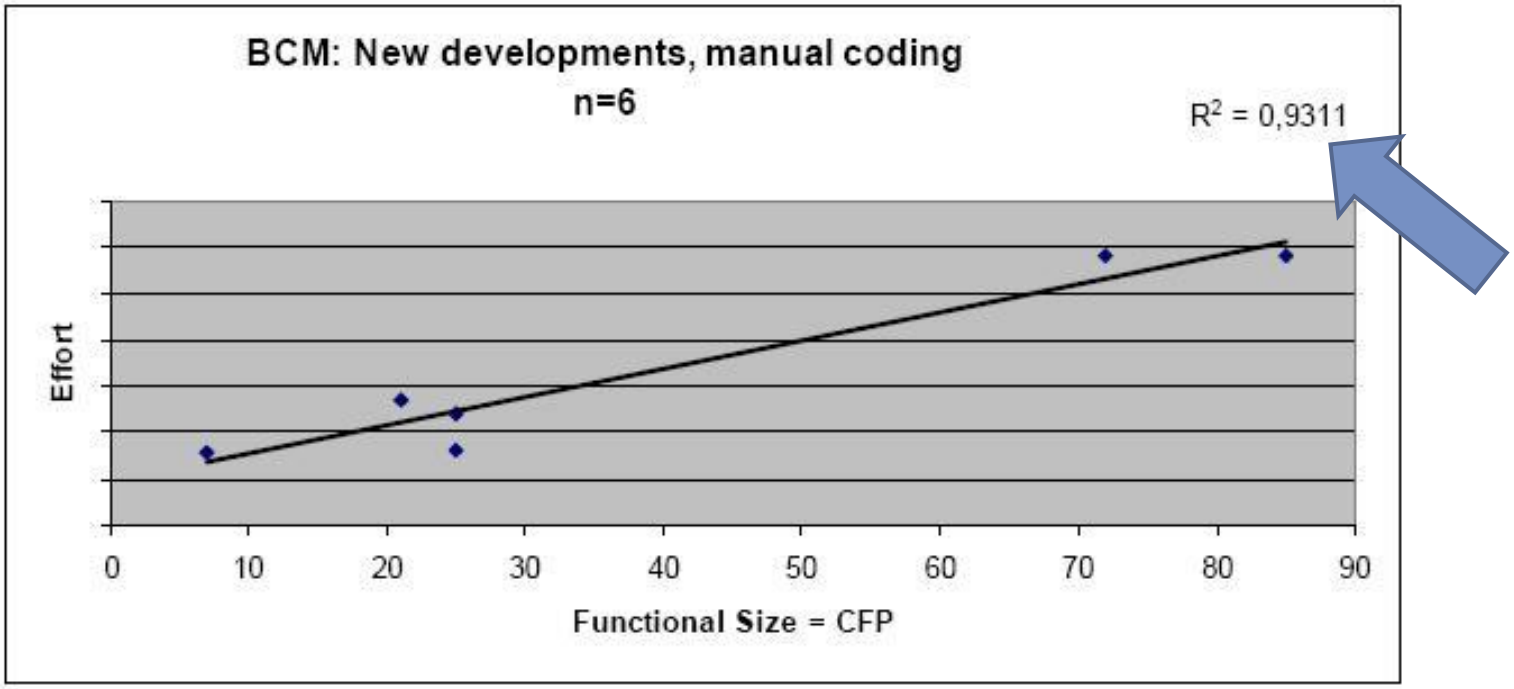
Renault – 2012

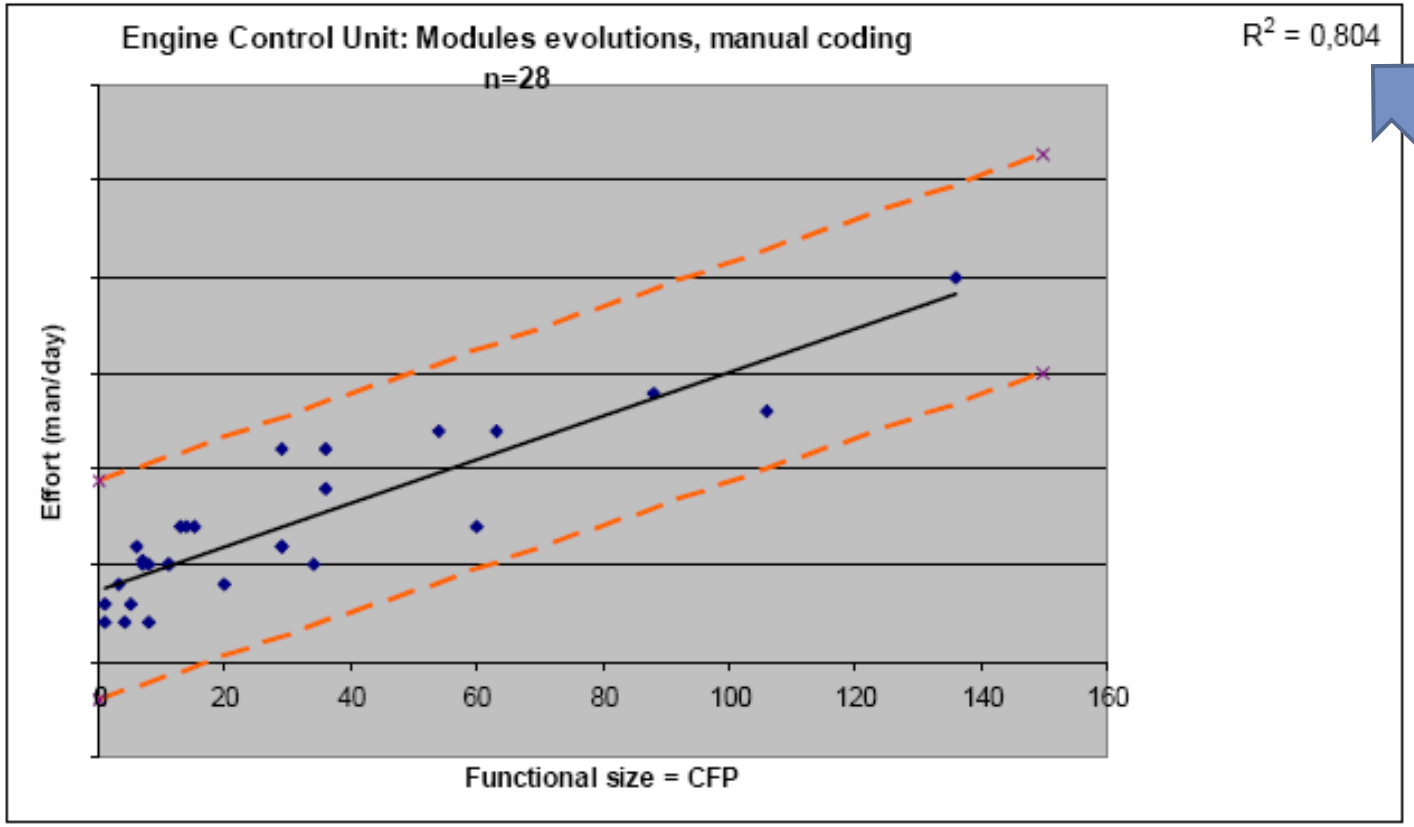


Renault – 2012

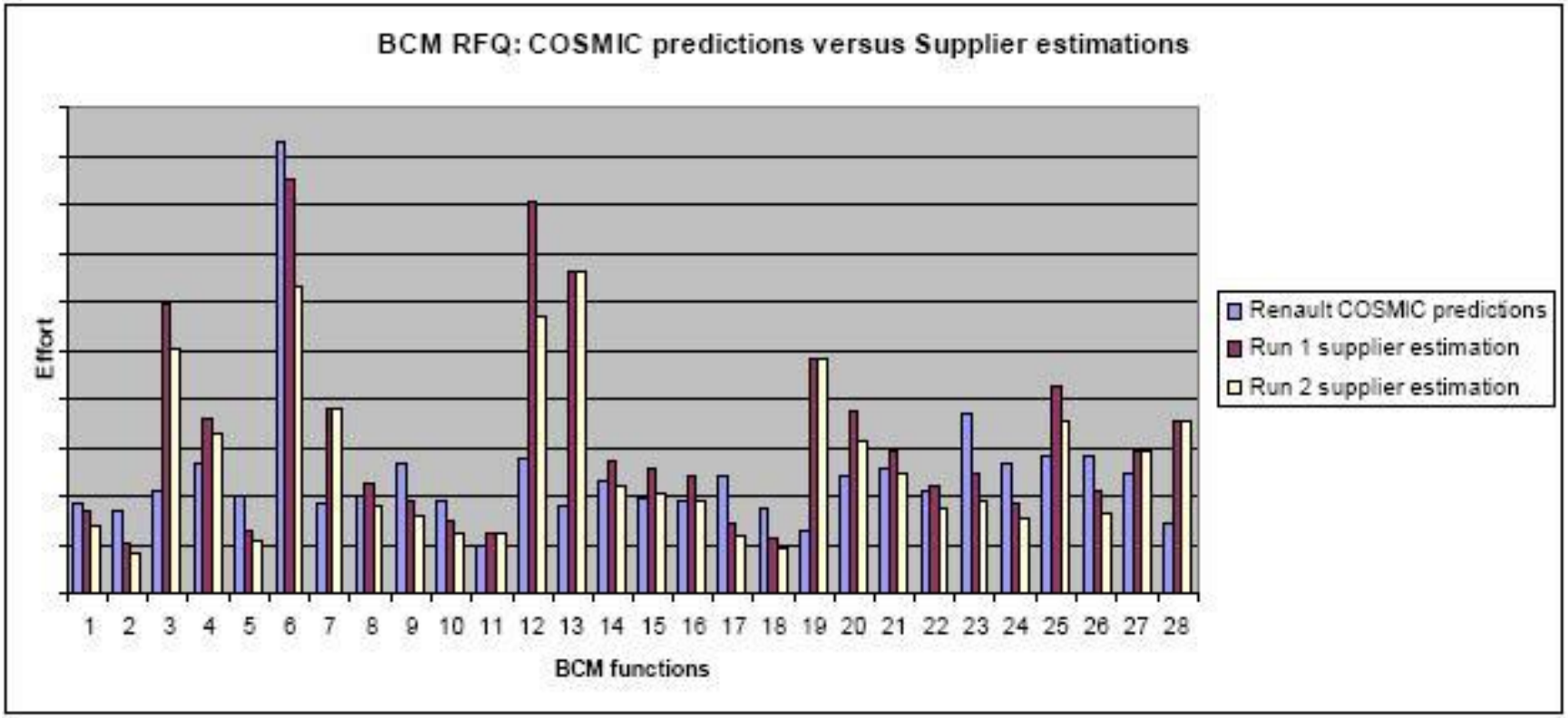


Renault – 2012

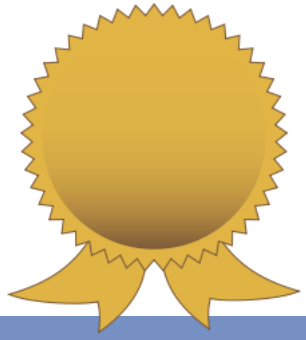




Renault: Estimation & Negociations



Renault COSMIC context & usage



- Automated measurements
  - Matlab Simulink
  - 99% accuracy
- Estimation of CPU memory space based on COSMIC function points
- Planning of Requirements Specifications workload based on COSMIC functions points

Industry data with COSMIC

Productivity Analysis & benchmarking of projects from:

- Financial governmental organization (Canada)

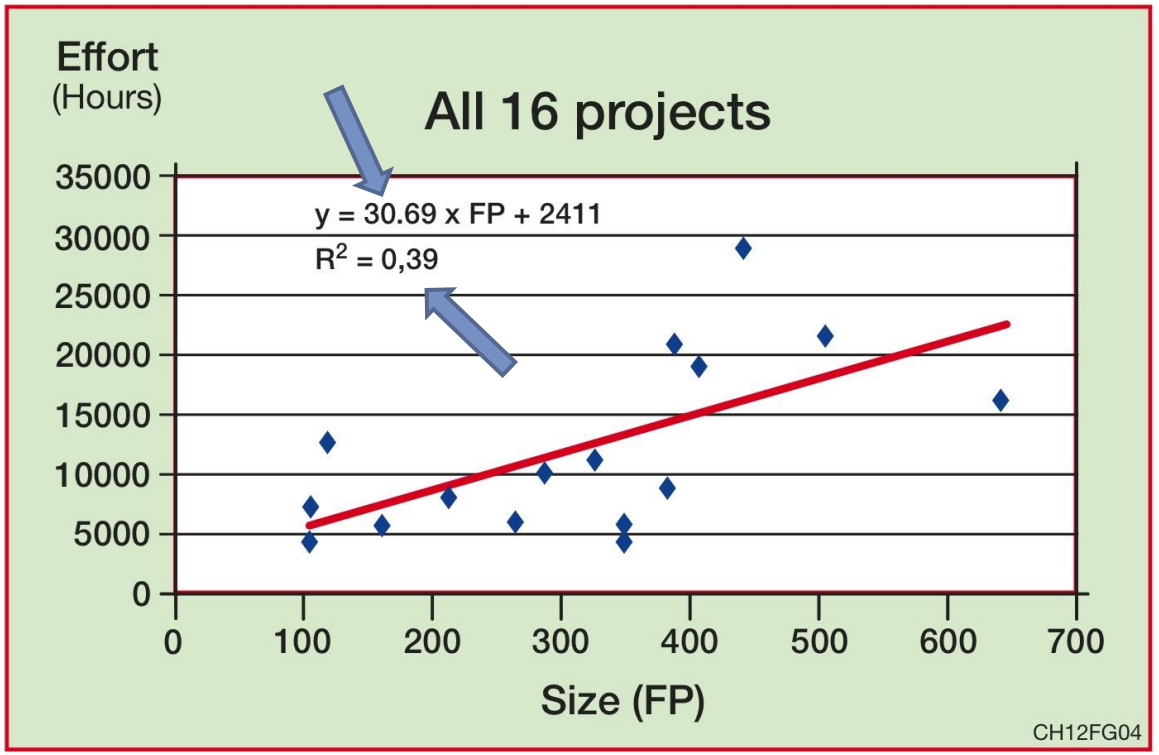


Figure 12.4 The organization's production model.

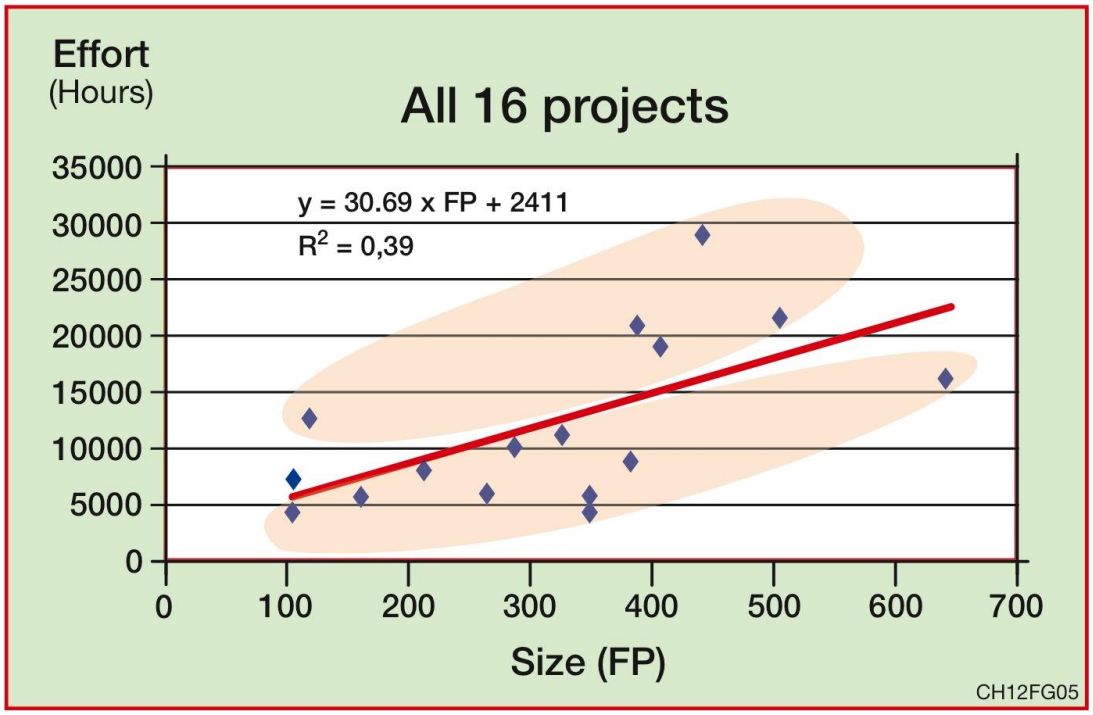


Figure 12.5 The two subsets of projects within the single dataset.

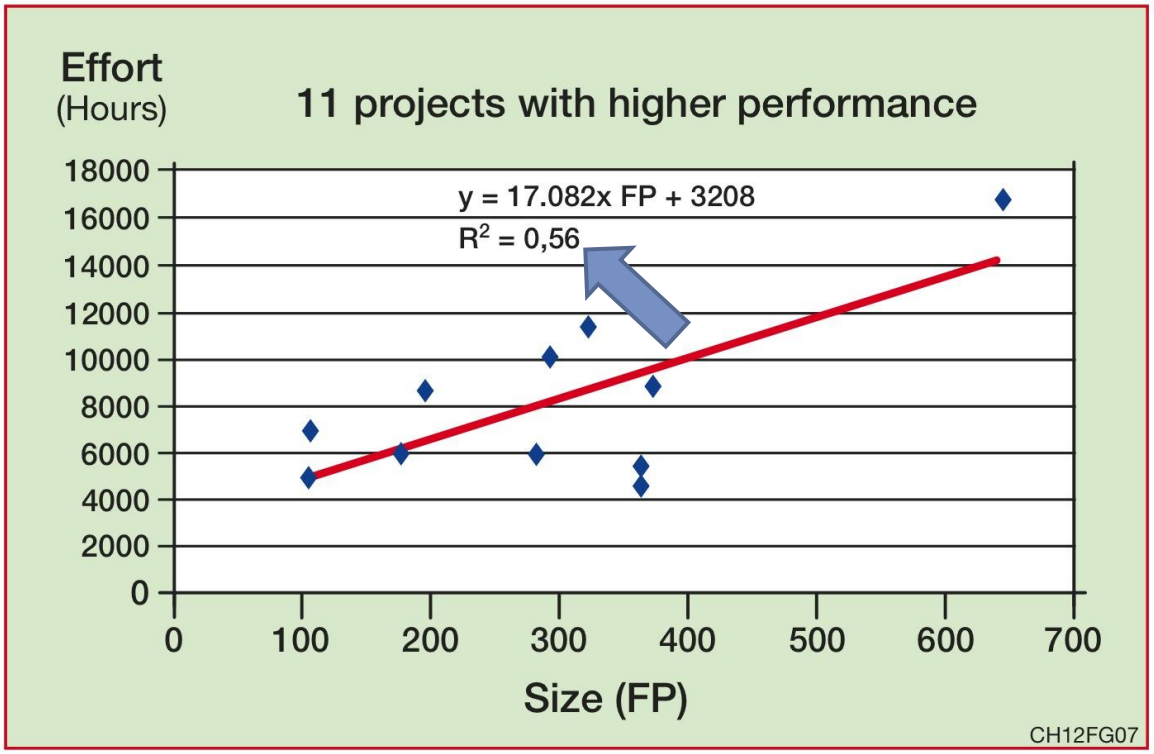


Figure 12.7 Most productive projects.

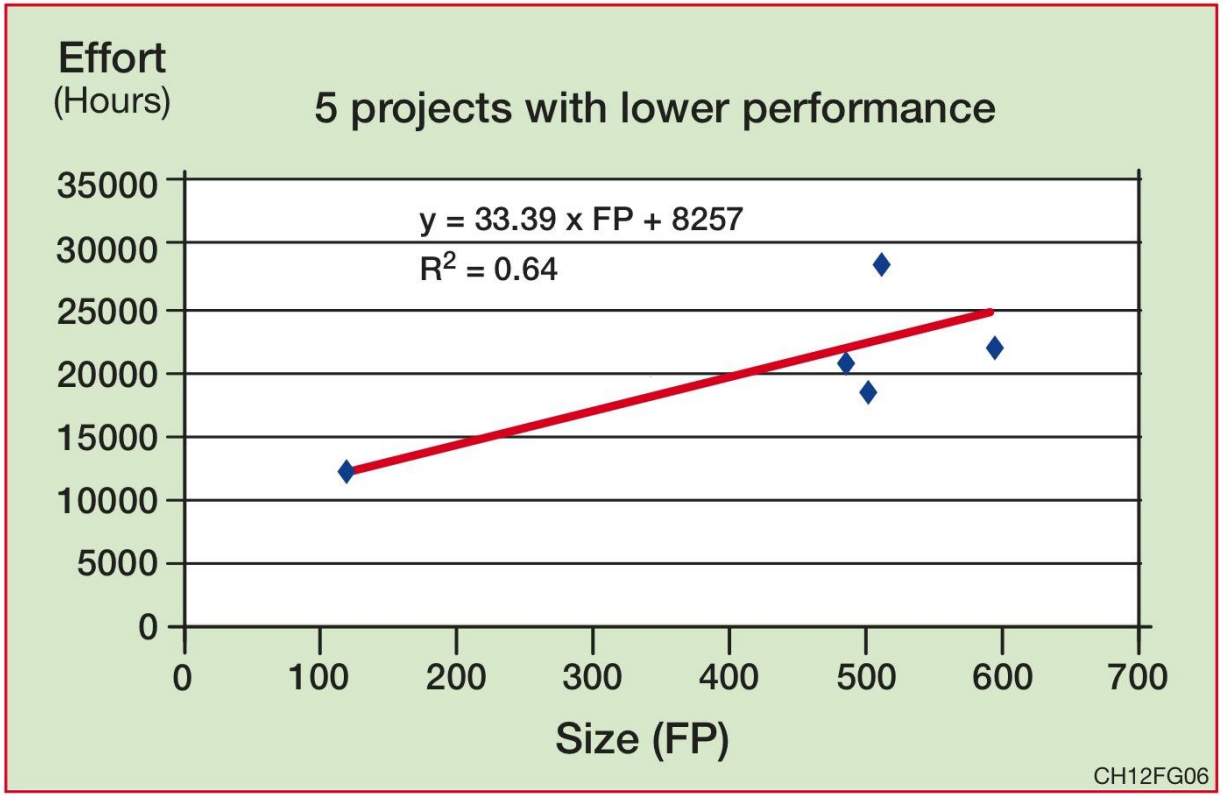


Figure 12.6 Least productive projects.

Which estimation model to use in which contexts?

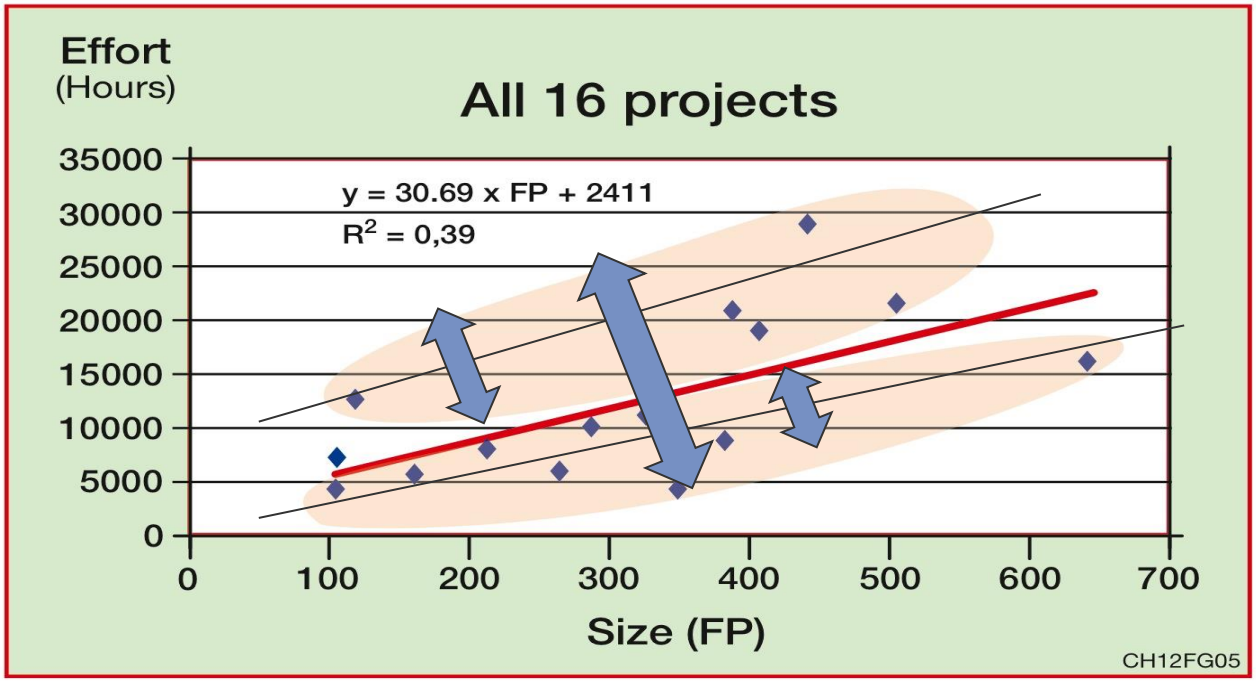


Figure 12.5 The two subsets of projects within the single dataset.

International benchmarking with ISBSG

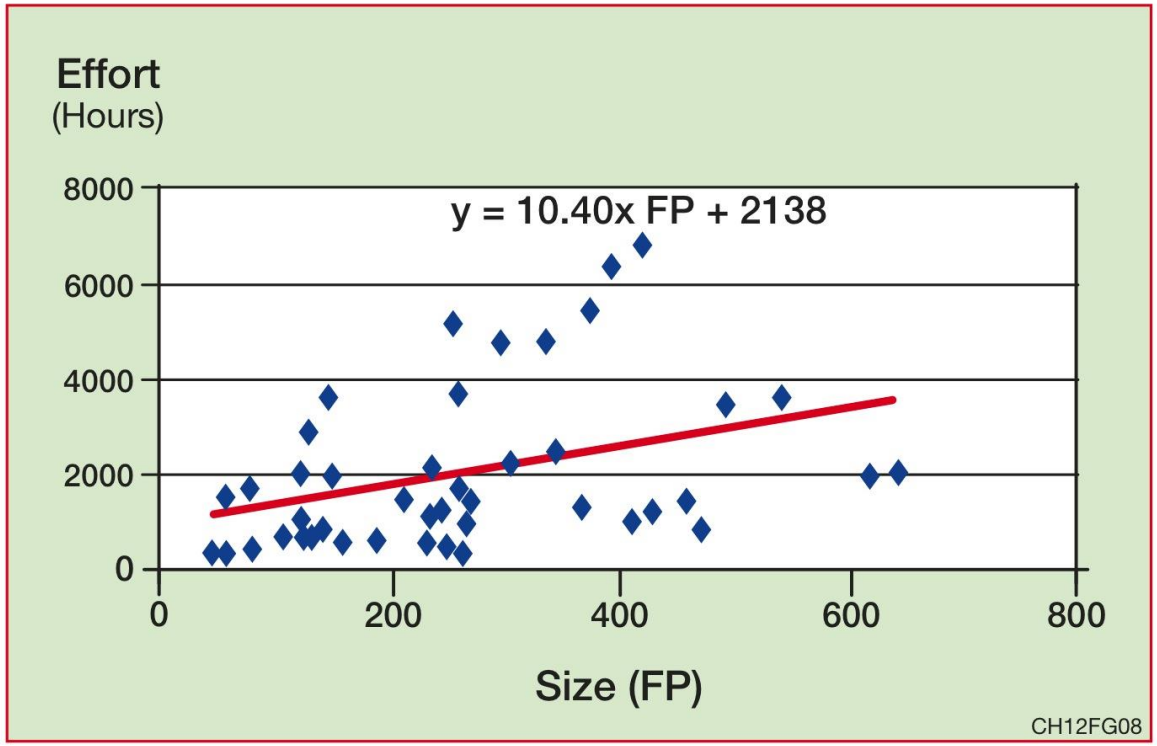


Figure 12.8: 3GL ISBSG governmental projects.

Organization A: Effort = 31hrs/CFP x CFP + 2,411 hours

ISBSG benchmark: Effort = 10hrs/CFP x CFP + 2,138 hours

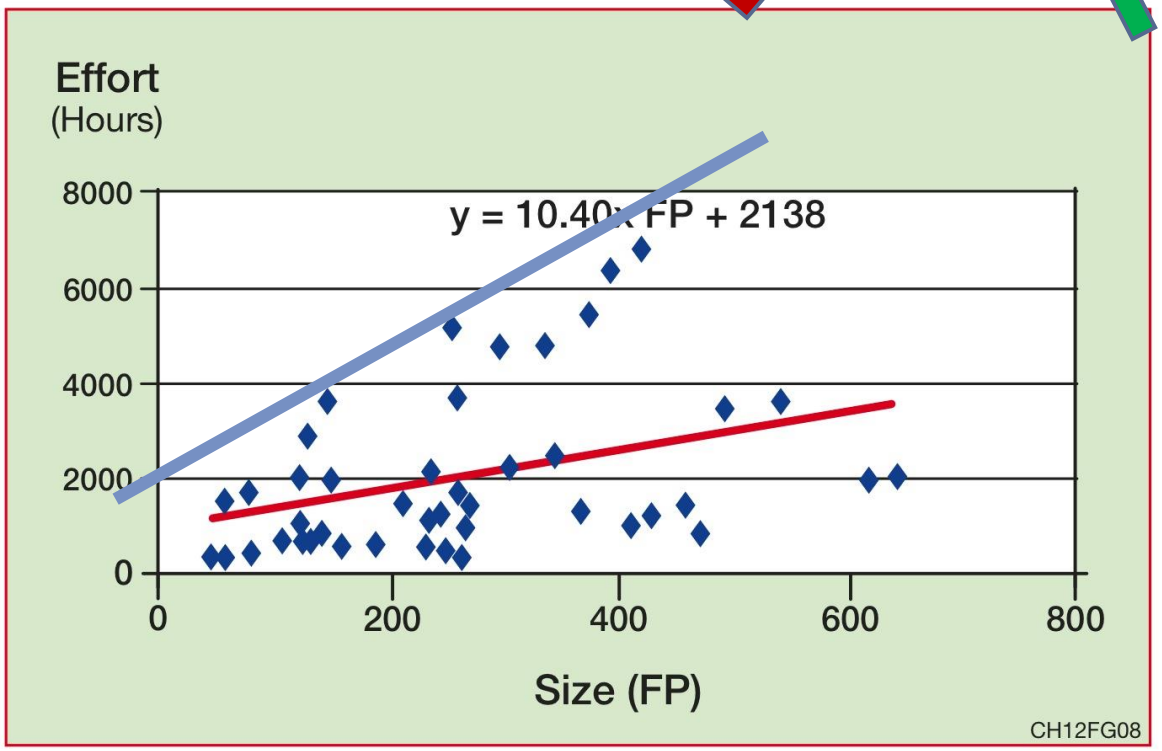
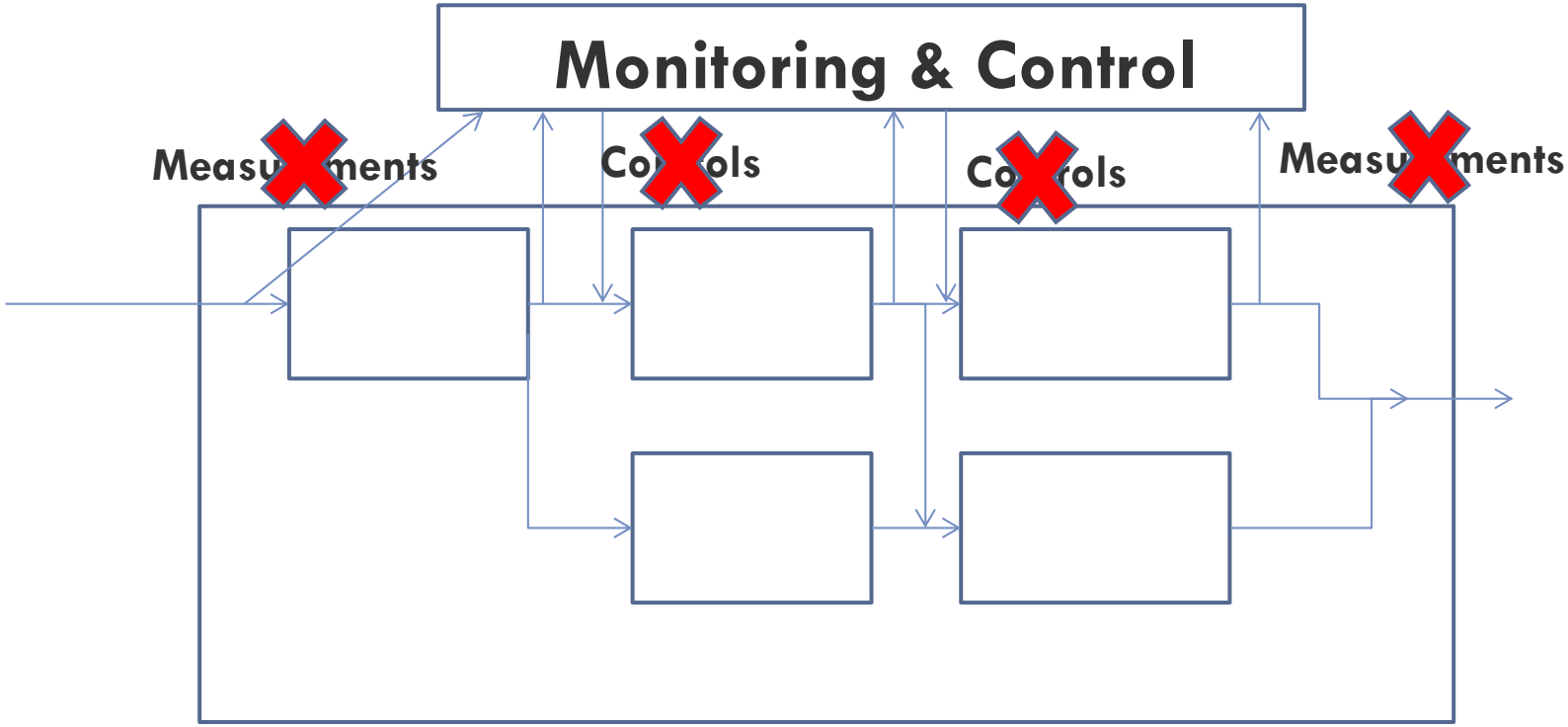


Figure 12.8: 3GL ISBSG governmental projects.

NOT

Managed Process



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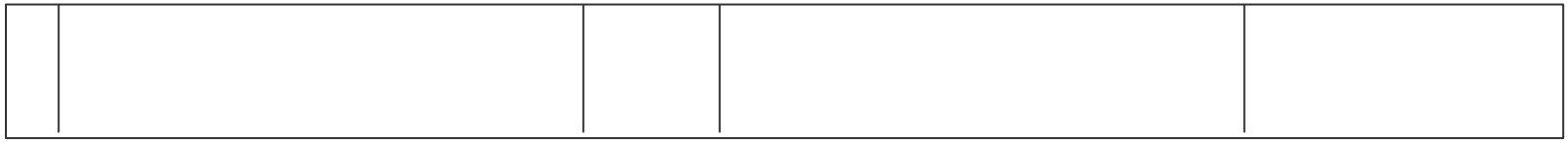
A look at the most-known estimation approach:

The 'COCOMO-like' models

Effort = F (Size, +15 cost drivers)

Each COCOMO cost driver has a similar structure



Distinct irregular intervals for each factor

	Low		**High**	**Very high**

Each interval is assigned the same ordered label (ordinal scale type)

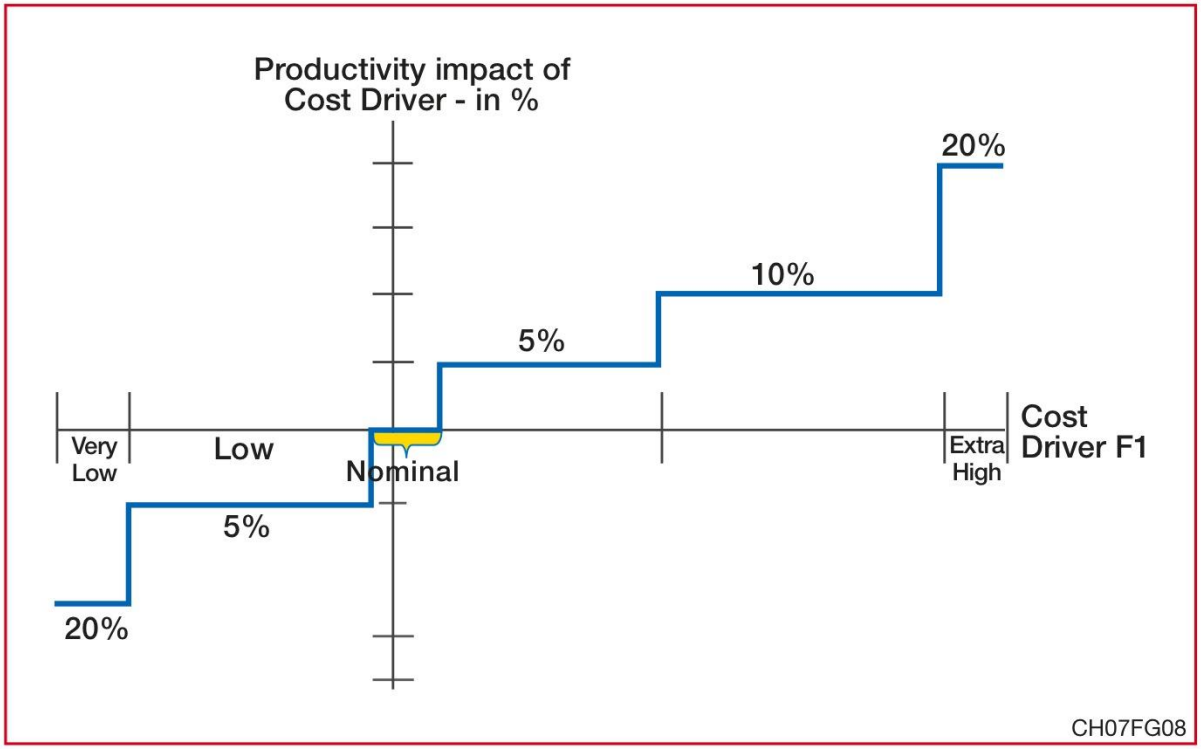
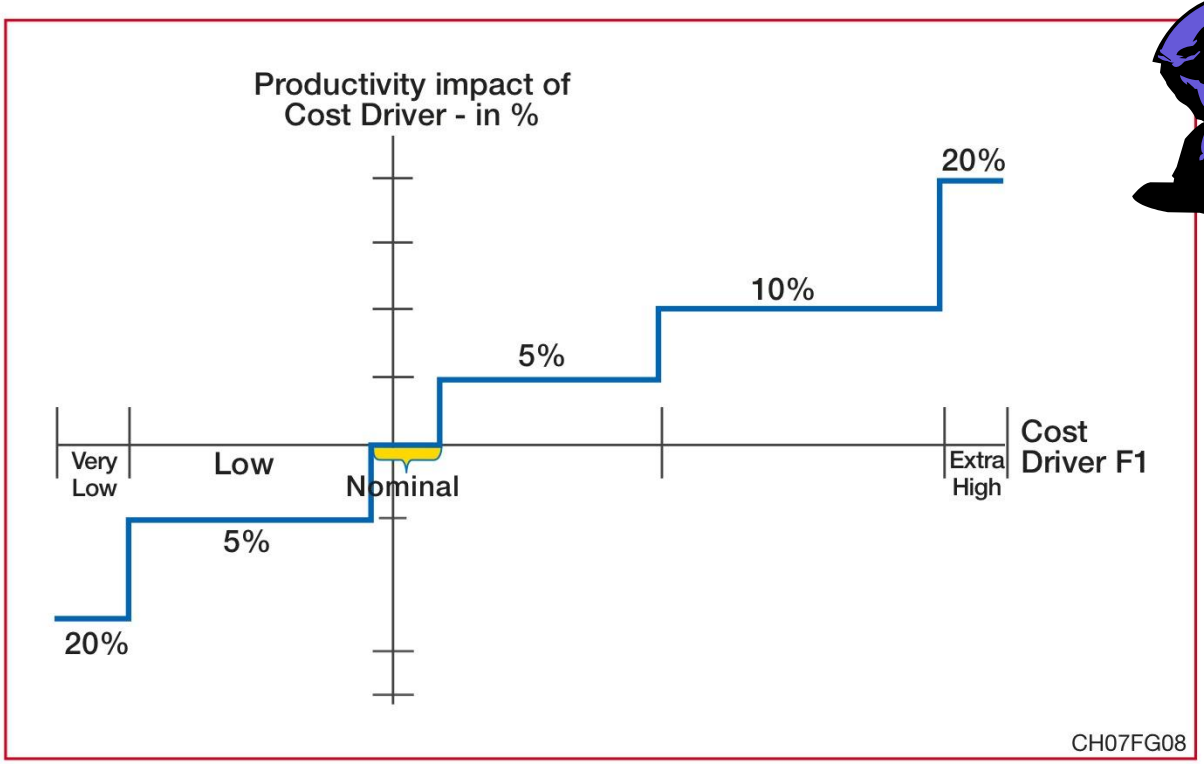


Figure 7.8 A step-function estimation model-with irregular intervals.



Impact guessed by 'experts'

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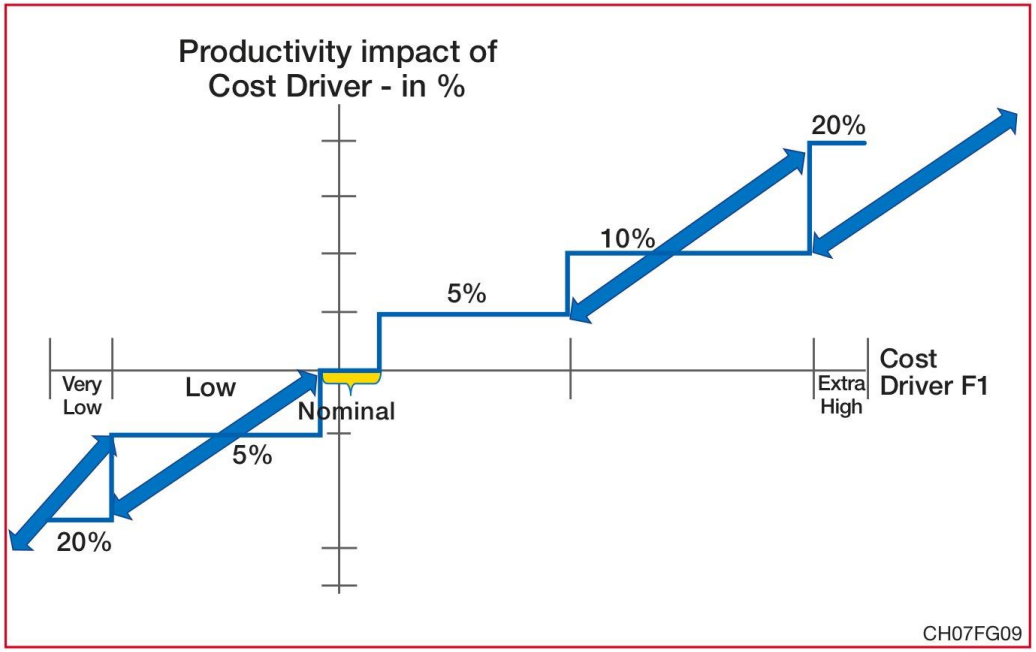
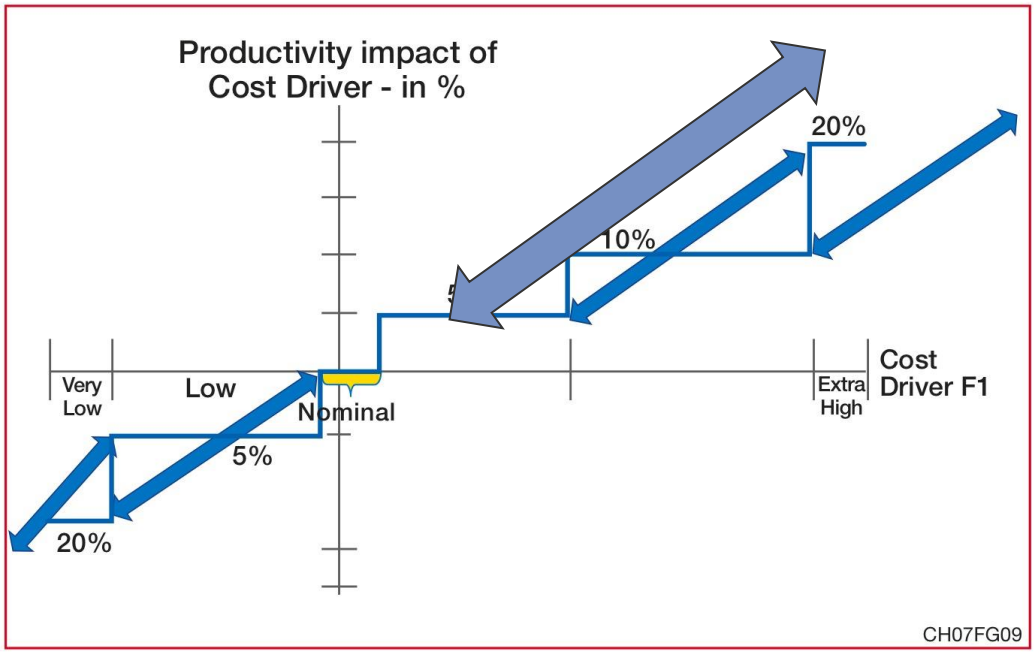


Figure 7.9 Approximation of step-funtion productivity models with irregular intervals.



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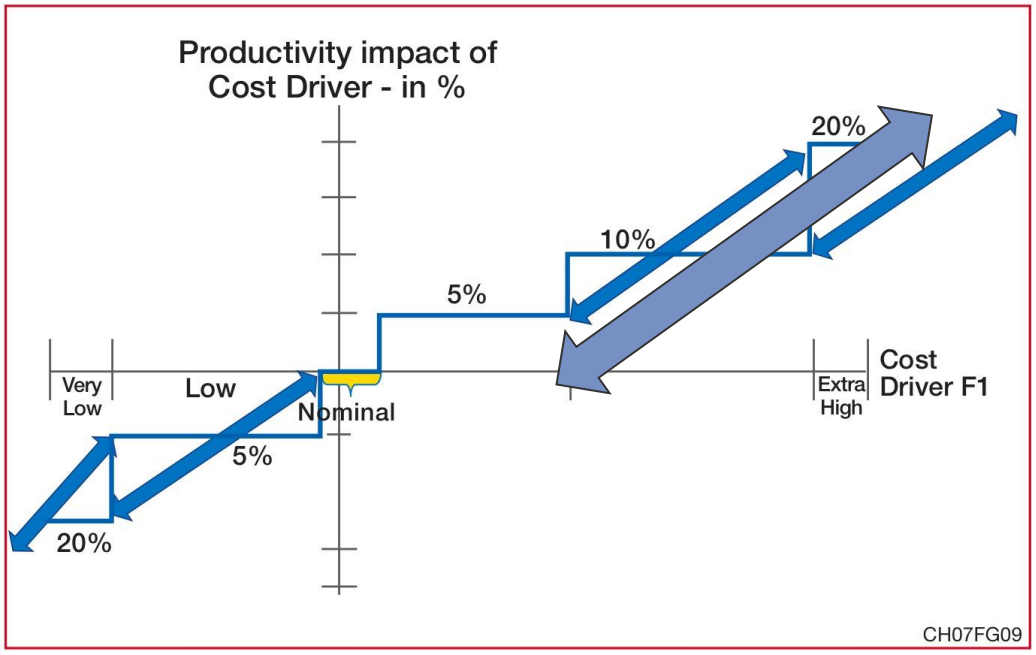

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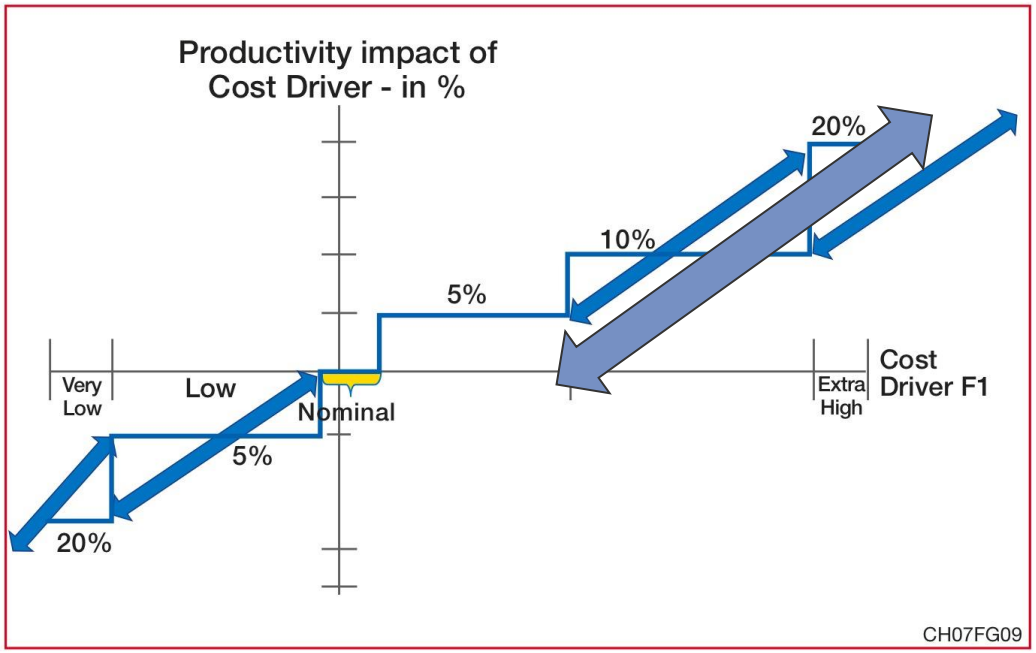
Each COCOMO cost driver =

An estimation sub-model with unkown quality & large errors



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Each COCOMO cost driver =

an estimation sub-model with unkown quality & large errors

COCOMO-like estimation models: Effort is a mutiplication function of (Size & 15 step-functions)

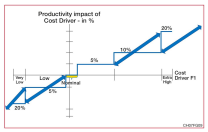
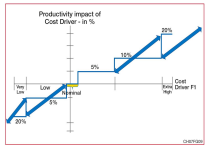


Figure 7.9 Approximation of step-funtion productivity models with irregular intervals.



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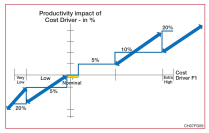

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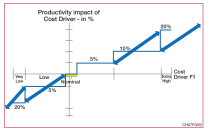

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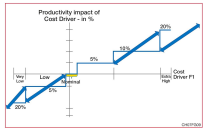

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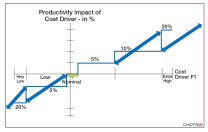

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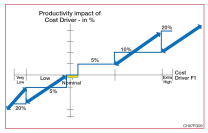

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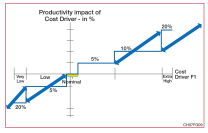

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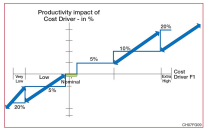

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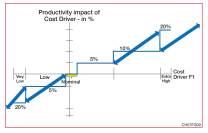

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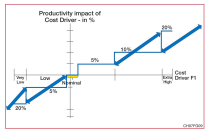

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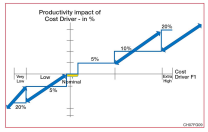

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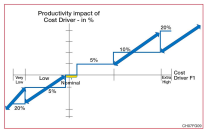

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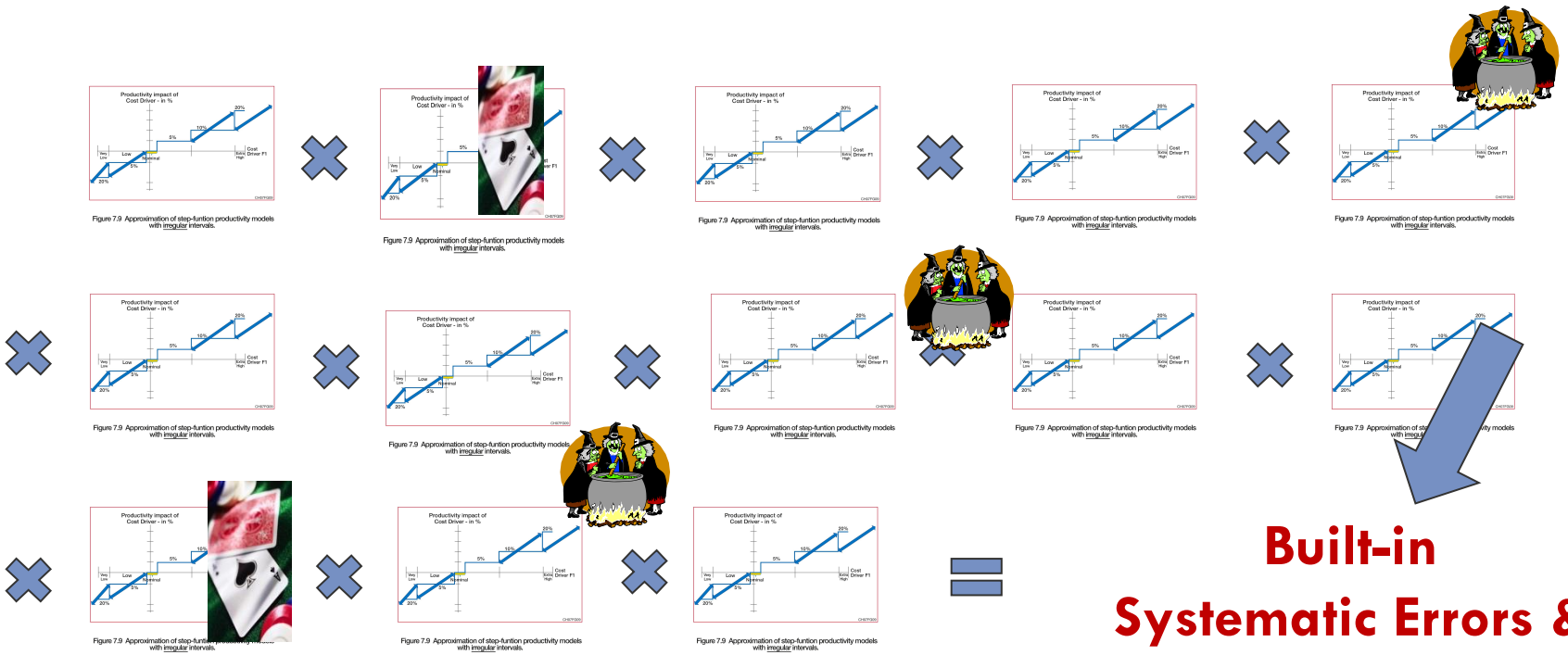
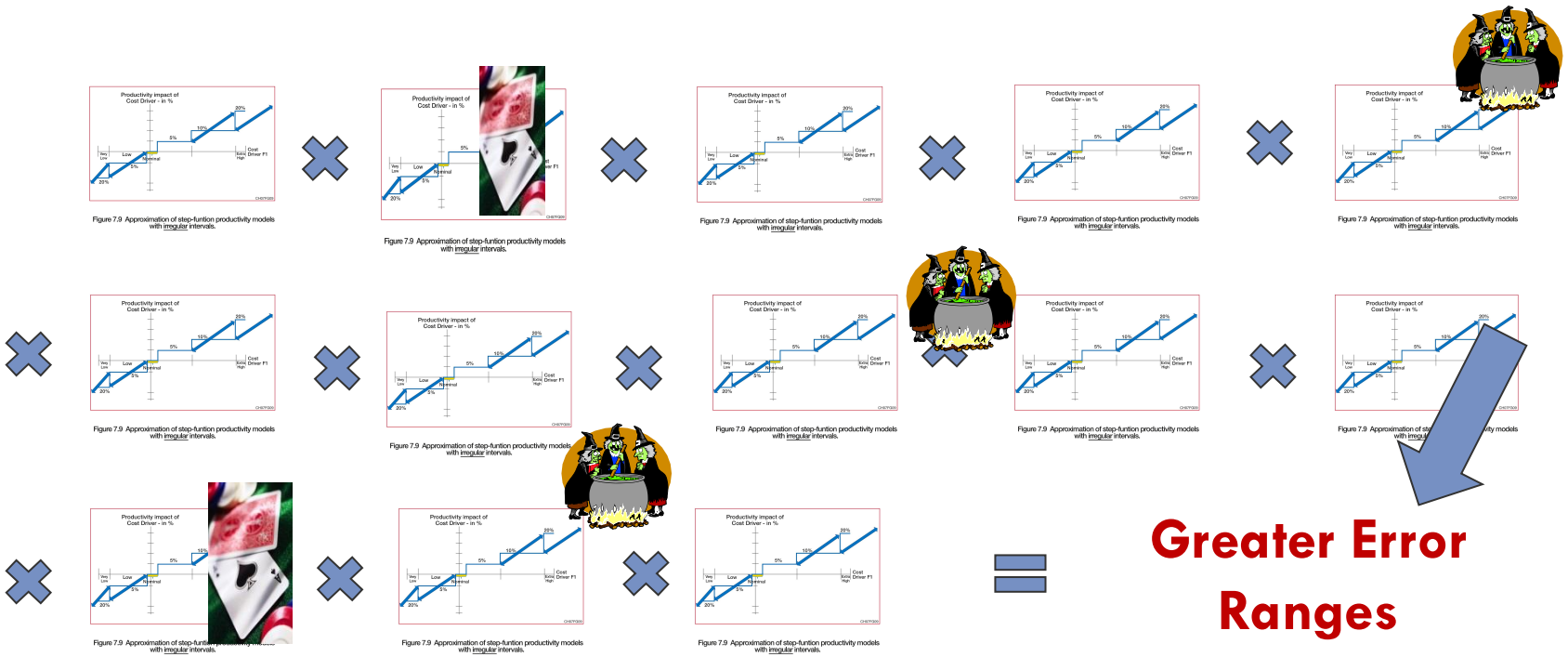
COCOMO-like estimation models:
Effort is a function of (Size & +15 step-functions)
of unknown quality combined into a single number!



Built-in
Systematic Errors &
Error Propagation

COCOMO-like estimation models:
Effort is a function of (Size & +15 step-functions)
of unknown quality combined into a single number!



MIT study on COCOMO81
(Kemerer, 1987)

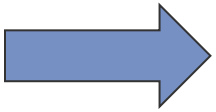
COSMIC

Small scale replication study - 17 projects

	Basic Exponential on Size	Intermediate & 15 cost drivers	Detailed & 4 project phases
R^2 (max=1.0)	**0.68**	**0.60**	**0.52**
Model Errors (Mean magnitude of relative errors - MMRE)	**610%**	**583%**	**607%**

Estimation Outcomes!

The ***'feel-good'***,



Quick & Easy…

COCOMO-like estimation models

The '*feel-good*' → dead end!

Quick & Easy…

Lessons learned
(in primary school)

- Scale type are important:
  - Nominal
  - Ordinal
  - Interval
  - Ratio
  - Absolute
- Measurement units
- Measurement ‘étalons’
- International standards

COSMIC

Maths ≠ Measurement

- Maths: 2 + 5 = 7

- Measurement:
  - 2 tables + 5 cars: cannot be added!
  - Rank 2 and rank 4: cannot be added, multiplied, averaged, etc.

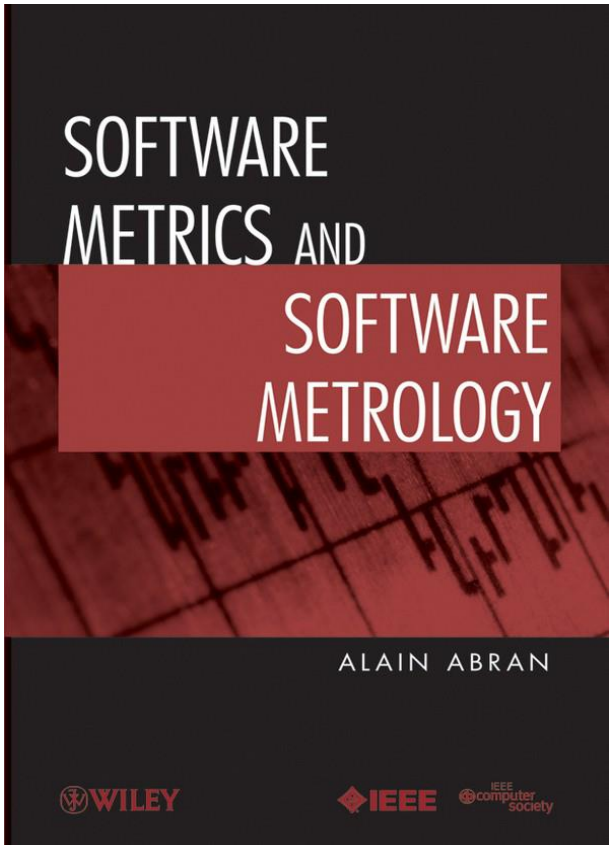
Examples of Poor & Good designs of software measures

Poor:

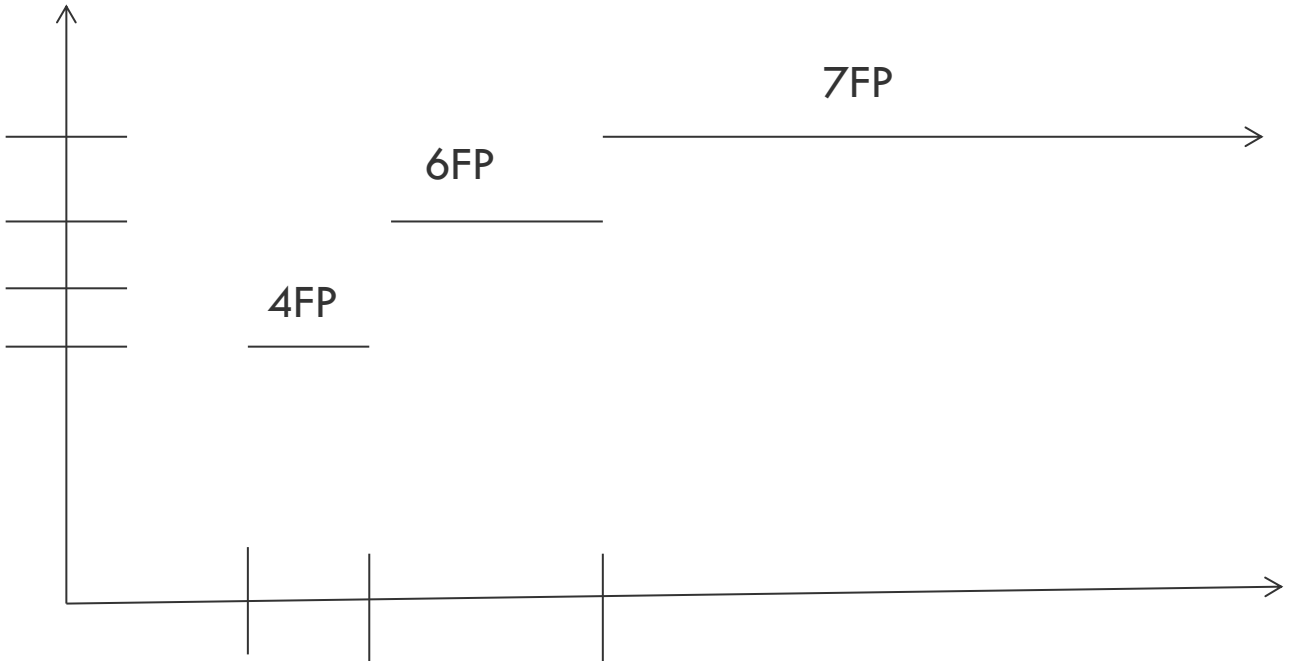
- Halstead
- McCabe
- IFPUG-Function Points
- Usecase points
- ISO 9126

Design based on Metrology:

- COSMIC – ISO 19761



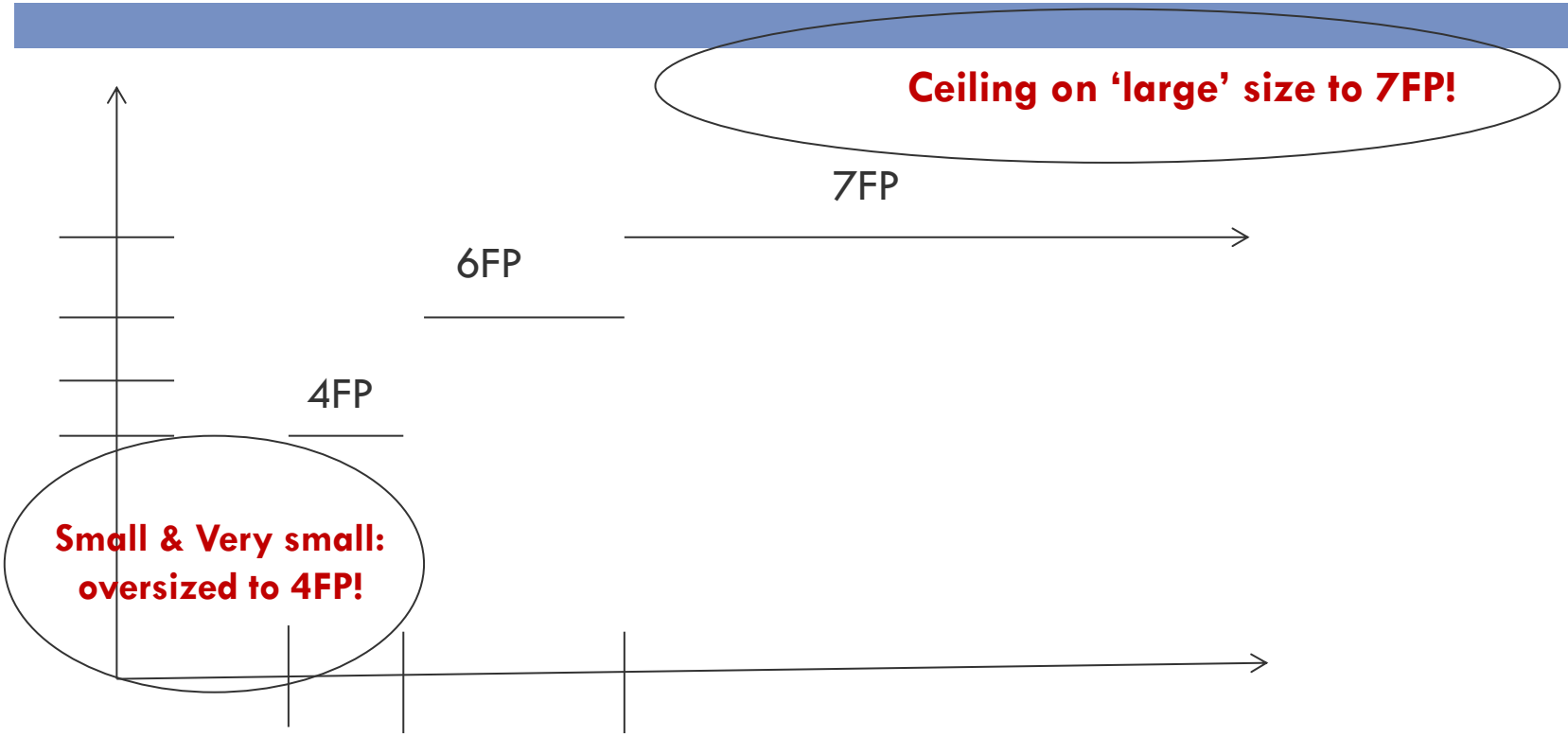
Weight-based sizing methods



Irregular intervals with 2 dimensions

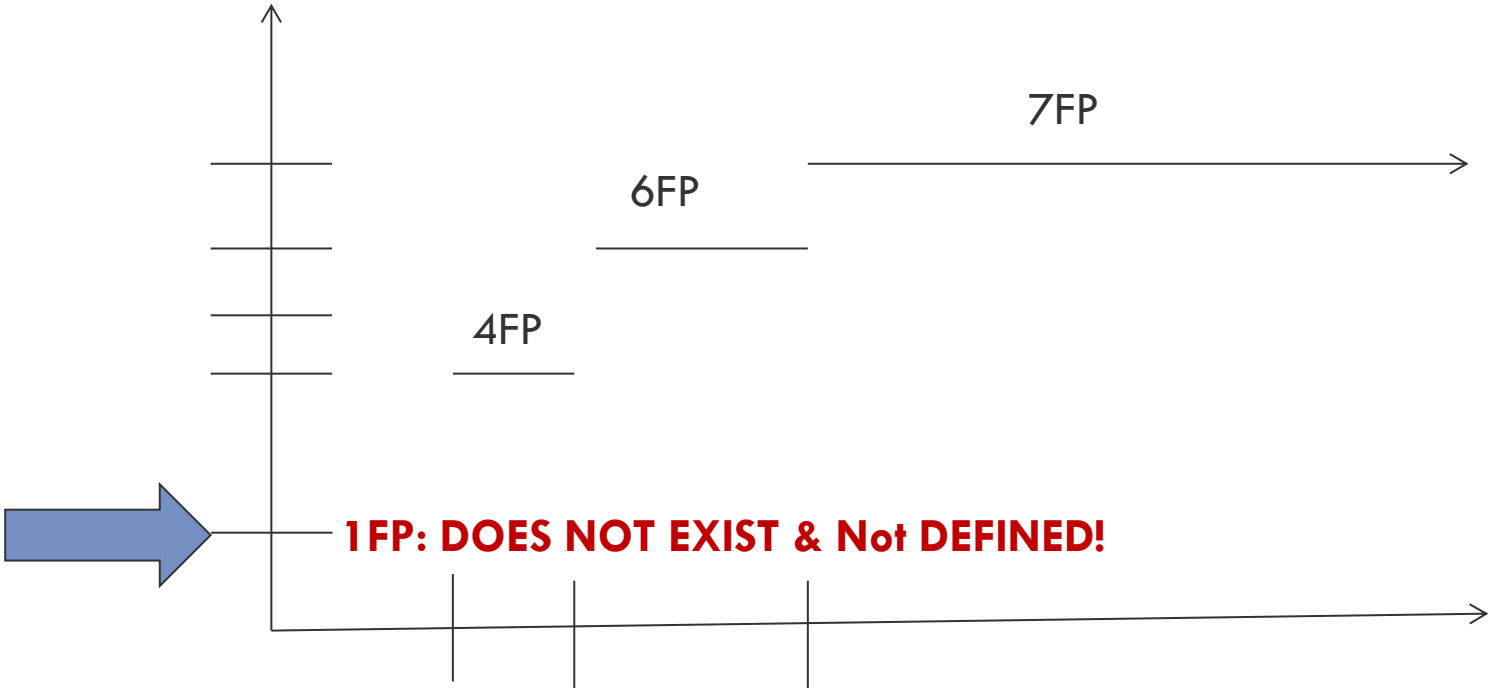
IFPUG-Function Points - FP

Weight-based sizing methods



Systematic Errors!

Weight-based sizing methods



No Measurement unit !!!

Size Adjustment with 14 Factors

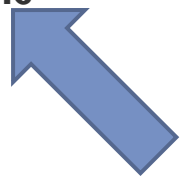
Distinct Irregular Intervals for each factor

	Low		High	Very high

Same ordinal textual labels

1	2	3	4	5

From 'textual' to 'number' labels



Size Adjustment Factors

Labels!

1	2	3	4	5

X

.01	.01	.01	.01	.01

Multiplied by the same 'factor' for each distinct irregular intervals

.01	.02	.03	.04	.05

= **???**

Primary School = Fail !

Issues with 1st generation Function Points methods

1st generation: IFPUG Function Points - 1979

- Innovator (in 1979, but not in 2015!)
- Systematic errors! (step function with min & max)
- Invalid maths!
- No measurement unit!

- Still cannot be automated & compliant after 35 years

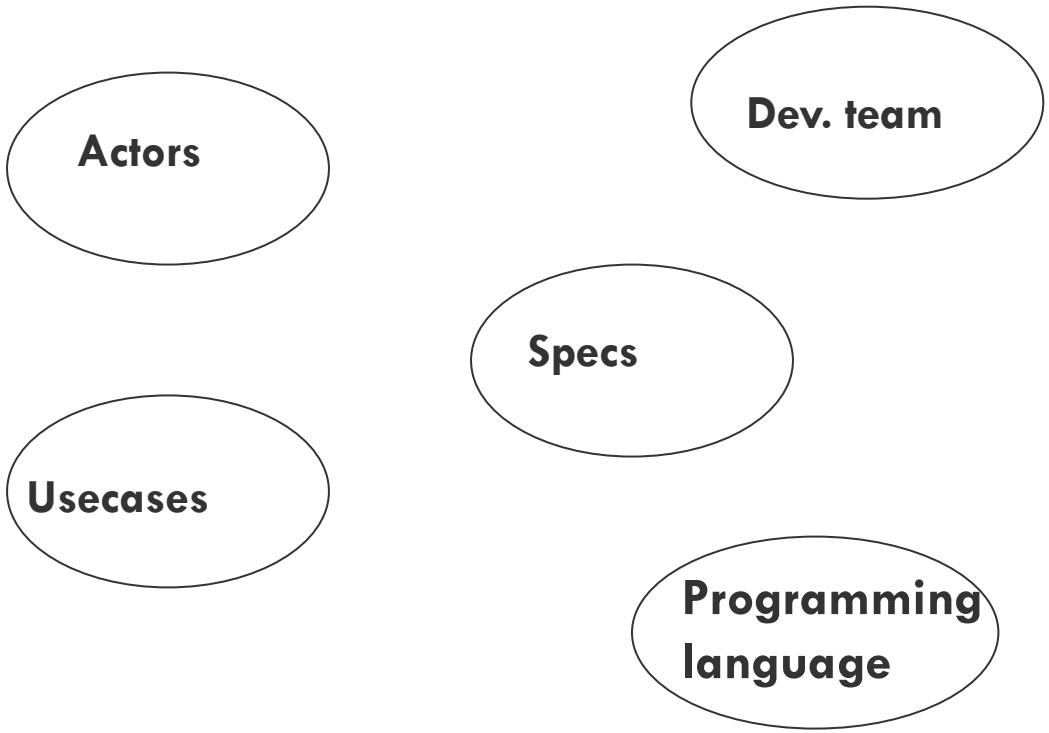
- OMG specifications = an approximation with:
  - unknown variance from standards &
  - no impact analysis of variance!

Usecase Points

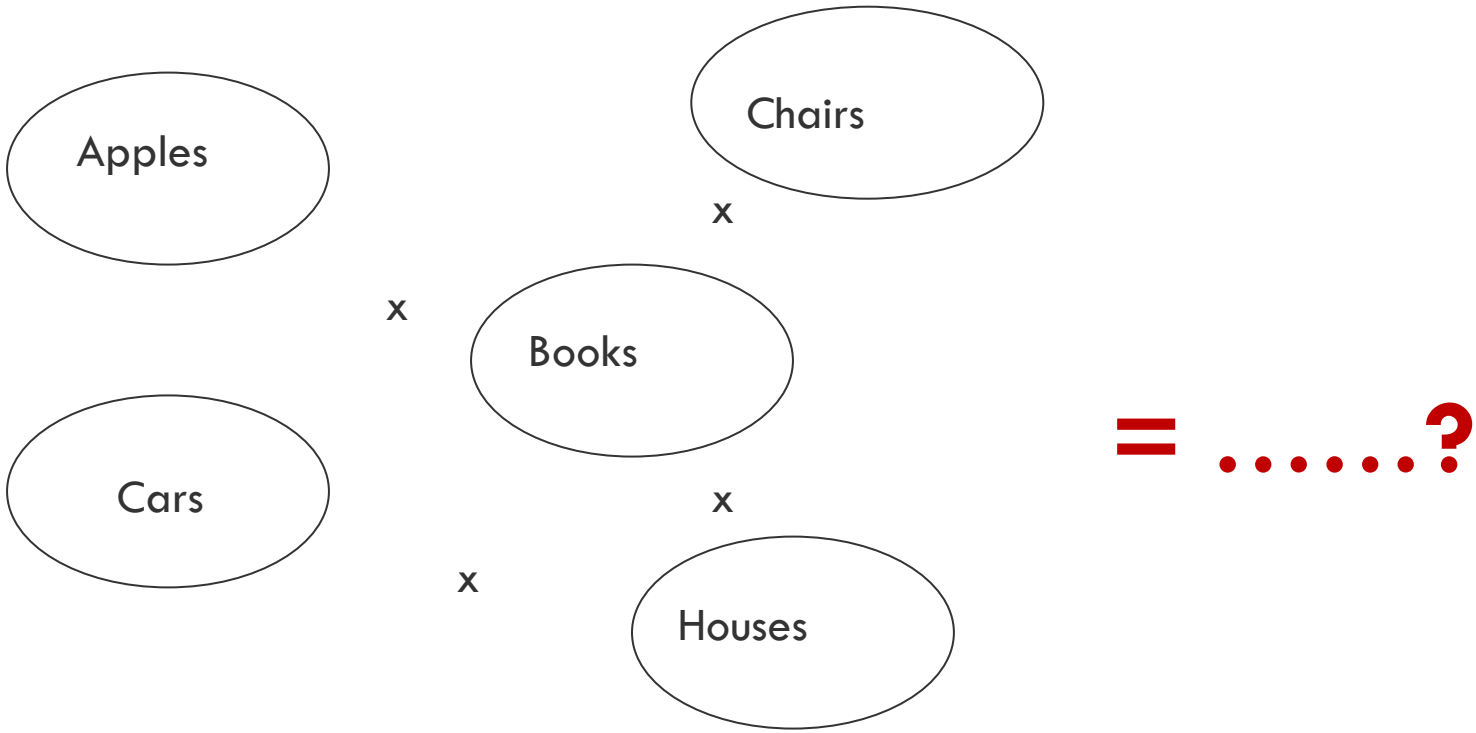
& similar Points-based metrics

Table 1: Entities, Attributes, and Measurement Rules		
Entity	**Attribute**	**Measurement rule**
Actor	Complexity (of actor)	The type of complexity (simple, average, or complex) of the interaction between the actor and the system
Use case	Complexity (of use case)	The type of complexity (simple, average, or complex) measured in the number of transactions
Specification of requirements	Relevance of the technical quality requirements	The level of relevance (from 0 to 5) of each of the 13 known non-functional qualities
	Stability of the requirements	The level of stability (from 0 to 5) of the functional and non-functional requirements
Development team	Familiarity with the methodology	The level (from 0 to 5) of skills and knowledge of the development methodology in use for the project.
	Part-time status	The level (from 0 to 5) of part-time staff on the team
	Analysis capability	The level (from 0 to 5) of analysis capabilities of the development team with respect to project needs
	Application experience	The level (from 0 to 5) of team experience with the application domain of the system
	Object-oriented experience	The level (from 0 to 5) of team experience with object-oriented design
	Motivation	The level (from 0 to 5) of team motivation
Programming language	Difficulty	The level (from 0 to 5) of programming difficulty

Usecase Points & Similar Points-based Metrics



Usecase Points
& similar Points-based metrics



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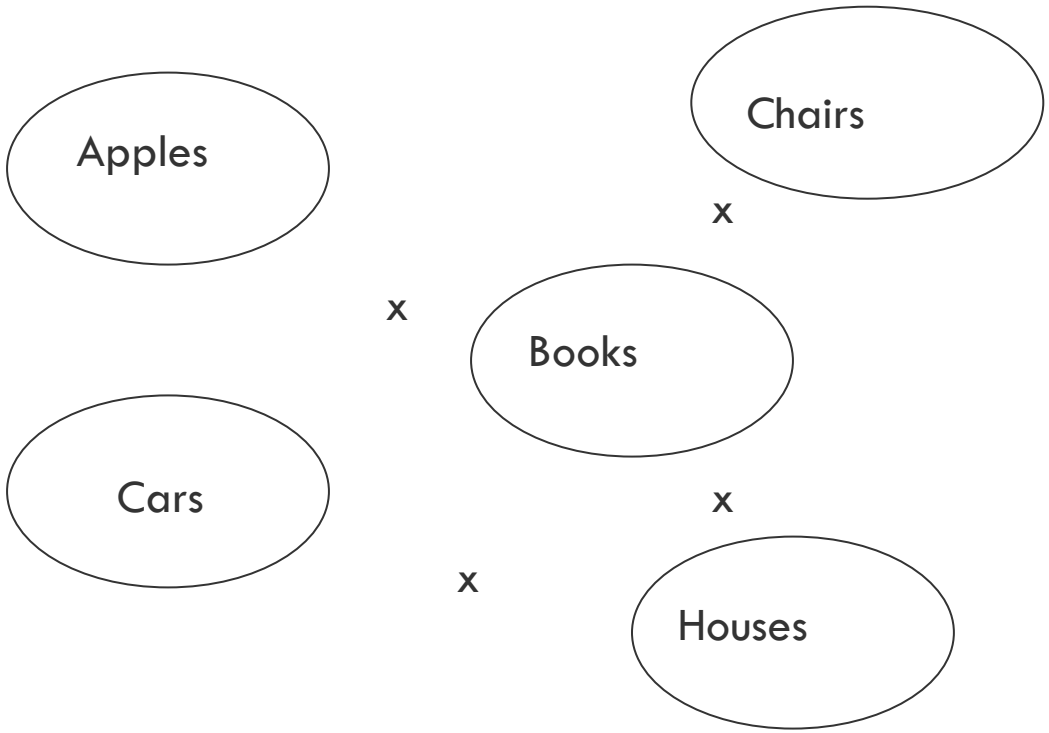
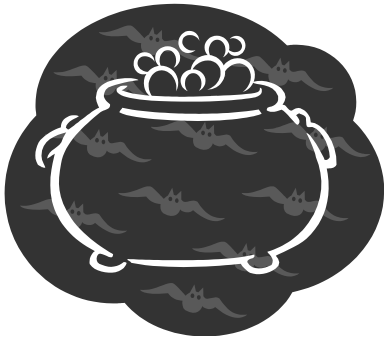


= ……?

Primary School = Fail !

‘feel-good”

Hell is paved all over with good intentions!

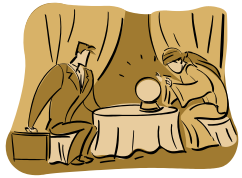


The 'Feel Good'

ProjectCodeMeter assertions:

http://www.projectcodemeter.com/cost_estimation/kop3.html

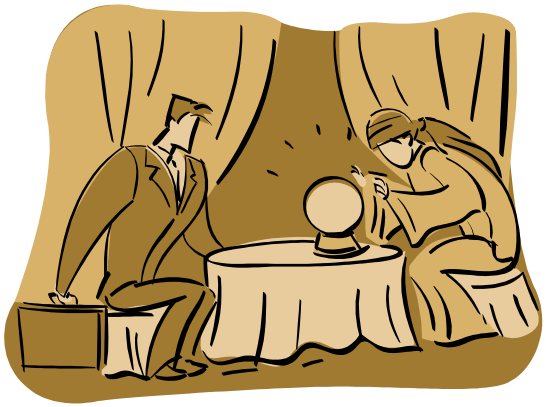
- 'A professional software tool to measure & estimate Time, Cost, Complexity, Quality & Maintainability of software projects, Development Team Productivity by analyzing their source code'.
- 'Using a modern software sizing algorithm called **Weighted Micro Function Points** (WMFP) a successor to **solid ancestor scientific methods** as COCOMO, COSYSMO, Maintainability Index, Cyclomatic Complexity, & Halstead Complexity'.
- **'More accurate results** than traditional software sizing tools, while being **faster & simpler to configure'**.



Agenda

1. Estimation: Craft or Engineering?
2. The phases in estimation
3. Economics concepts for estimation models
4. Estimation models with COSMIC: data from industry
5. Conditions for credible estimation models
6. **Conclusions**

(Software) Estimation



Or?

A sound Measurement Foundation

2nd Generation Functional Size:

- ✓ No upper size limit
- ✓ No 'weigths'
- ✓ No unsound mathematical operations
- ✓ Based on a concept common to all types of software of any 'size': a data movement
- ✓ A measurement unit: 1 data movement of a single data group
- ✓ A measurement symbol: 1 CFP

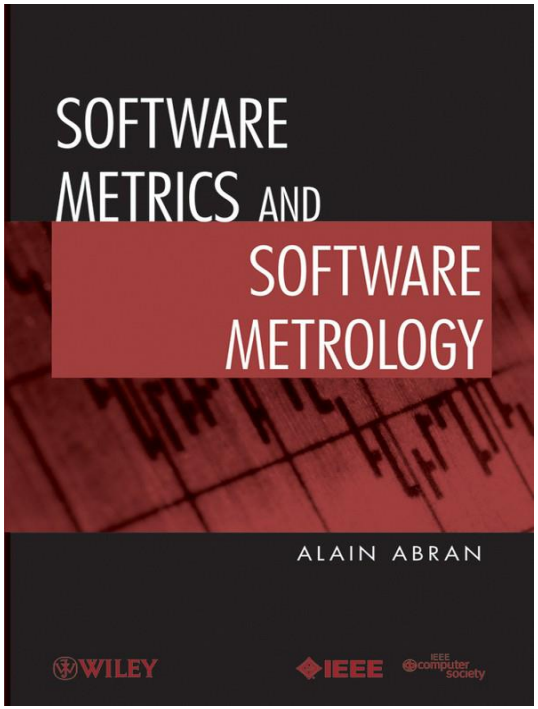
COSMIC – ISO 19761

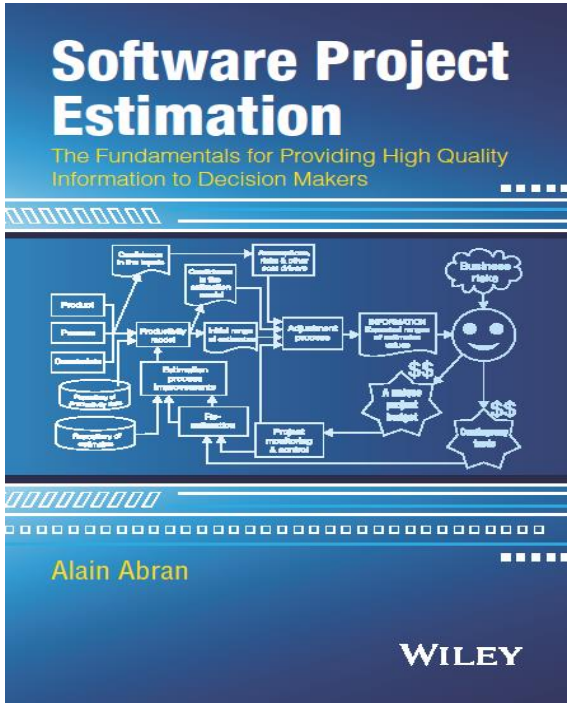
(Common Software Measurement International Consortium)

Building 'good' estimation process & good estimation models

- ✓ Sound Measurement Units
- ✓ Sound Maths!
- ✓ Recognition of uncertainties:
  - ✓ how to recognize this & how to deal with it
- ✓ The estimator has to provide information, not a single estimate
- ✓ The manager has to select a single budget number
  - ✓ & manage risks through contingency planning.
- ✓ Discipline, rigor, commitments & $$$

Want to know about good & bad practices in software estimation?





alain.abran@etsmtl.ca