The Estimation Process
(Chapter 1 – Software Project Estimation)

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(Tutorial Contribution: Dr. Monica Villavicencio)

Topics covered

1. Introduction

2. Approaches to Estimation

3. The Estimation Process: Overview & Current Practices

4. Level of Uncertainty in an Estimation Process

5. The Productivity Model

6. The Estimation Process

7. Roles & Responsibilities

1.2 Approaches to Estimation

Generic approaches in estimation models

- Judgment & craftsmanship

- Engineering

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Craftsmanship

http://activerain.trulia.com/blogsview/1613004/new-craftsman-homes-in-atlanta-ga—newer-craftsman-style-homes-for-sale


Adapted from https://sites.google.com/site/seourpicz/1/humor/ar/1/chistes-page-50

Judgment & craftsmanship

- Known as: "expert judgment" estimation approach

- Highly dependent on the expertise of people (craft)

- Varies from project to project

- This estimation process is subjective:

  - Without statistical analysis
  - Little traceability to quantitative historical data

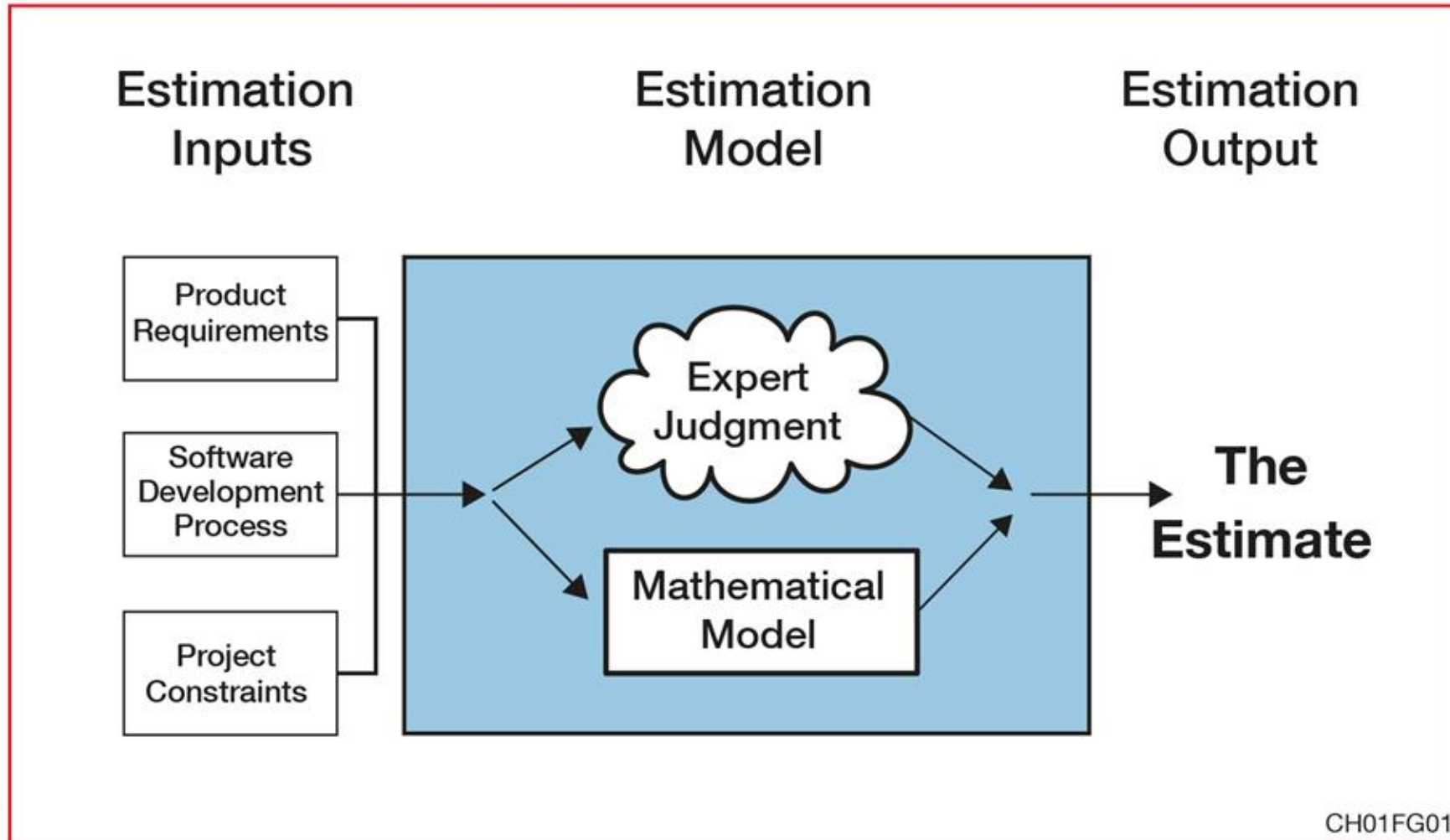- Improving 'expert judgment' is also subjective

Engineering
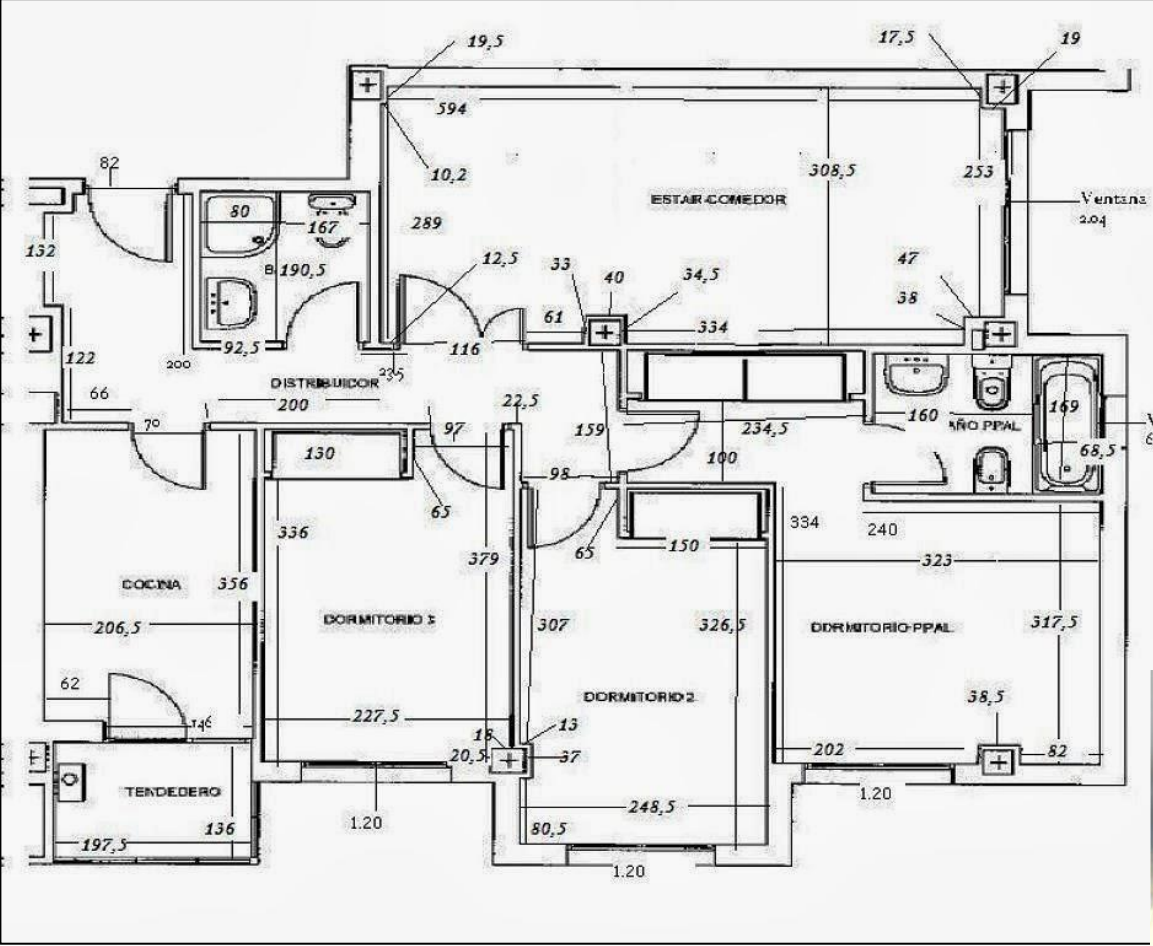
Engineering

- Detailed observation of past projects

- Quantitative data collection

- Analysis of the impact of individual variables (one at a time)

- Selection of relevant samples

- Demographics and statistical analyses

- Very careful extrapolation to similar or other contexts

1.3 The estimation process: Overview & current practices

Common view of a estimation process

Estimation Inputs · Estimation Model · Estimation Output

Product Requirements

Software Development Process

Project Constraints

Expert Judgment

Mathematical Model

The Estimate

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Estimation inputs

- Product requirements (functional and non-functional)

- Software development process (iterative, agile, etc.)

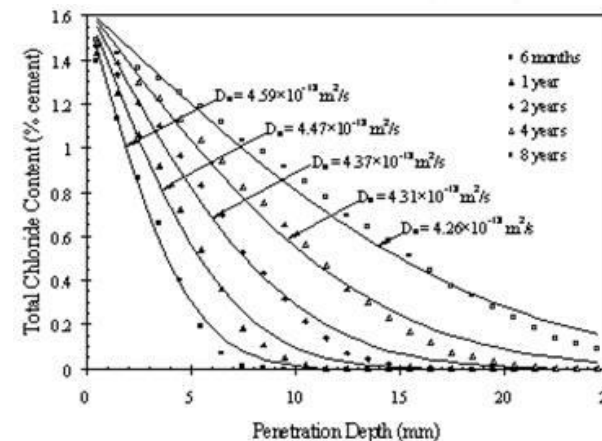- Project constraints (deadlines, budget, etc.)

Estimation models

- ## Expert judgment
  - ### Implicit models from experts
  - ### The models are not document
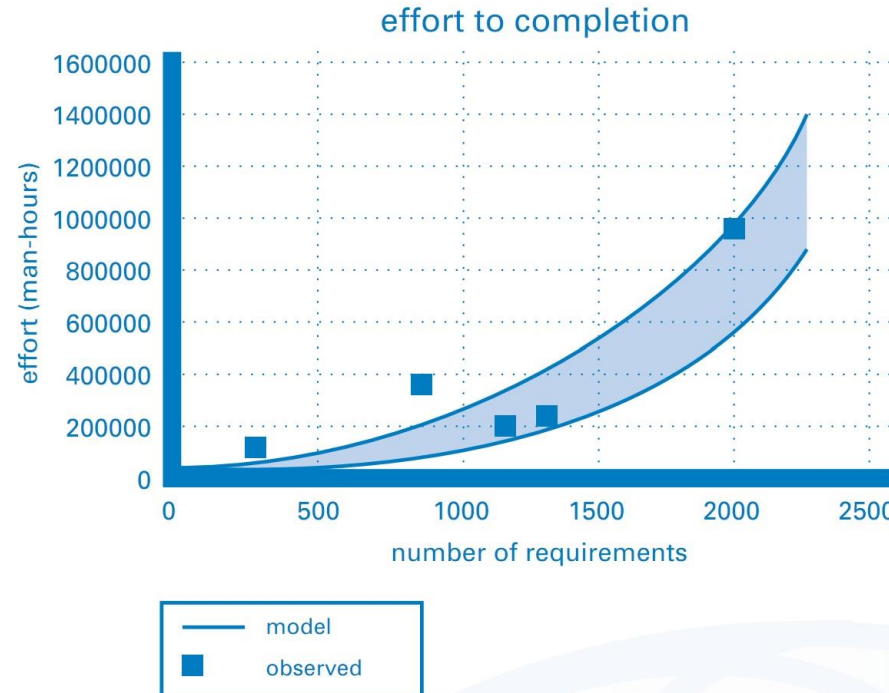
"Trust me, I'm an expert!"

- ## Mathematical model
  - ### Regression, case-based reasoning, neural networks, etc.
  - ### Traceability to quantitative data

The estimate

- Effort

- Cost

- Project duration

effort to completion

https://incoseonline.org.uk/Program_Files/Publications/zGuides_3.aspx?CatID=Publications

Are current estimation practices mostly craft practices or engineering practices?
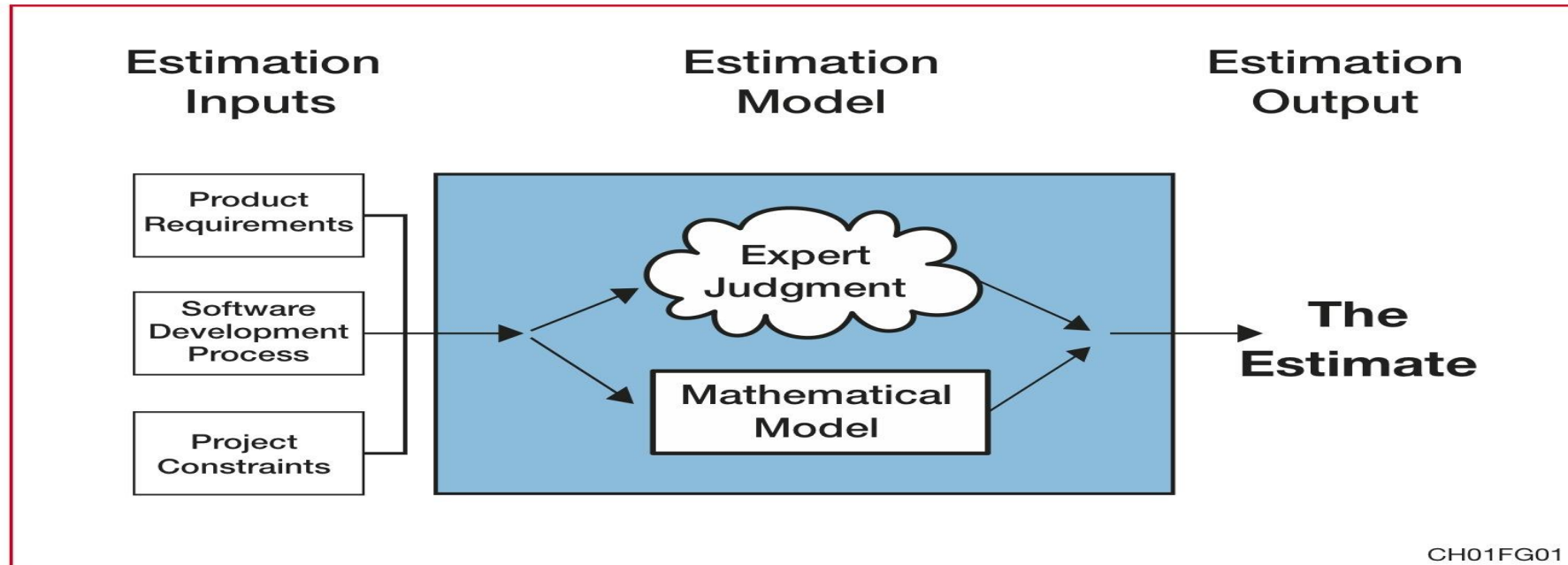

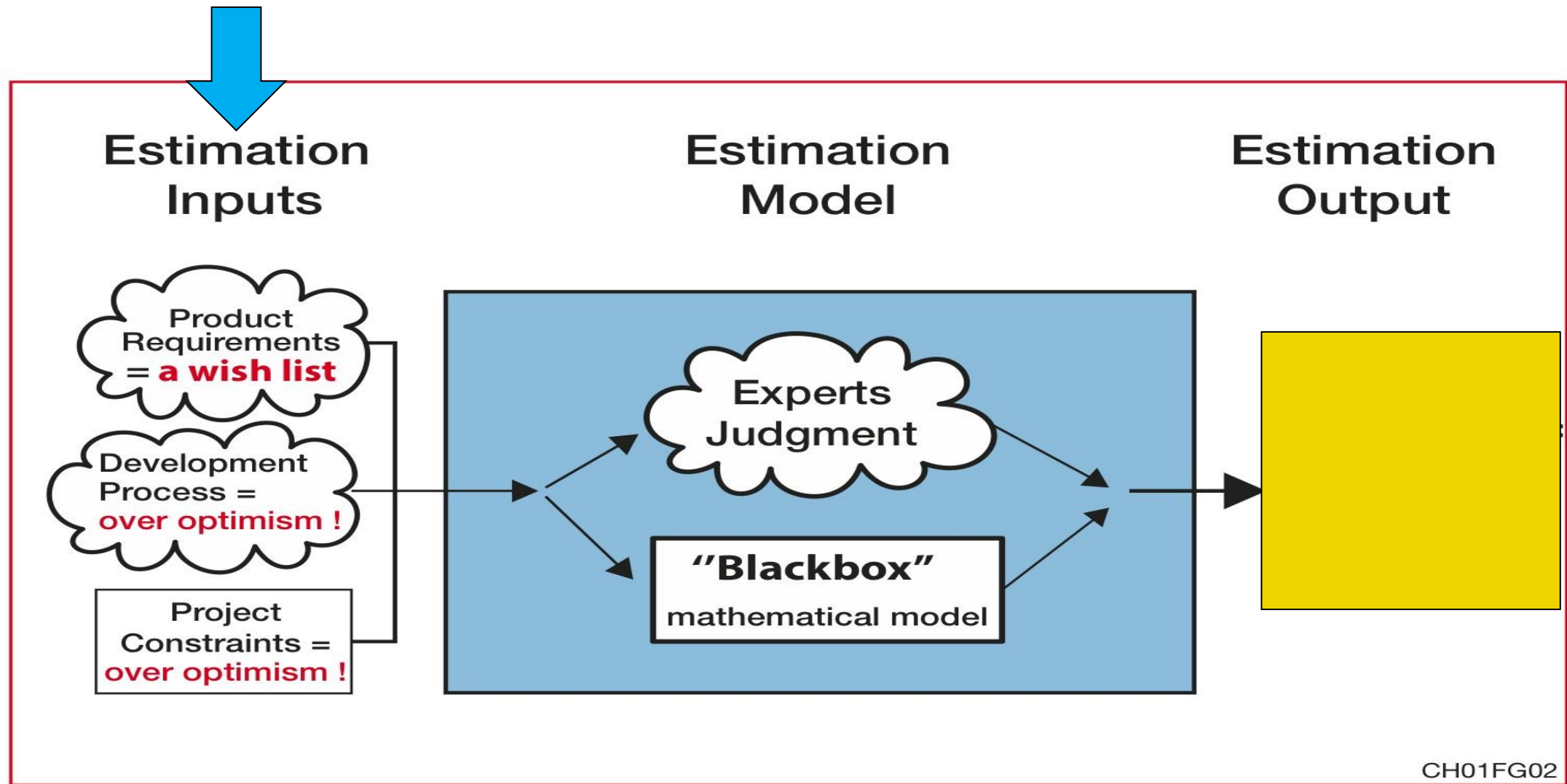Figure 1.1   Common view of an estimation process.

Figure 1.2 Some poor estimation practices observed in industry.

Poor estimation practices: Inputs

Estimation inputs from customers:

- Brief description of the expected software system

- No measurement of functional requirements

- Summary text descriptions of non-functional requirements

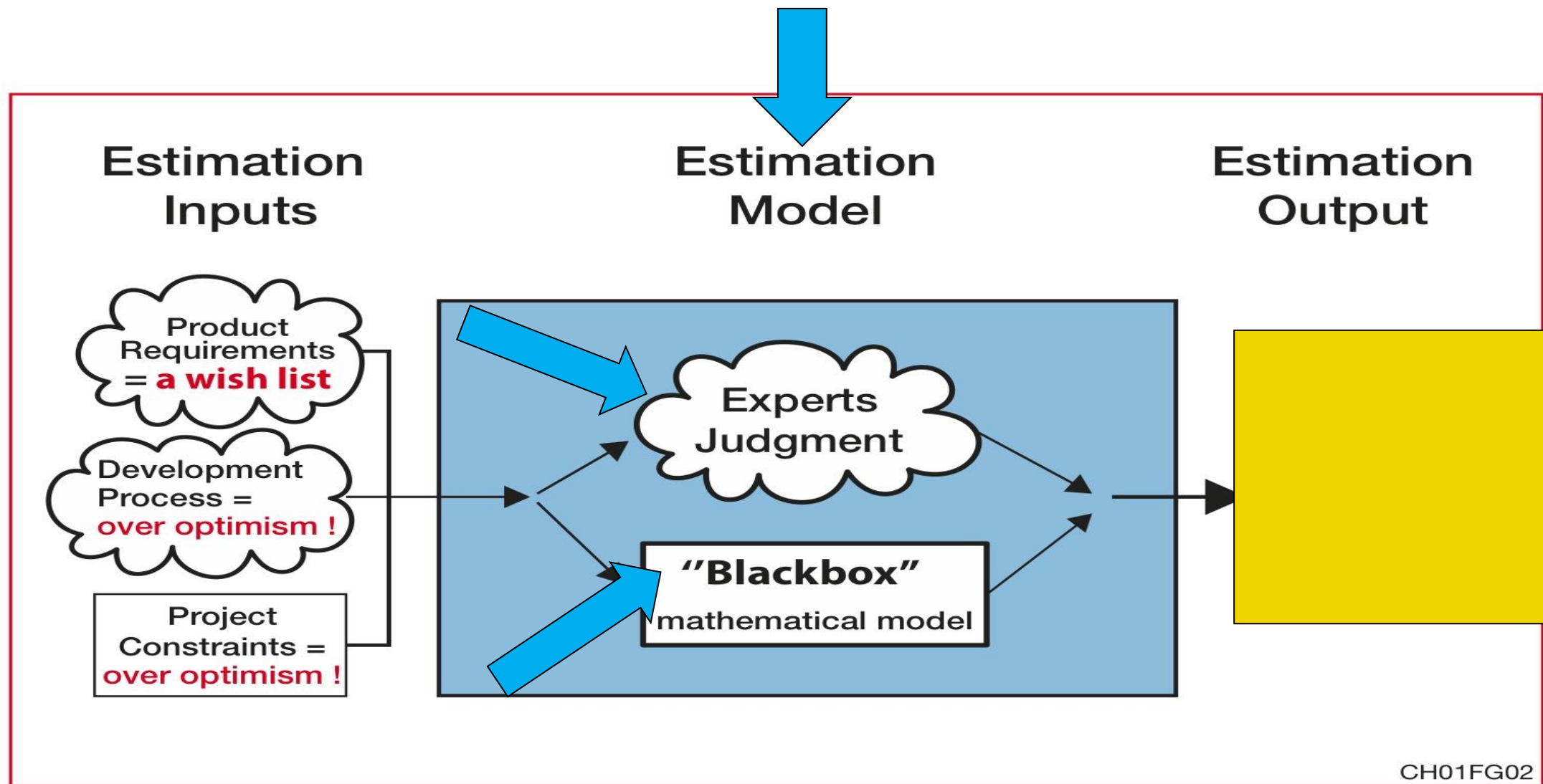- Lack of description → many cost drivers

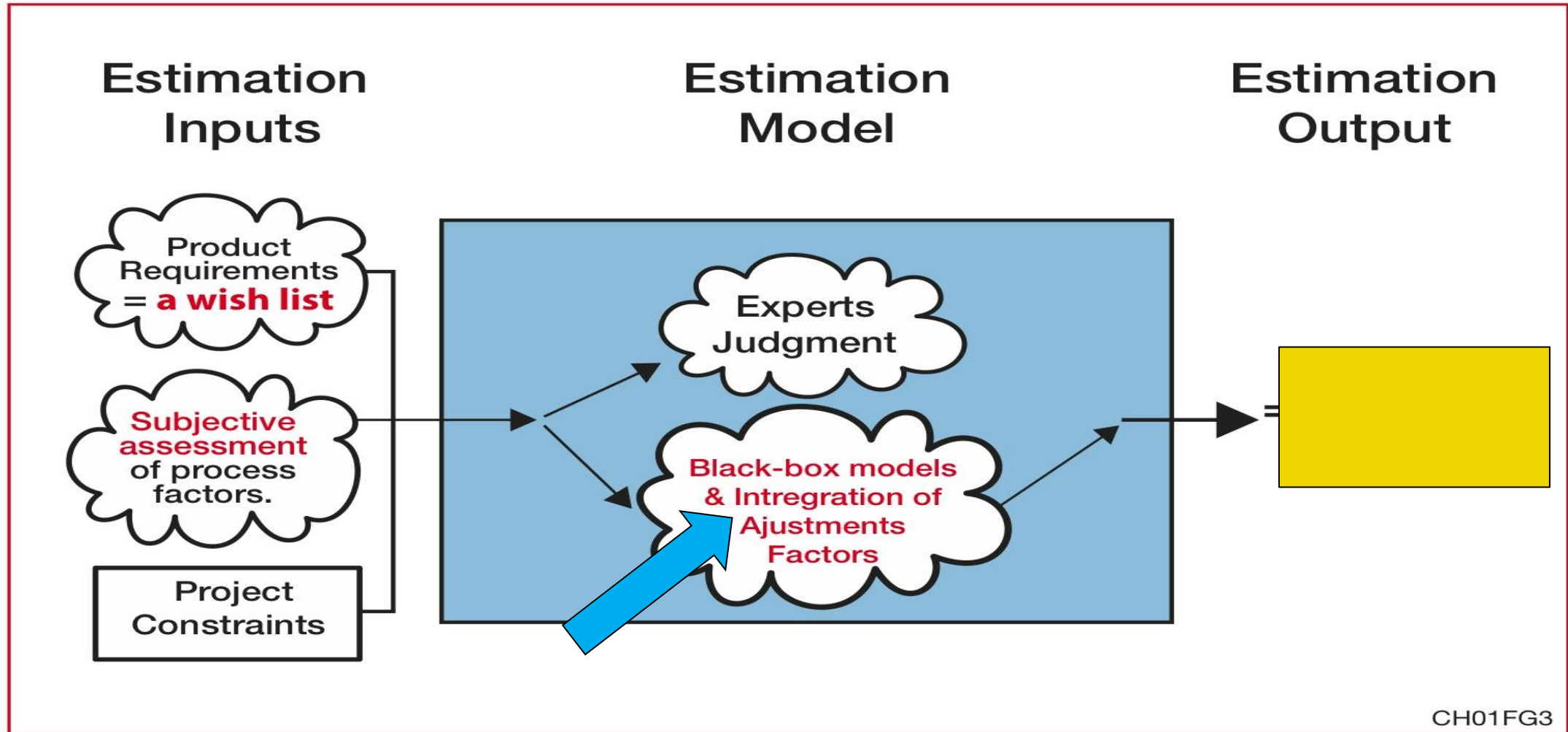Figure 1.2 Some poor estimation practices observed in industry.

Figure 1.3 Some of the worst estimation practices.

Poor estimation practices: Models

- Mix of formal or informal models with:
  - Local experience (expert judgment approach)
  - Mathematical models (books or tools)

  - Guesstimate of Lines of Code:
    - with little knowledge of requirements
    - Limited knowledge of mix of programming languages, etc.
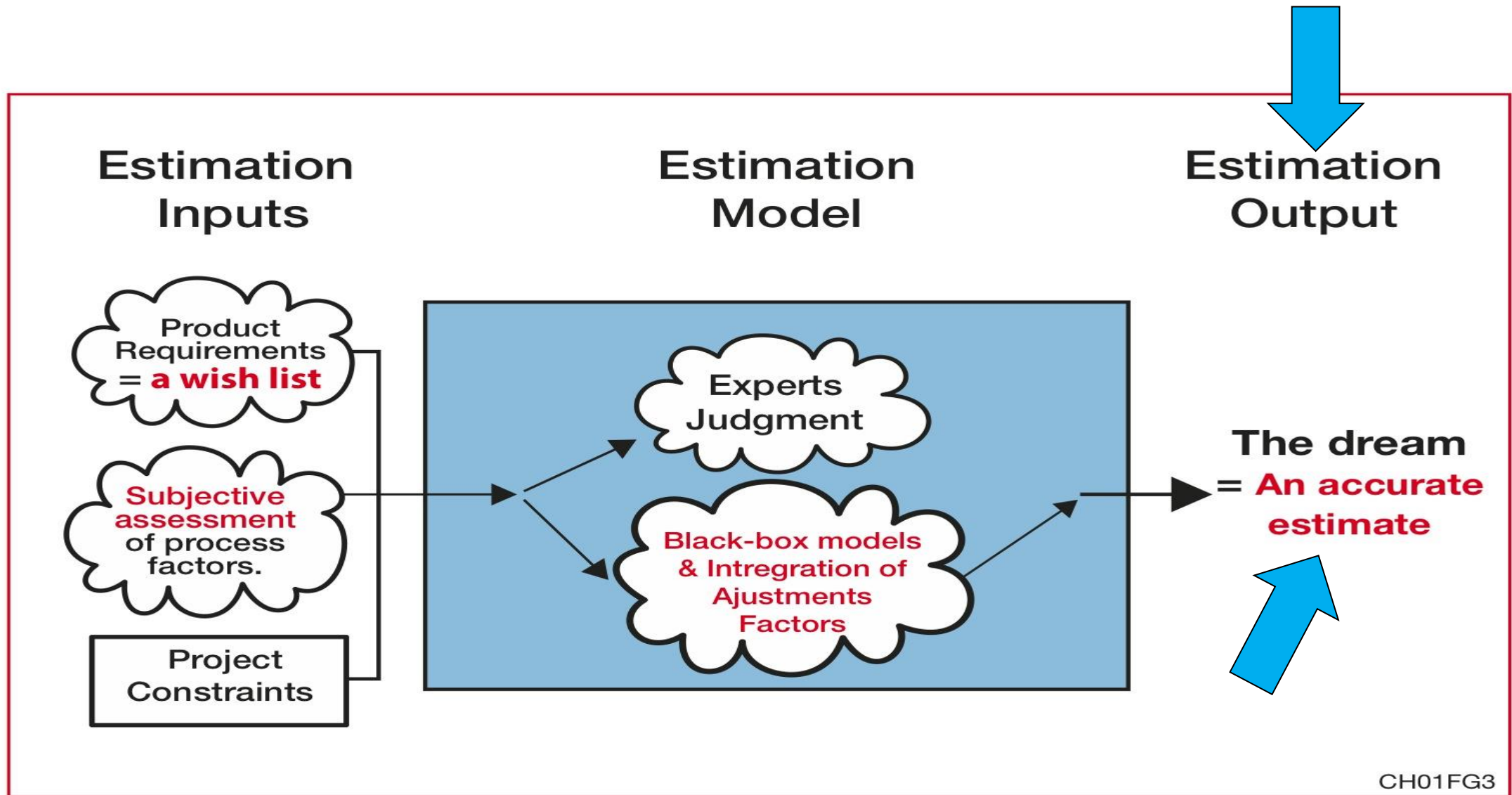
- Too many variables & cost drivers

Figure 1.3 Some of the worst estimation practices.

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Estimation expectations

The dream: an accurate estimate

Estimation Inputs → Estimation Model → Estimation Output

Product Requirements = **a wish list**

Subjective assessment of process factors.

Project Constraints

Expert Judgment

Black box models & Integration of adjustment factors

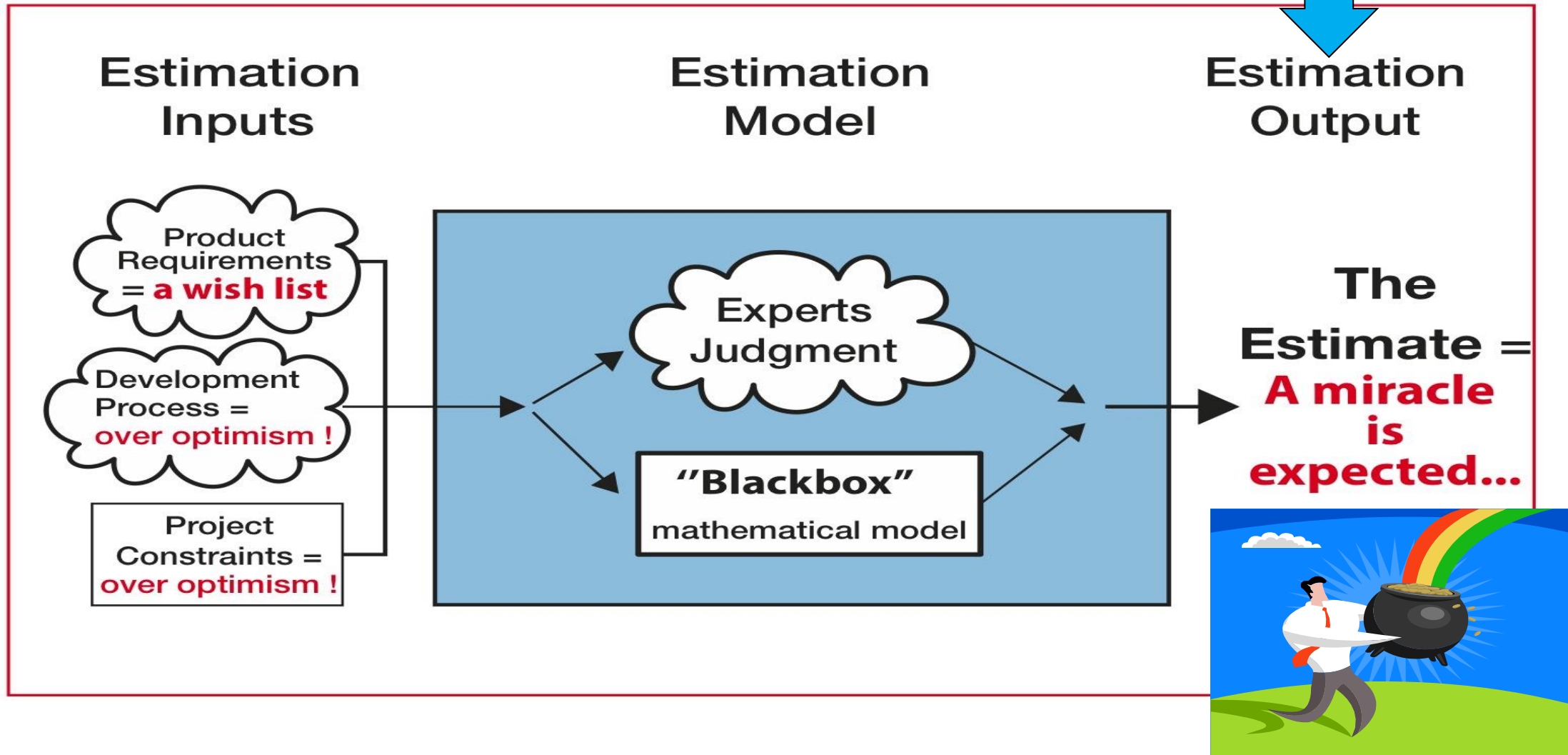**The dream = An accurate estimate**
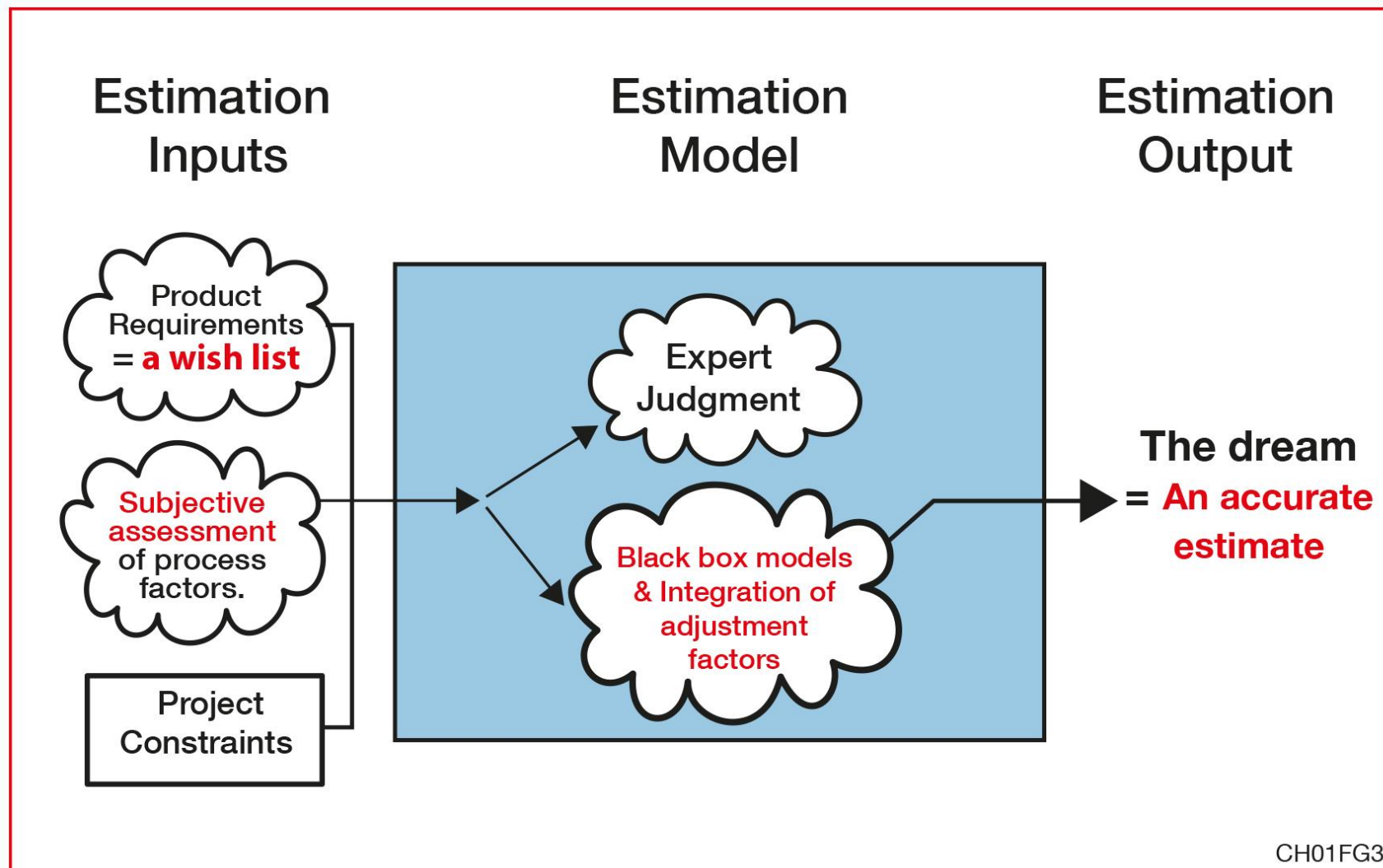
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Figure 1.2 Some poor estimation practices observed in industry.

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Poor estimation practices: Outputs

- A single estimate selected as the project budget

- Limited analysis of variations in the estimates

- Limited documentation on the quality of the estimation process itself and of its estimation outcomes

- Overly optimistic attitude!

http://www.jakecando.com/3-strategies-for-determining-a-project-budget-for-clients/

Current estimation practices lead to a tally of failures
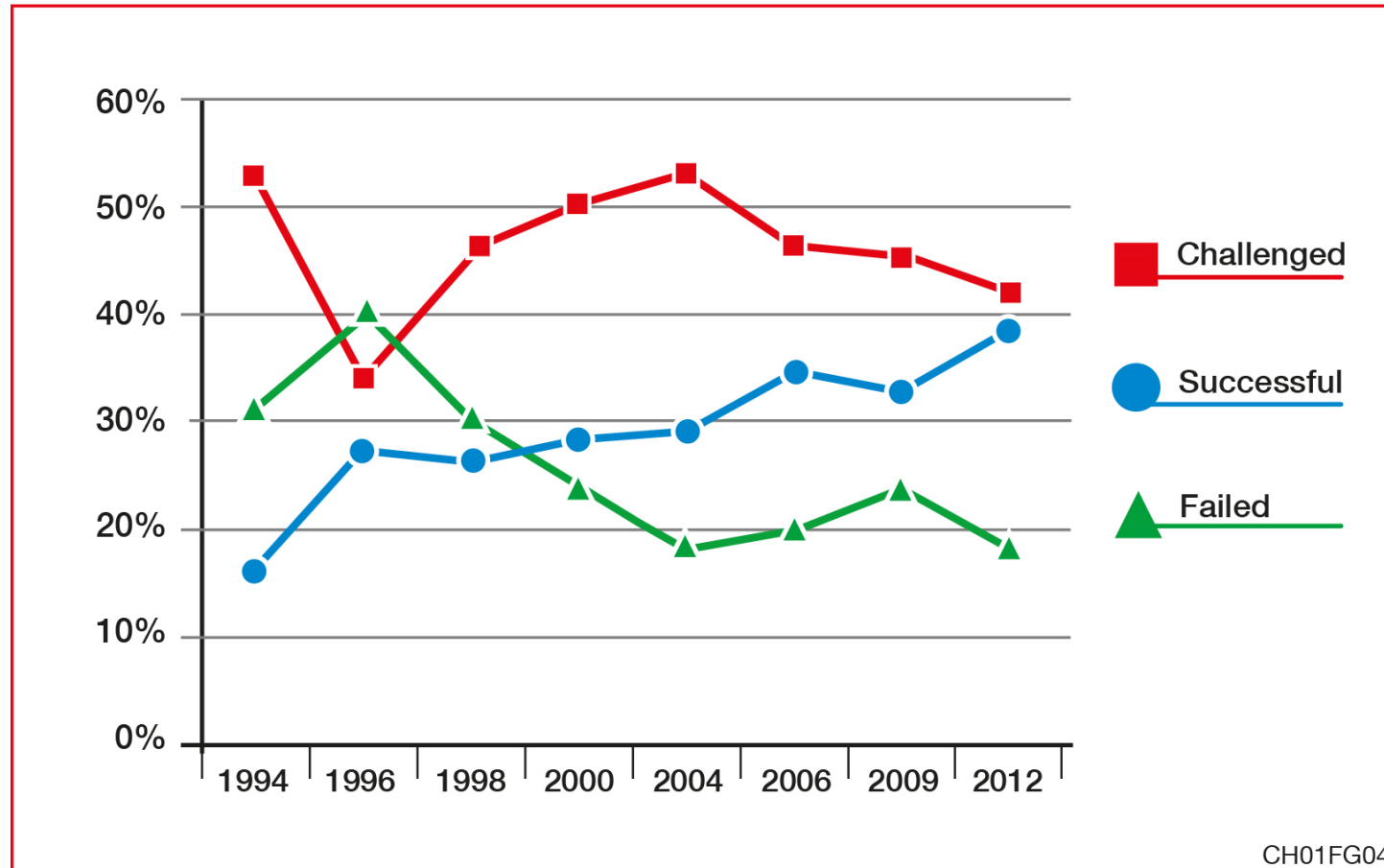
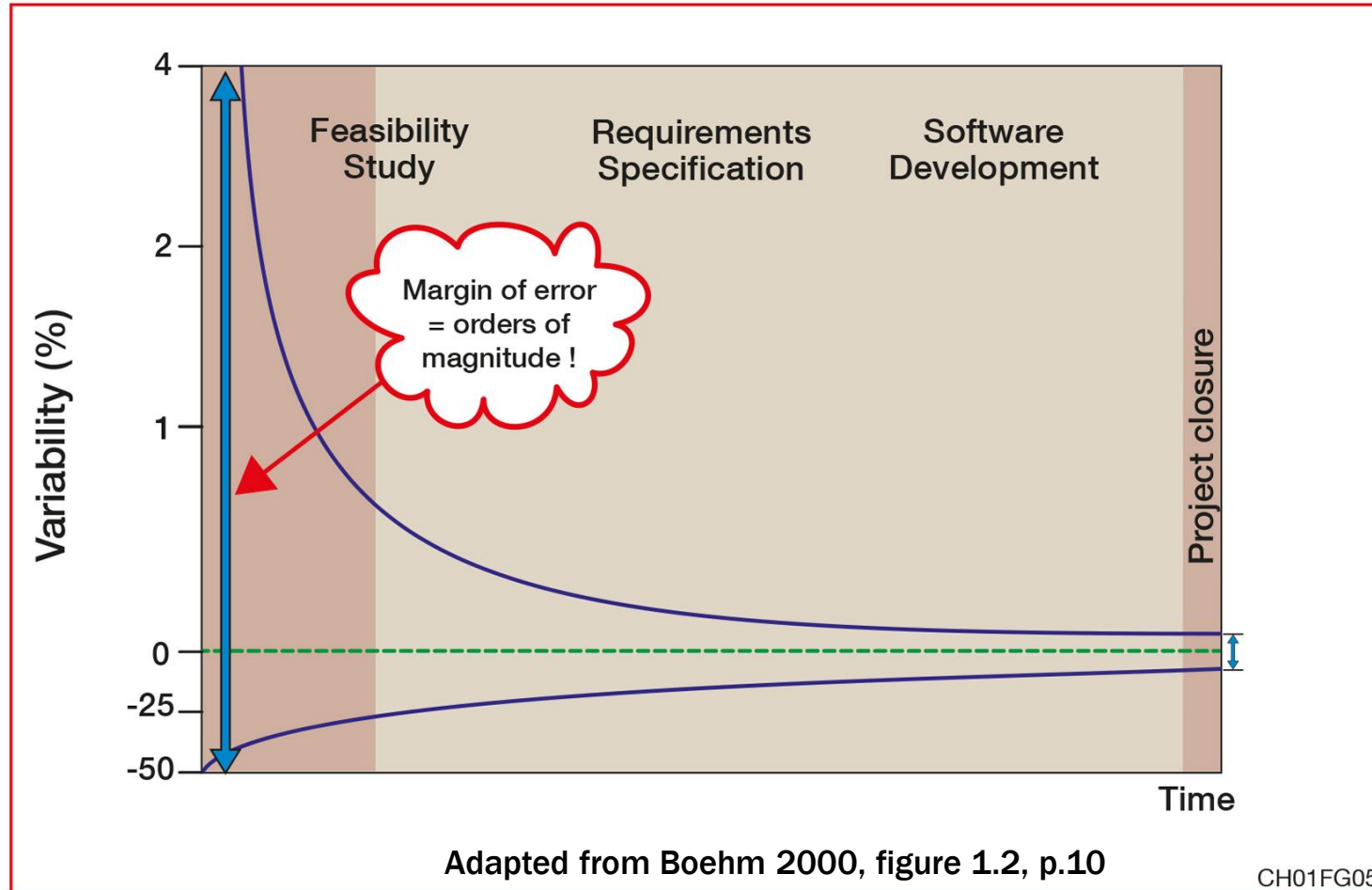**Project success trends based on Standish Group data** (adapted from Miranda 2010)

1.4 Level of Uncertainty in an Estimation Process

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Levels of uncertainty

- The cone of uncertainty

- Uncertainty in a productivity model

The cone of uncertainty

Adapted from Boehm 2000, figure 1.2, p.10

Range of expected variations in models across the project life cycle

Uncertainty in a productivity model

CH01FG07
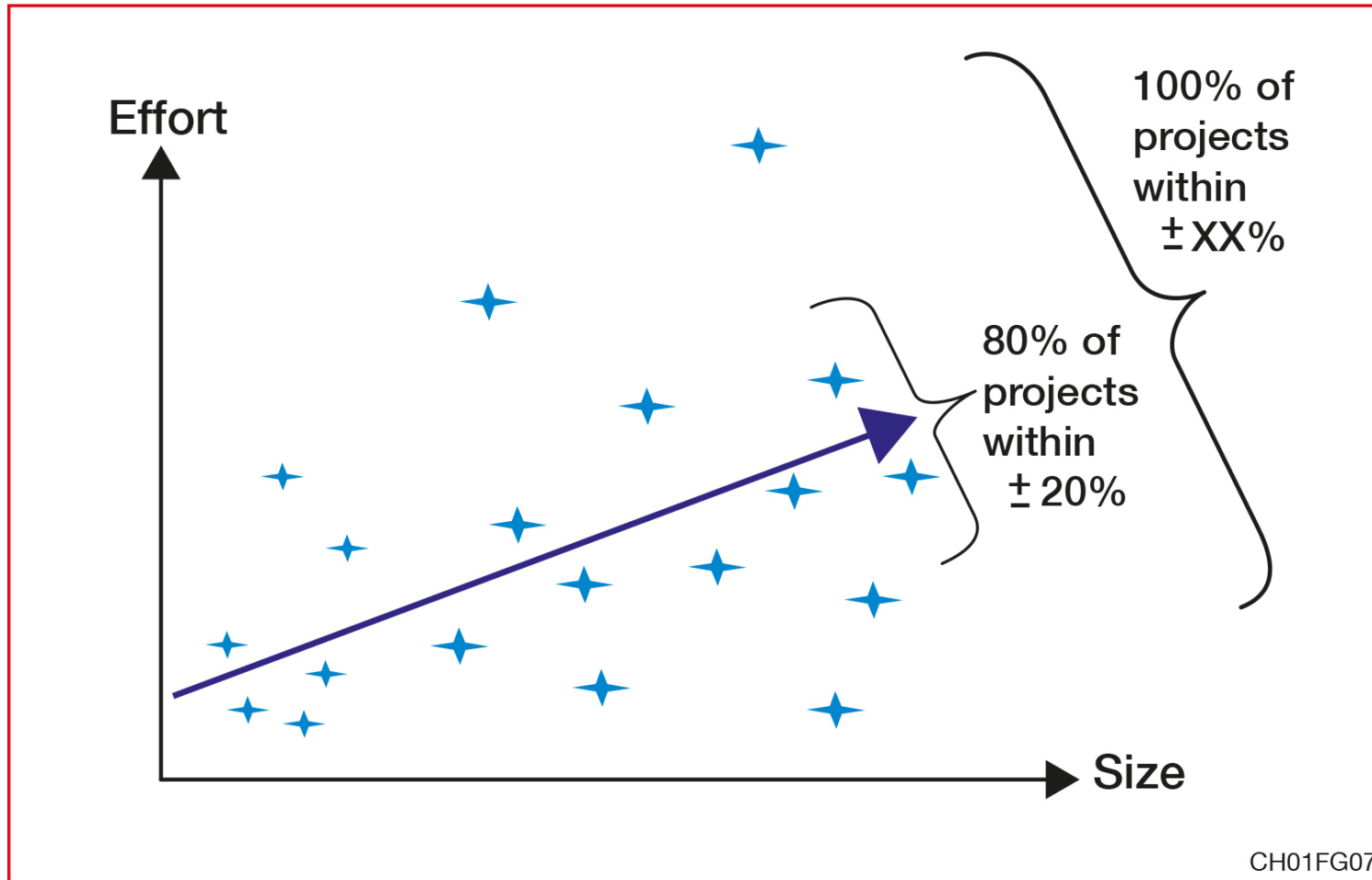
Uncertainty in a productivity model

- The context used to build the model may be different from the current situation

  - data collected

- Estimations are performed early in the project life cycle.

1.5 Productivity models

How productivity models are built ?

- Using data from completed projects

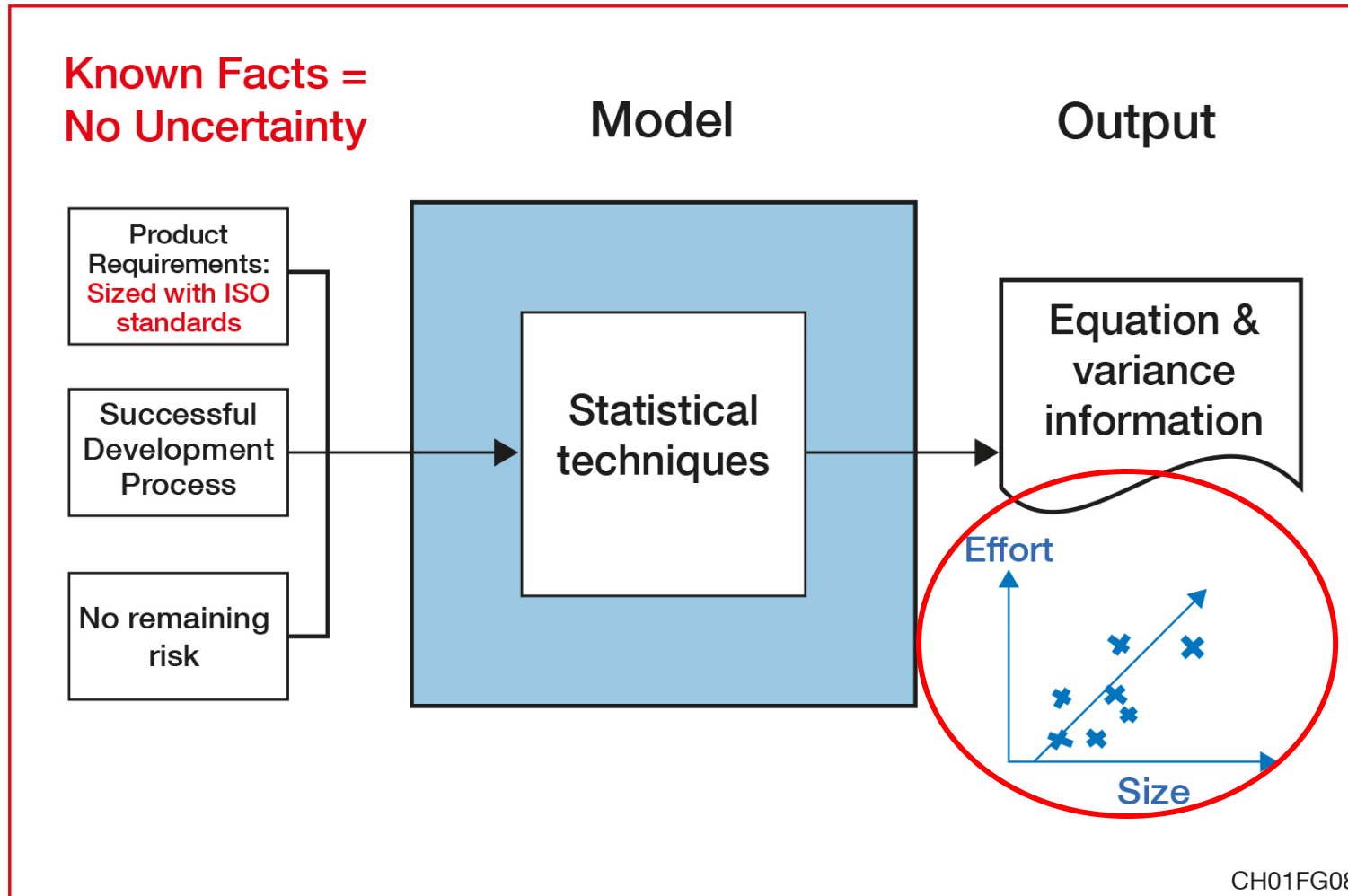- Quantitative information
  - Example: functional size of software

- Nominative information
  - Programming language
  - Categories of case tools
  - Levels of complexity

http://www.improgrammer.net/top-big-data-projects/

Mathematical equation models

Known Facts =
No Uncertainty

Model

Output

Product Requirements: Sized with ISO standards

Successful Development Process

No remaining risk

Statistical techniques

Equation & variance information

Effort

Size

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Benefits of mathematical equation models

- The variables are described using a documented set of conventions.

- The variables are quantitative & objective

- The performance of the model can be described and analyzed.

- The models can be used by anybody.

Expert judgment approach (a model ?)

- Informal, not documented

- Derived from past experience (subjective recollection of past projects)

- Lack of precise quantitative information of independent variables
  - Product size
  - Cost drivers

Can then precise information of dependent variables be reasonably expected?
  - effort & duration?

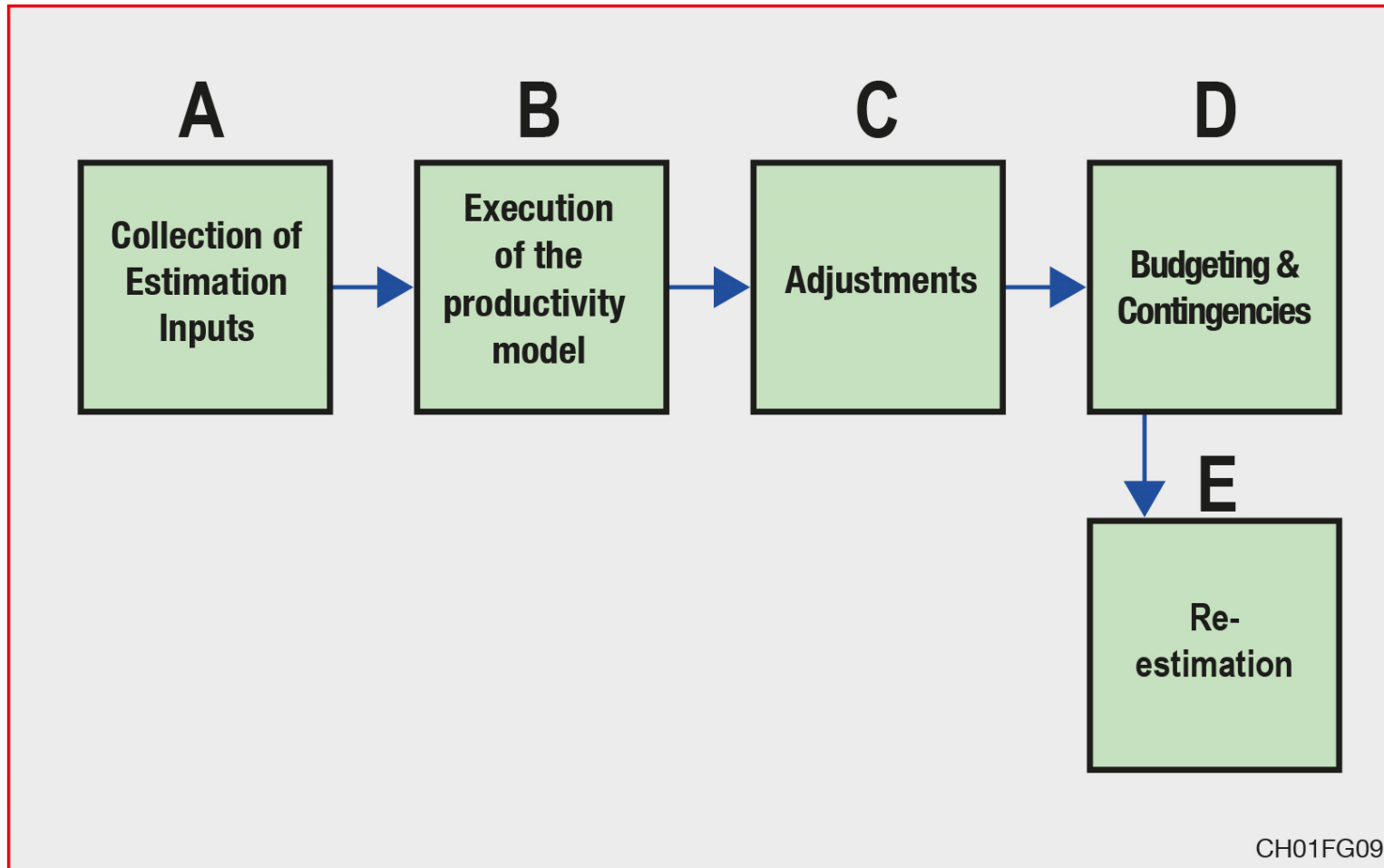http://www.rsc.org/chemistryworld/Issues/2007/March/RidingRAERollerc oaster.asp

1.6 The Estimation Process & its Phases

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The estimation process

The estimation process

Staff experience

Imprecise requirements

Unknowns

COST EFFORT RISK

http://www.123rf.com/photo_14119838_brain-finance-as-a-concept-of-opportunity-cost-effort-and-risk-isolated-on-a-white-background-as-a-c.html

Phases of the estimation process

A. Collection of Estimation Inputs → B. Execution of the productivity model → C. Adjustments → D. Budgeting & Contingencies → E. Re-estimation
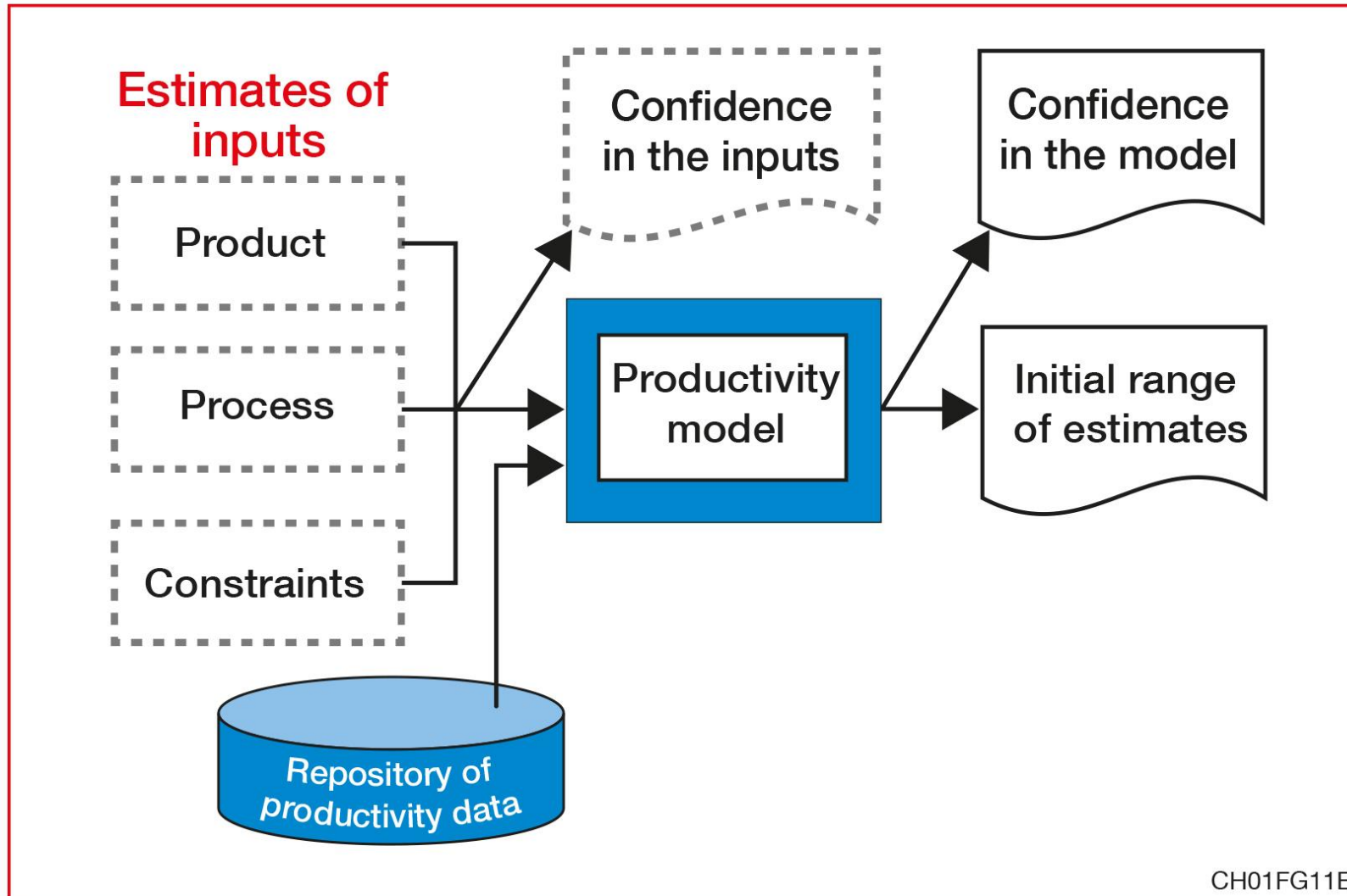
CH01FG09

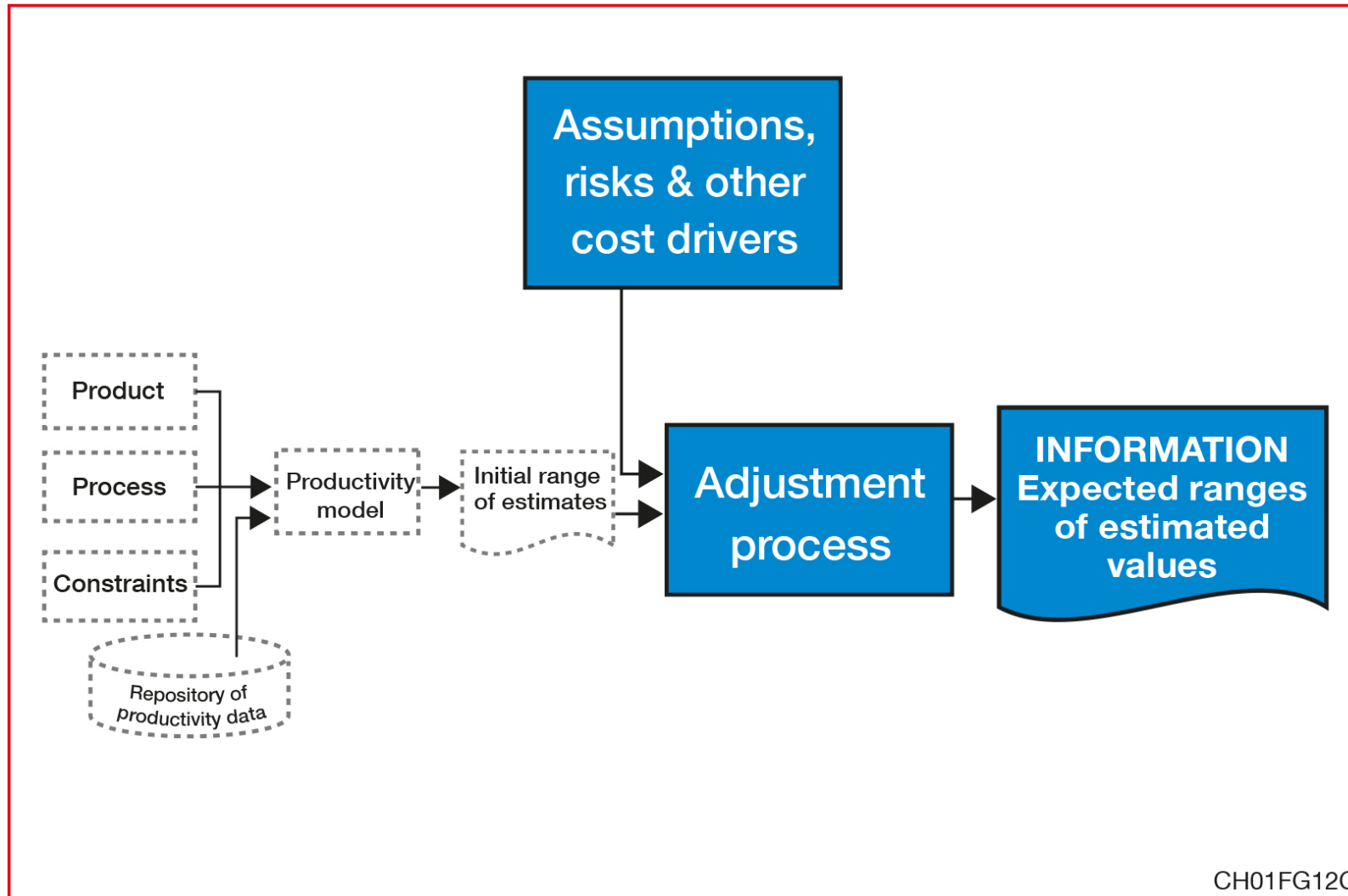# Phase A: Collection of the estimation inputs

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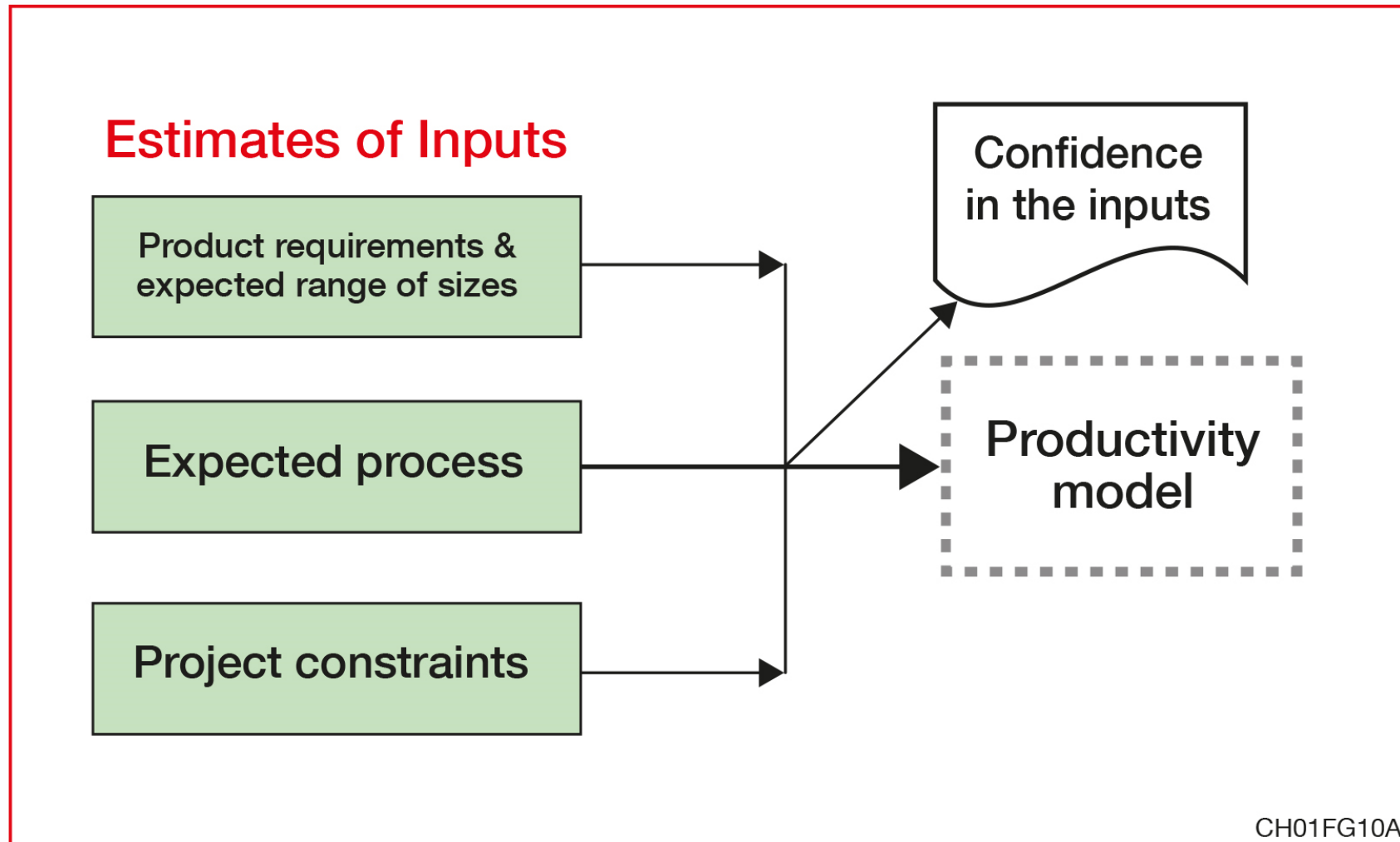
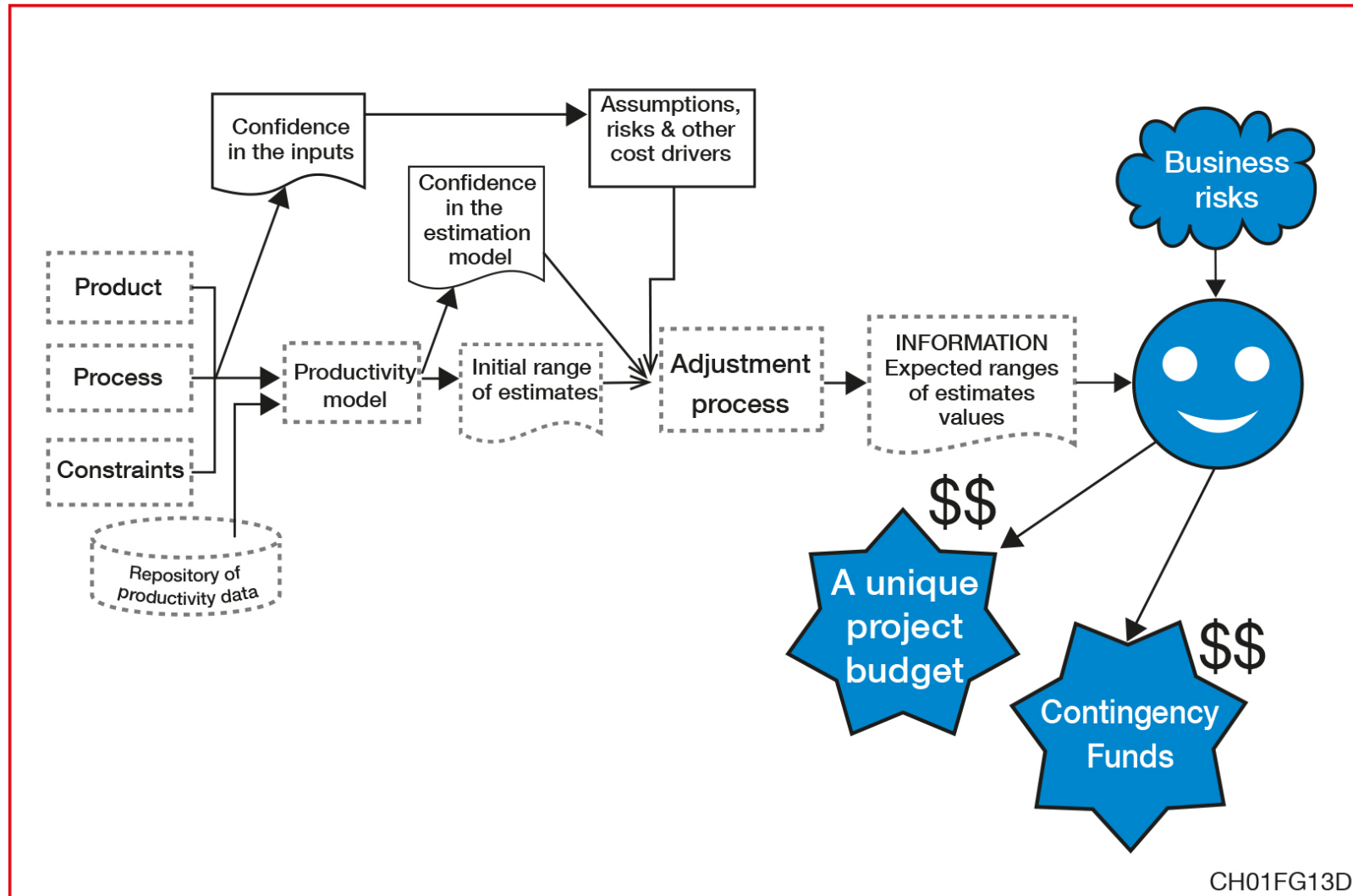# Phases B: Execution of the productivity model

CH01FG11B

Phase C: The adjustment process

CH01FG12C

Phase D: The budget decision

Confidence in the inputs

Assumptions, risks & other cost drivers

Confidence in the estimation model

Product

Process

Constraints

Productivity model

Initial range of estimates

Adjustment process

INFORMATION Expected ranges of estimates values

Repository of productivity data

Business risks

$$

A unique project budget

$$

Contingency Funds

CH01FG13D

CH01FG14E

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Estimation process improvements

A. Collection of estimation inputs
B. Execution of the productivity model
C. Adjustment phase
D. Budgeting & contingencies
E. Re-estimation
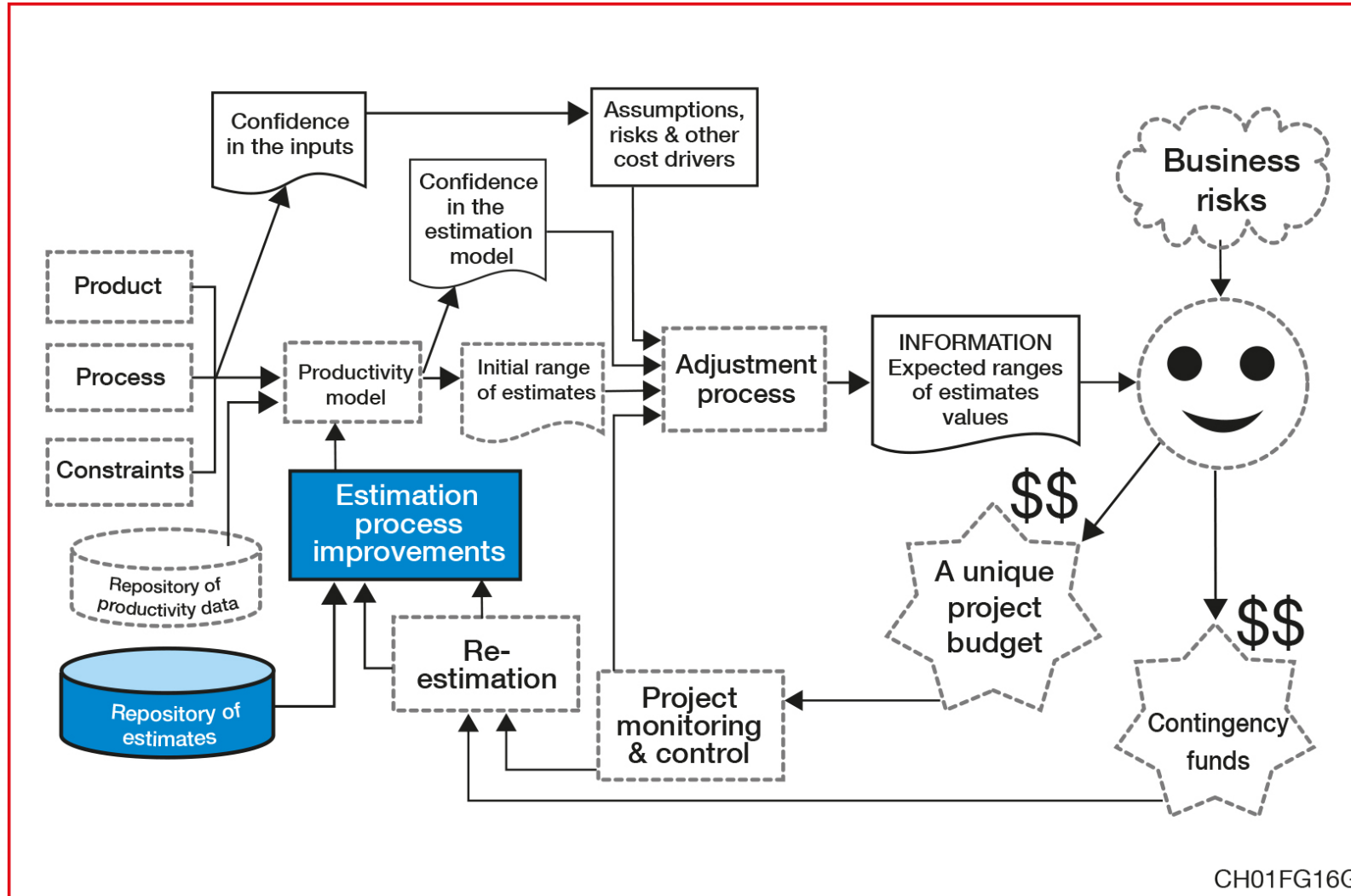F. Estimation process improvements

CH01FG15F

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Phase F: Estimation process improvements

CH01FG16G

1.7 Budgeting & Estimating

Project budget

A budget = a single value (**selected by a manager**)

from a large range of candidate values

(**identified by the software estimator**)

http://quoteimg.com/budget-icon/
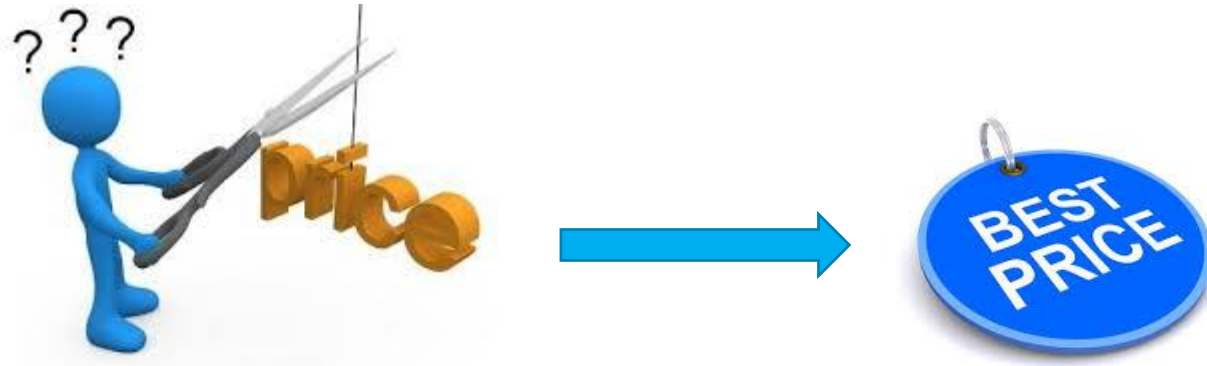
Project budget: Strategies

- Overly optimistic culture

- Very conservative culture

- Hybrid

http://www.123rf.com/photo_16596571_two-business-teams-fight-each-other-by-pulling-rope-over-a-ground-crack.html

Overly optimistic budget

- Aggressive commercial culture

- Price to win

http://feedvisor.com/blog/you-cant-win-the-buy-box-on-price-alone-1464
http://www.improveit360.com/should-you-lower-bids-to-win-the-deal/

Very conservative budget

- Long delays for approval

- Budget with a large number of contingencies

- Non competitive environment

http://thewisdompearls.com/budget-management-tips/

1.7.2 Roles & Responsibilities

Estimation Roles

Estimator

- Build the productivity model

- Carry out phases A to C of the estimation process

http://www.ppiclaimcompany.co.uk/claim-estimator

Manager

- Select the optimal budget

- Allocate resources for implementing the estimation process

- Assign skilled and trained resources to the estimation process

http://www.successandyouth.com/youth-development/are-you-a-good-decision-maker.html

Estimation Roles

Estimator

- Build the productivity model

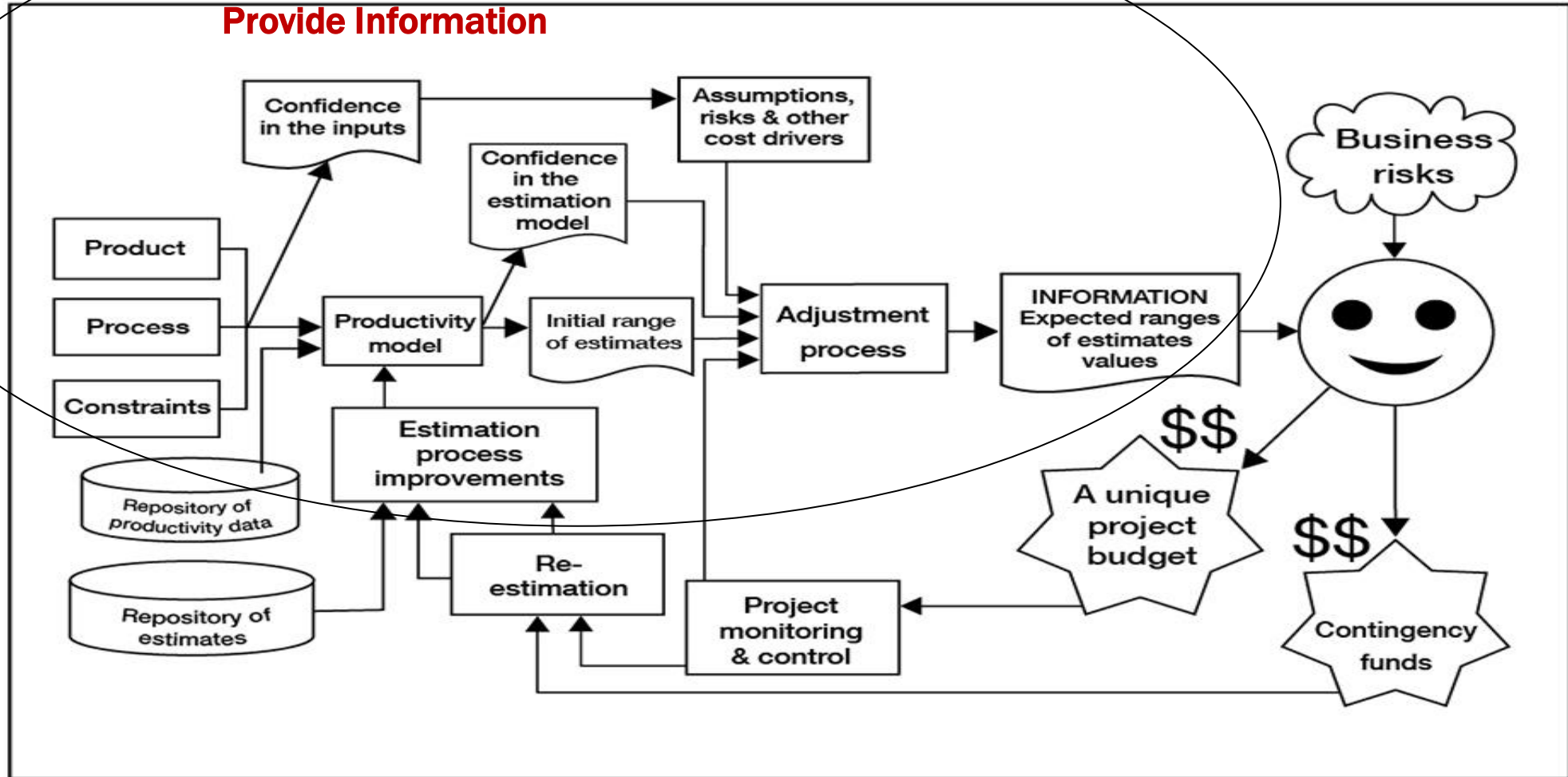- Carry out phases A to C of the estimation process

Manager

- Select the optimal budget

- Allocate resources for implementing the estimation process

- Assign skilled and trained resources to the estimation process

Estimator role:
Provide Information

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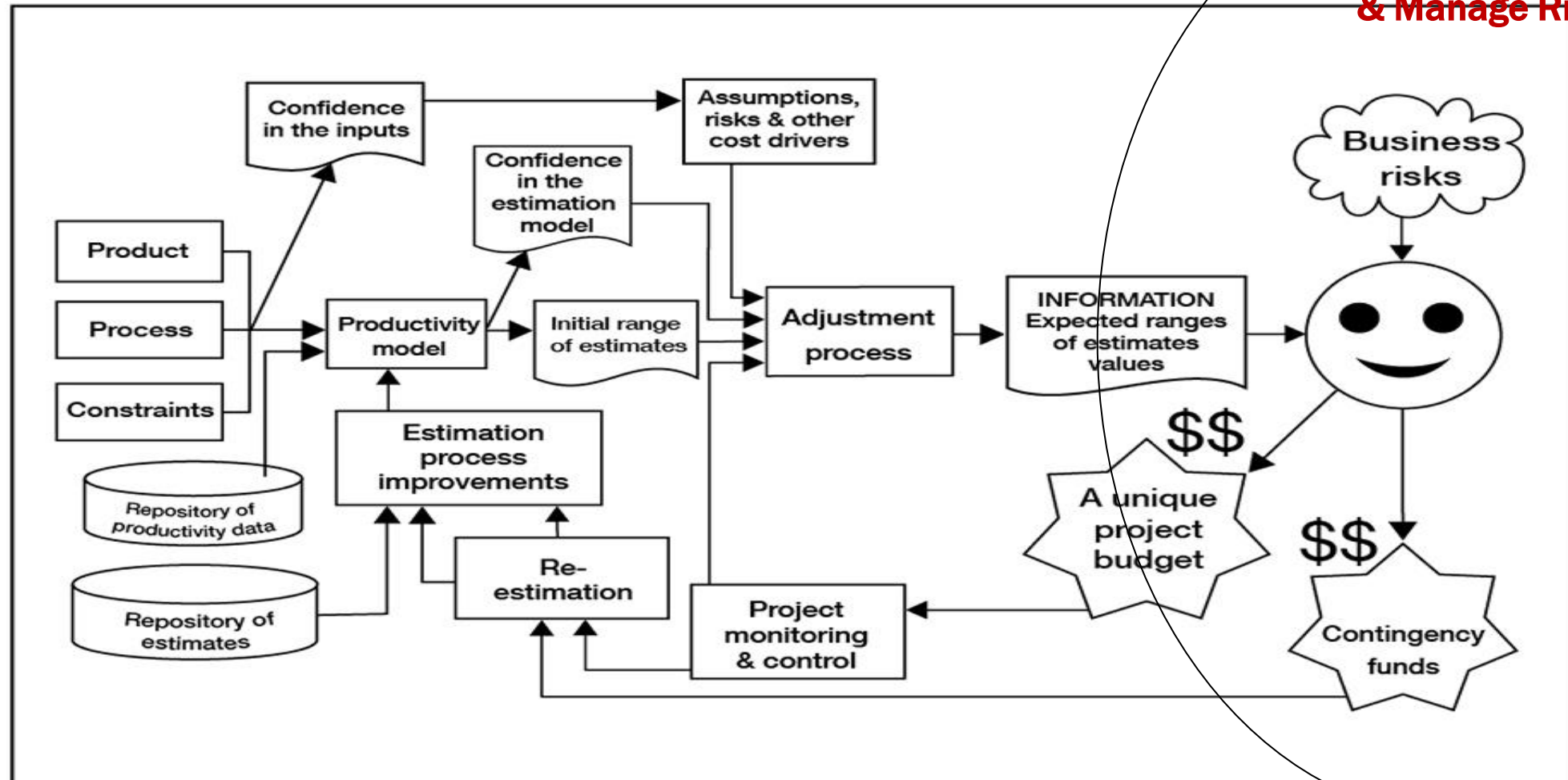
1.8 Pricing strategies

Pricing strategies

- Time and materials billing mode

- Fixed price contract

http://www.stratagem-intl.co.uk/projects-pricing-strategy

Summary:
Which one correspond to your estimation process?
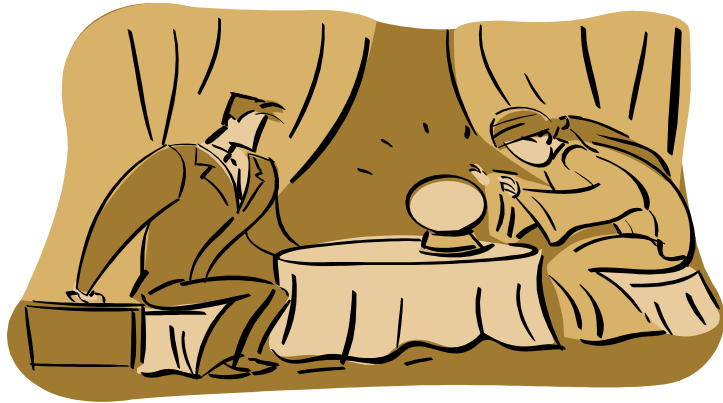
Or?
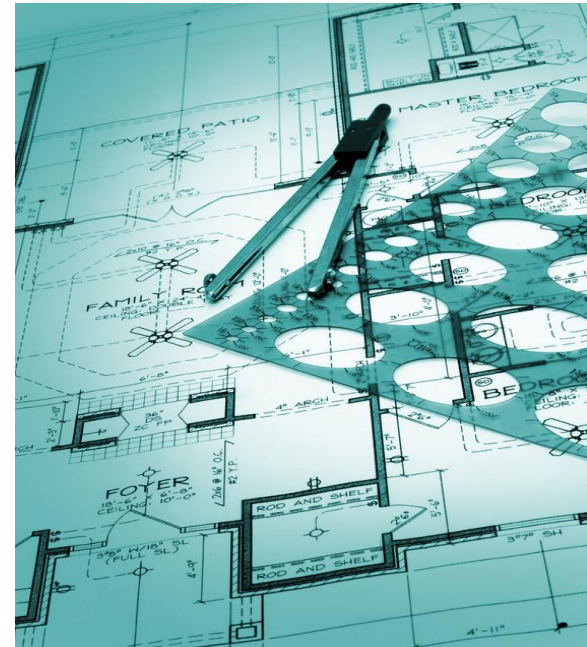
Key Lessons Learned

The goal of an estimation process should not be to provide a single hard figure, but rather to provide:

- information about ranges of plausible values,

- feedback about how good this information is,

- limitations of the information used as input to the estimation process,

- limitations of the information provided as output of the estimation process,

- analysis and mitigation of risks by documenting the assumptions made about the inputs, and the use of these inputs, in the estimation process.

Exercises

1. If you do not have quantitative information on your organization's performance in software project delivery, can you expect to have good estimates for the next project? Explain your answer.

2. What are the two broad approaches to software estimation, and what are their differences?

3. Identify some of the <u>worst</u> practices with regard to <u>inputting</u> to an estimation process.

4. Identify some of the <u>best</u> practices with regard to <u>inputting</u> to an estimation process.

5. Identify some of the <u>poor</u> practices in handling the <u>outputs</u> of an estimation process.

Exercises

7. What do industry surveys tell us about the performance of software projects in meeting their budget and deadlines?

8. What is the difference between a 'productivity model' and an 'estimation process'?

9. If you know the accuracy of a productivity model, what is the expected accuracy of its use in an *estimation* context?

10. How can you design a productivity model?

11. How do you evaluate the performance of a productivity model?

12. What are the benefits of mathematical productivity models?

13. For estimation, how would you handle <u>cost drivers</u> not included in the productivity model?

14. For estimation, how would you handle <u>risk factors</u> not included in the productivity model?

Exercises

14. How can an organization take into account <u>potential scope changes</u> when using its <u>productivity model</u> in an *estimation* context?

15. Discuss the key differences between providing an estimate for a project and taking a decision on a project budget. Discuss roles and responsibilities in estimation.

16. What are some of the key characteristics of estimation? Taking into account these key characteristics, what can you deliver when an organization expects accurate estimates from you? Provide your management with a better definition of 'accuracy' in this context.

17. When a manager selects a project budget from a range of estimates, what other major decision should he take concurrently?

18. How can an organization take into account <u>actual scope changes</u> in its <u>estimation process</u>?

19. Why should an organization have not only a plain productivity model, but also a re-productivity model?

Term Assignments

1. Document the estimation process in your organization.

2. Compare the performance of your projects with that documented in industry surveys, such as the Standish Group Chaos Report.

3. Compare the estimation process in your organization with the estimation processes illustrated in Figures 1.2 and 1.15. Identify improvement priorities for your organization's estimation process.

Term Assignments

1. Propose an action plan to address the top 3 priorities for improving an organization's software estimation process.

2. Compare the estimation process in Figure 1.15 with an estimation model proposed in a book. Comment on the similarities & differences. Identify strengths & weaknesses in the productivity model analyzed.

3. Take an estimation model proposed by a vendor and compare it to the estimation process in Figure 1.15. Comment on the similarities & differences. Identify strengths & weaknesses in the productivity model analyzed.

4. Take an estimation model that is available free on the Web and compare it to the estimation process in Figure 1.15. Comment on the similarities and differences. Identify strengths and weaknesses in the productivity model analyzed.