A Multidimensional Performance Model for Consolidating Balanced Scorecards

Alain Abran

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Agenda

- Introduction
- Balanced Scorecards - BSc
  - Structure & Challenges
- Measurement & Information Models
- ISO 9126 Multi-Dimensional Quality Models
- Functional Size Measures in a BSc
- Integration of multi-dimensional representations

Introduction

Balanced Scorecards = Performance Measurement Framework

- *Conceptually: very attractive*
  - *Strong appeal to business executives*
- *Operationnally: very challenging*

Introduction

- *Then, why is it not more widespread in organizations, and in software organisations in particular?*
  - *People reluctance?*
  - *Organizational reluctance?*

Introduction

- *Widespread recognition of benefits of measures*
  - *Hundreds of measures proposed to the software industry*
- *Why is there so limited usage in practice?*

Introduction

- *Again:*
  - *People reluctance?*
  - *Organizational reluctance?*

Introduction

Research Lab. in Software Engineering

- *Focus:*
  - *Measurement for decision-making*
  - *Measurement as a technology*

- *Approach:*
  - *Which pieces of the measurement technology puzzle are missing?*

Introduction

- *What is missing for implementation?*
  - *Has the measurement technology really been tested?*
  - *Is it ready for the practitioners?*
  - *Can it be improved before deployment?*

Agenda

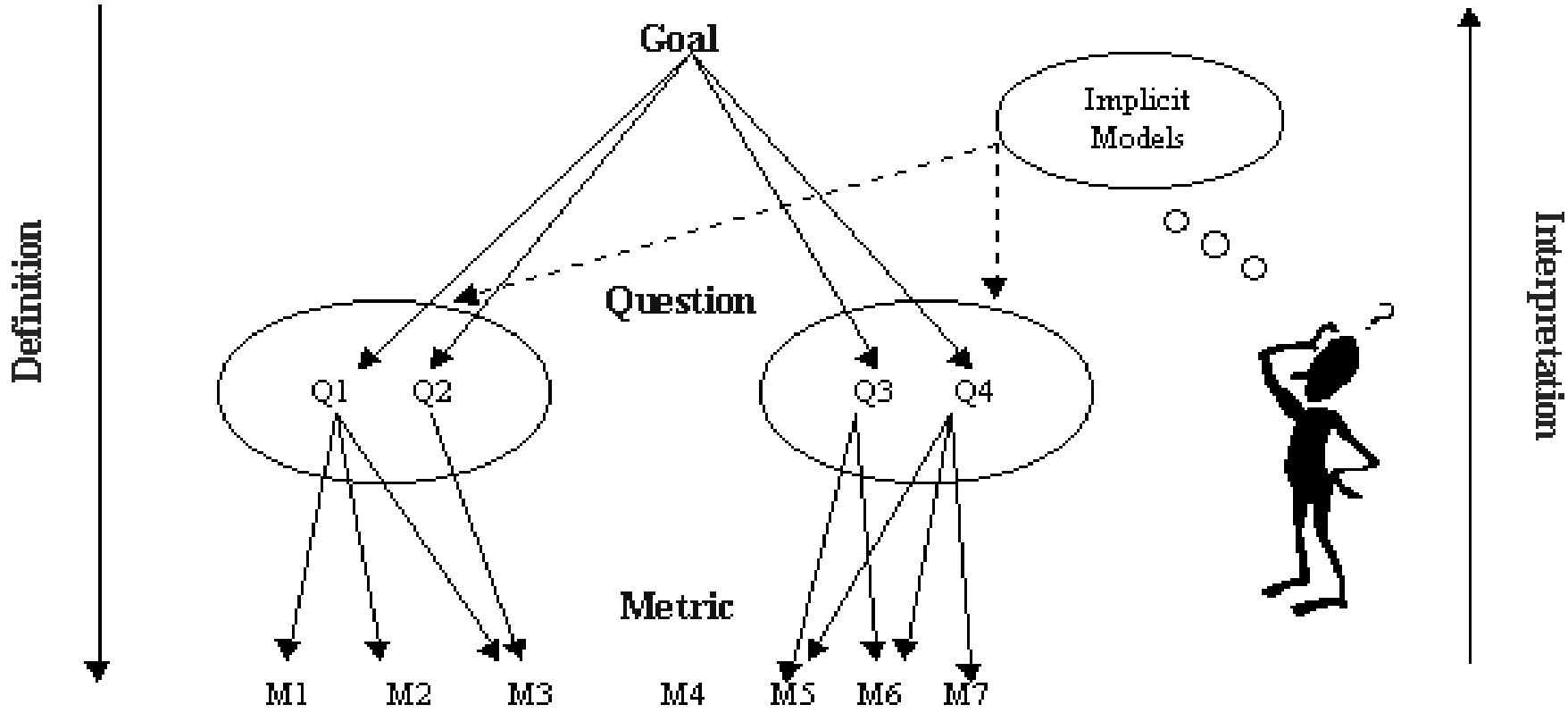
- *Introduction*
- ***Balanced Scorecards - BSc***
  - *Structure & Challenges*
- *Measurement & Information Models*
- *ISO 9126 Multi-Dimensional Quality Models*
- *Functional Size Measures in a BSc*
- *Integration of multi-dimensional representations*

Balanced Scorecards Predecessor

Most common approach to measurement in software:

Goal – Question - Metrics (GQM)

GQM Approach



GQM Approach

GQM - one of the most well-known and used measurement approaches for establishing a measurement program

GQM - a technique to derive measures for *project* control

starting from high-level goals, passing through the decomposition in several questions to answer.

Author: Victor Basili in the early ‘80s

(NASA Goddard Space Fligth Center)

Main measurement object: software projects

GQM Approach

Limitations

- *Limited scope – a project at a time*
  - *… re-inventing the wheels most of the time*
- *How to figure out the organizational view?*
- *How to leverage the business models?*

BSc Framework

Balanced Sc –

- A multidimensional framework for "*translating (organisational) strategy into action*" at all levels of an enterprise, by linking objectives, initiatives and measures to an organization's strategy

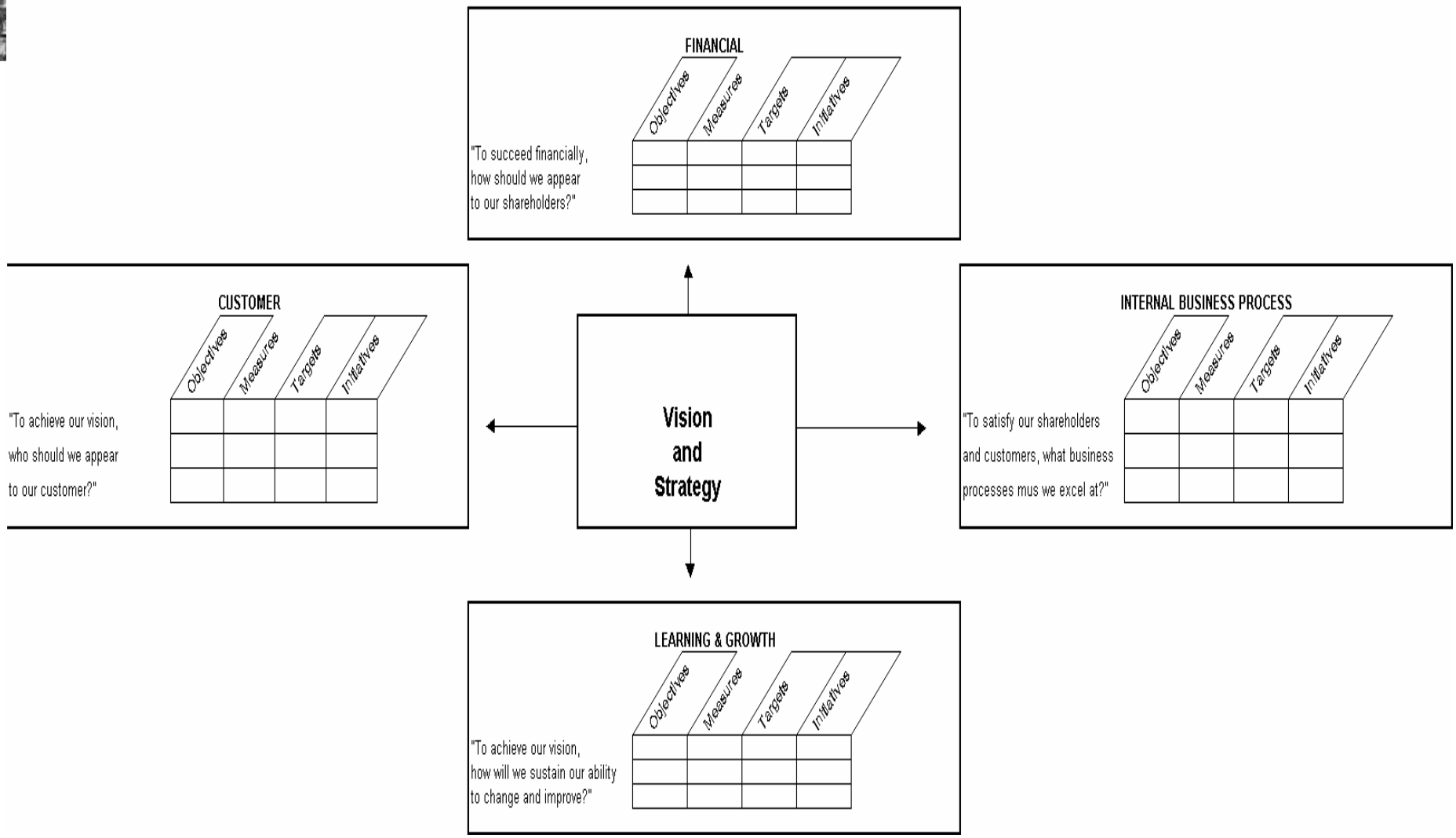
Authors: Kaplan & Norton (HBS) in the early '90s

- originating from the method: *Tableau de Bord*
  - turn of 20th century

Main measurement object:

- The whole organization / a Business Unit

BSc Framework



BSc and Management Needs

SPI is not a goal in itself, but a mean to achieve business goals more effectively

Basic Management need: align internal processes and activities to business objectives

- to maintain business competitiveness (Porter's Value Chain)

Strategic Management basic principles:

- Alignment of processes & strategic business goals
- Identification & application of measures for an overall business unit
- Performance management

BSc in the Software field

Two versions of the BSc for the software field developed in the last few years:

- Balanced IT Scorecard (**BITS**) by the European Software Institute (**ESI**)
- **AIS BSc** by the Advanced Information Services Inc. (**AIS**)

Commonalities: both frameworks support 5 perspectives, adding the “People/Employee” one

ESI BITS

Financial:

How do our software processes and SPI add value to the company?

- **Customer**:

  How do we know that our customer (int/ext) are delighted?

- **People**:

  Is the people issues (competence, satisfaction and retention) properly managed to implement a sustainable improvement program?

- **Process**:

  Are our software development processes performing at levels sufficient enough to meet customer expectations?

- **Infrastructure & Innovation**:

  Are the technology and organisational infrastructure issues being addressed to implement a sustainable improvement program?

BSc Support Technologies

- Data Presentations Tools using BSc framework
- OLAP Cubes manipulation
  - Based on an assumption that data is available
  - Most take for granted that the information models are available and mastered
  - No automated causal-impact linkages

BSc Technology Challenges

For software organizations:

- *Adequate and relevant measures for each perspective:*
  - *Definitions*
  - *Data collection*
  - *Normalization*
- *Analysis models for software organizations*
- *Integrating models that can map to business models of performance*
- *Techniques for multi-dimensional models*

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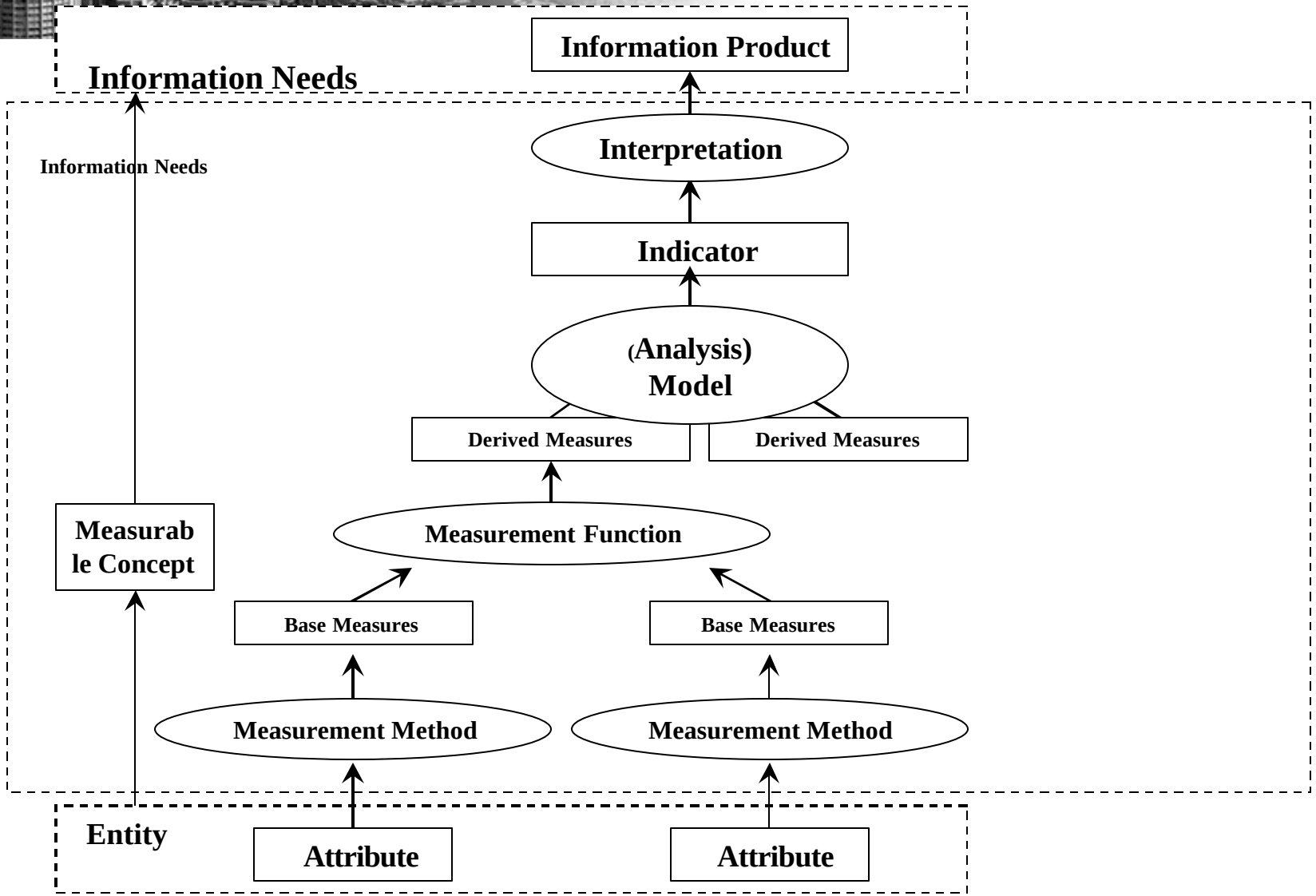
ISO 15939

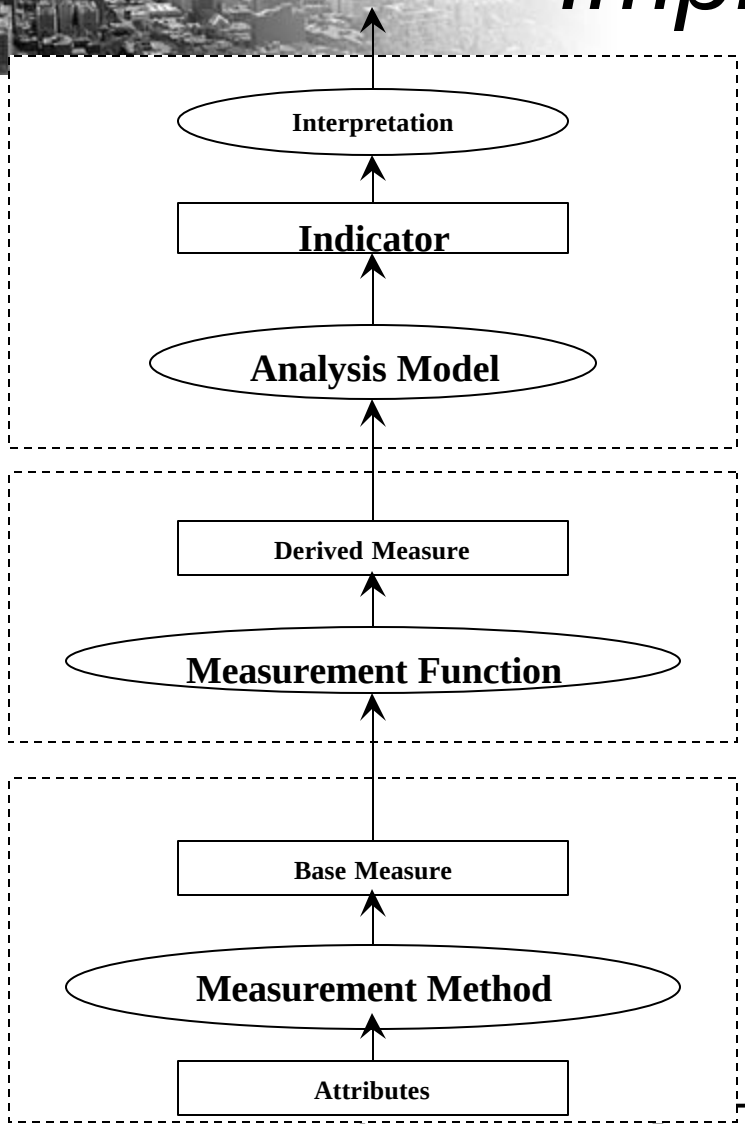

Information Product
Information Needs
Information Needs
Interpretation
Indicator
(Analysis) Model
Derived Measures
Derived Measures
Measurab le Concept
Measurement Function
Base Measures
Base Measures
Measurement Method
Measurement Method
Entity
Attribute
Attribute

ISO 15939 Implementation

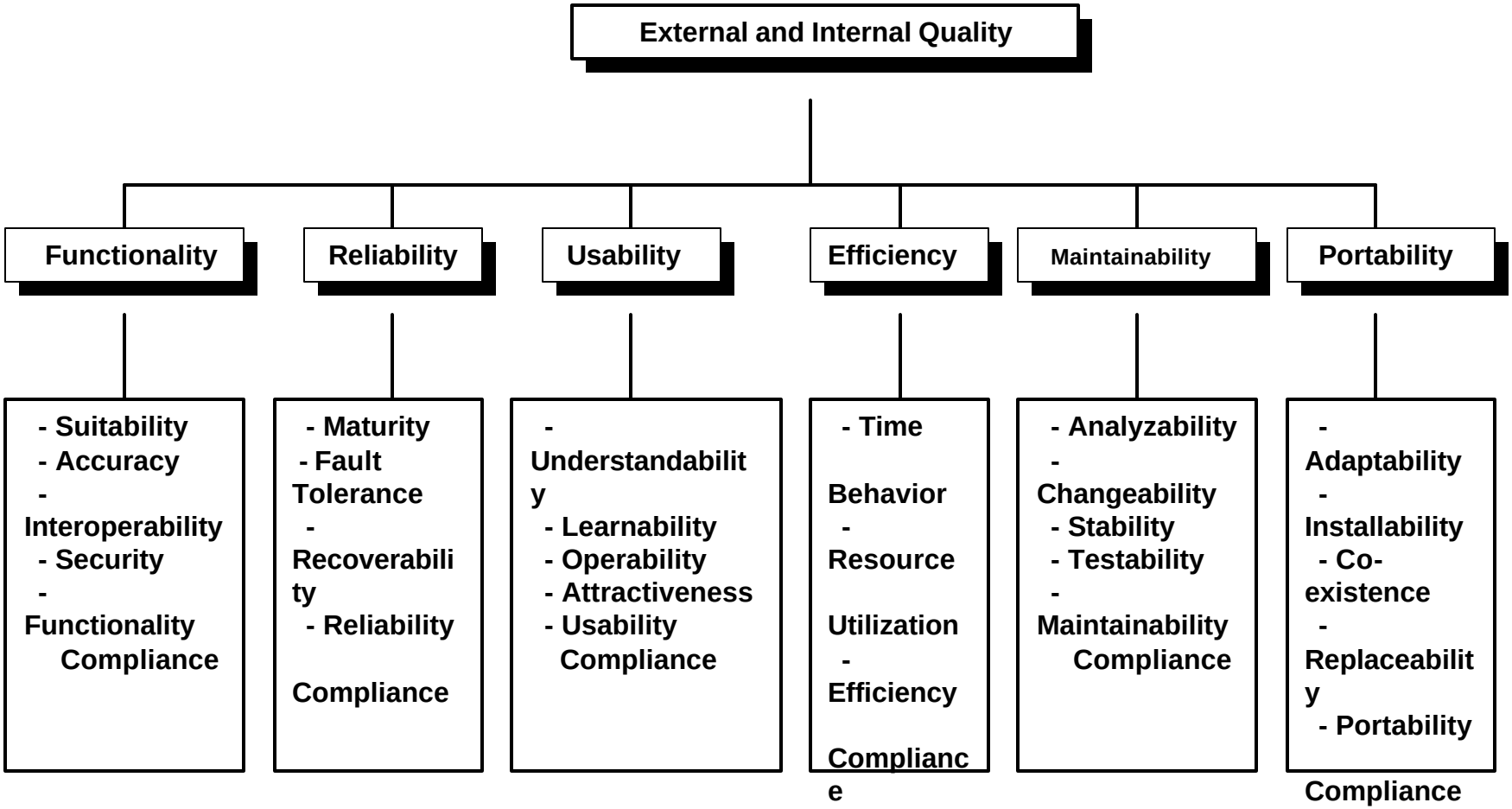
Data Analysis

Data Preparation

Data Collection



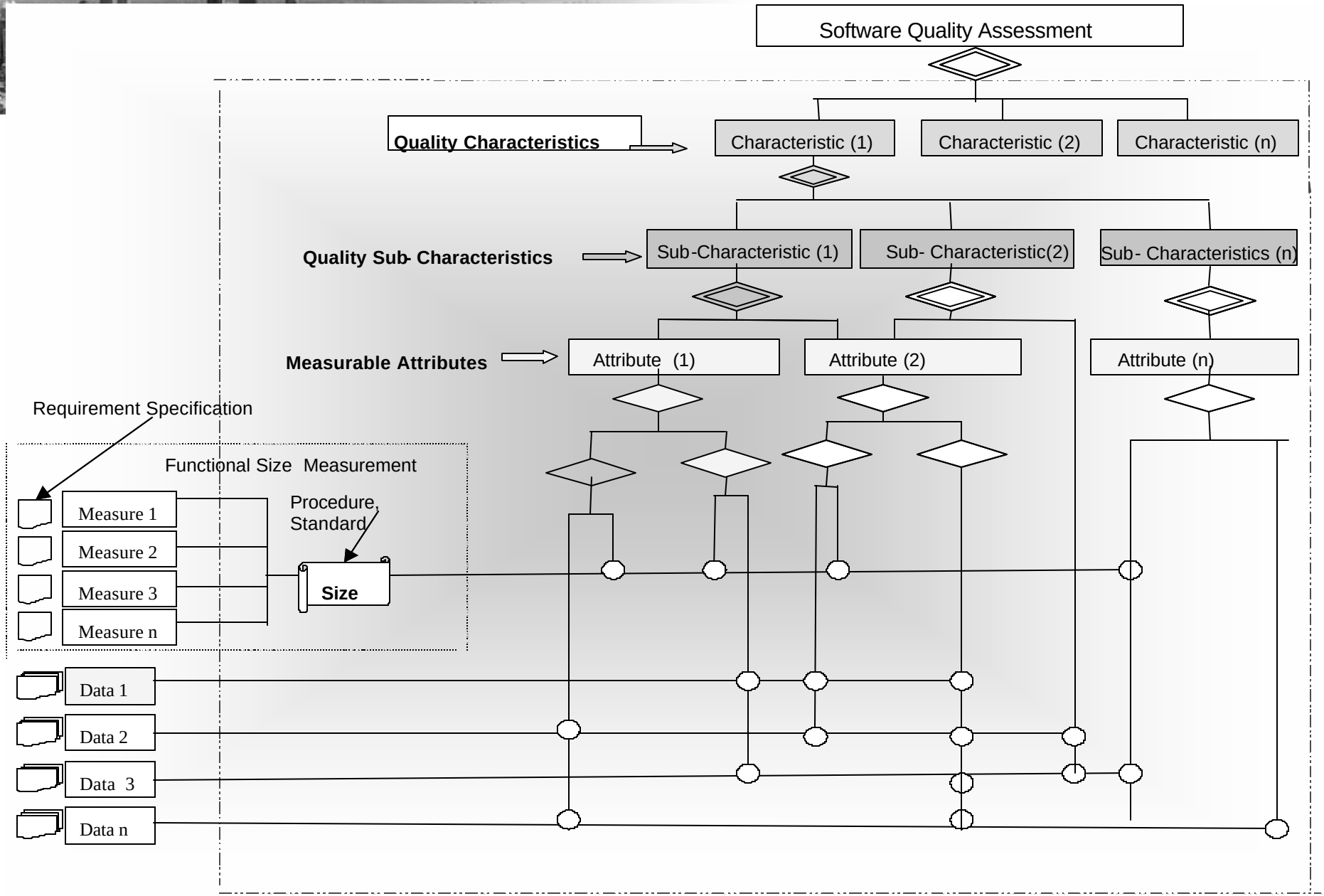
ISO 9126 Quality Characteristics



ISO 9126 Quality Assessment

- *Assumes that any software quality requirement can be a function of many variables (characteristics), linked in several ways among themselves*
  - *The highest level of its tree structure is given by quality characteristics*
  - *The lower one, by measurable quality attributes*

ISO 9126 Quality Analysis



Multiple viewpoints

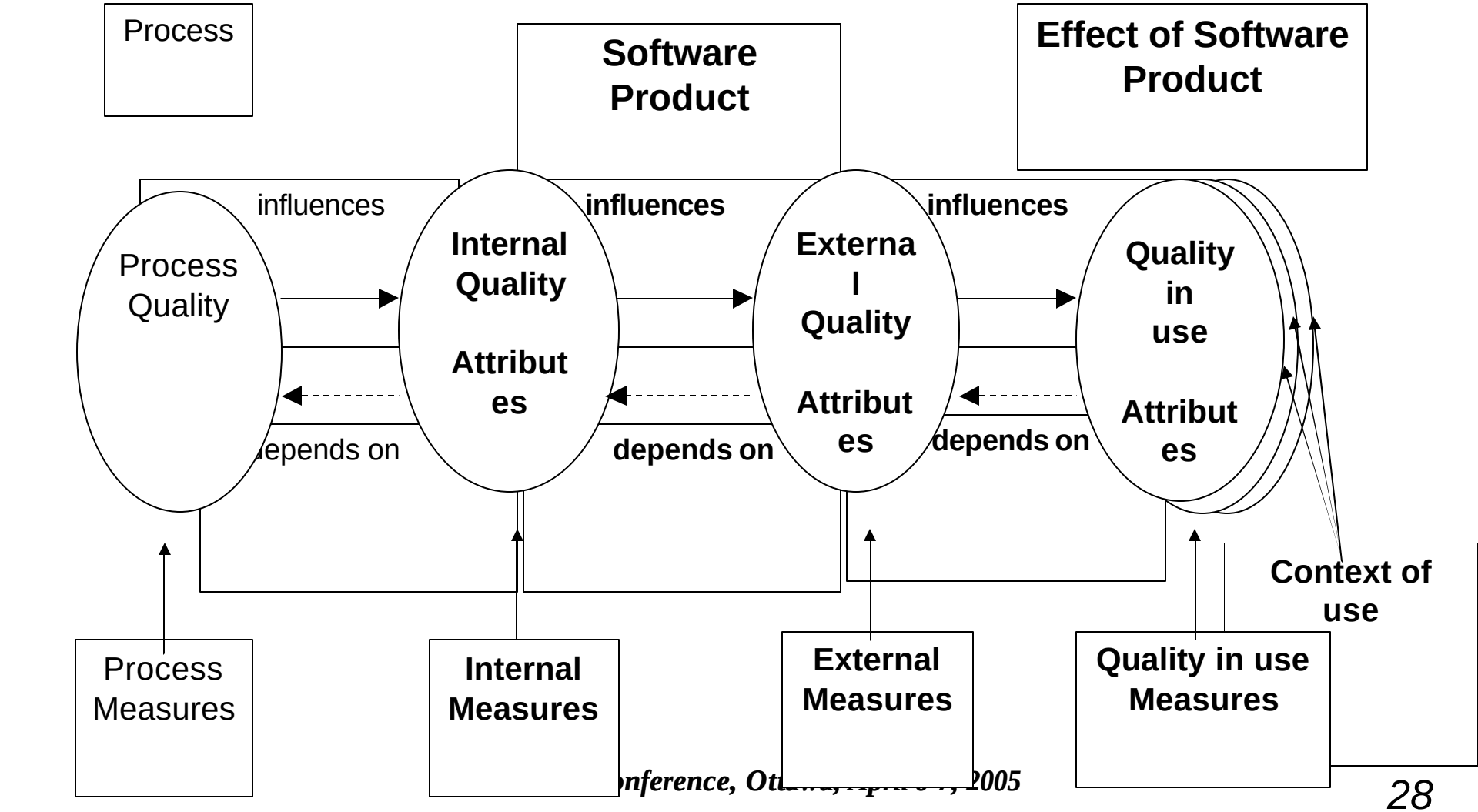
Multi perspectives To obtain a more complete and exhaustive assessment: multiple concurrent viewpoints from several stakeholders

Example: the "*organolectic analysis*" for wine evaluation takes into account three weighted concurrent criteria for determining the final quality value:

- visual (**20**%)
- smell (**28**%)
- taste (**52**%)

⇒ 100%

Multiple viewpoints ISO 9126 Quality Models



Multiple Viewpoints

Software : ISO 9126 standard explicitly considers three viewpoints (Manager, User, Developer):

Actors	Viewpoint	Objectives
Managers	Economic (**E**)	Overall quality
Users	Social (**S**)	Usability
Developers	Technical (**T**)	Conformance to requirements

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- **Functional Size Measures in a BSc**
- Integration of multi-dimensional representations

BSc Operational Challenge

Use of Measures in General Business Performance Analysis:

Measures need to be normalised based on the number of functional outputs of a production process

(or of a business unit: i.e. How many hours by car, what is the asset cost by unit of production,...).

Why normalise?

- For comparison purposes,
- To develop reference numbers.

BSc Operational Challenge

How can reference numbers be derived in evaluating software processes?

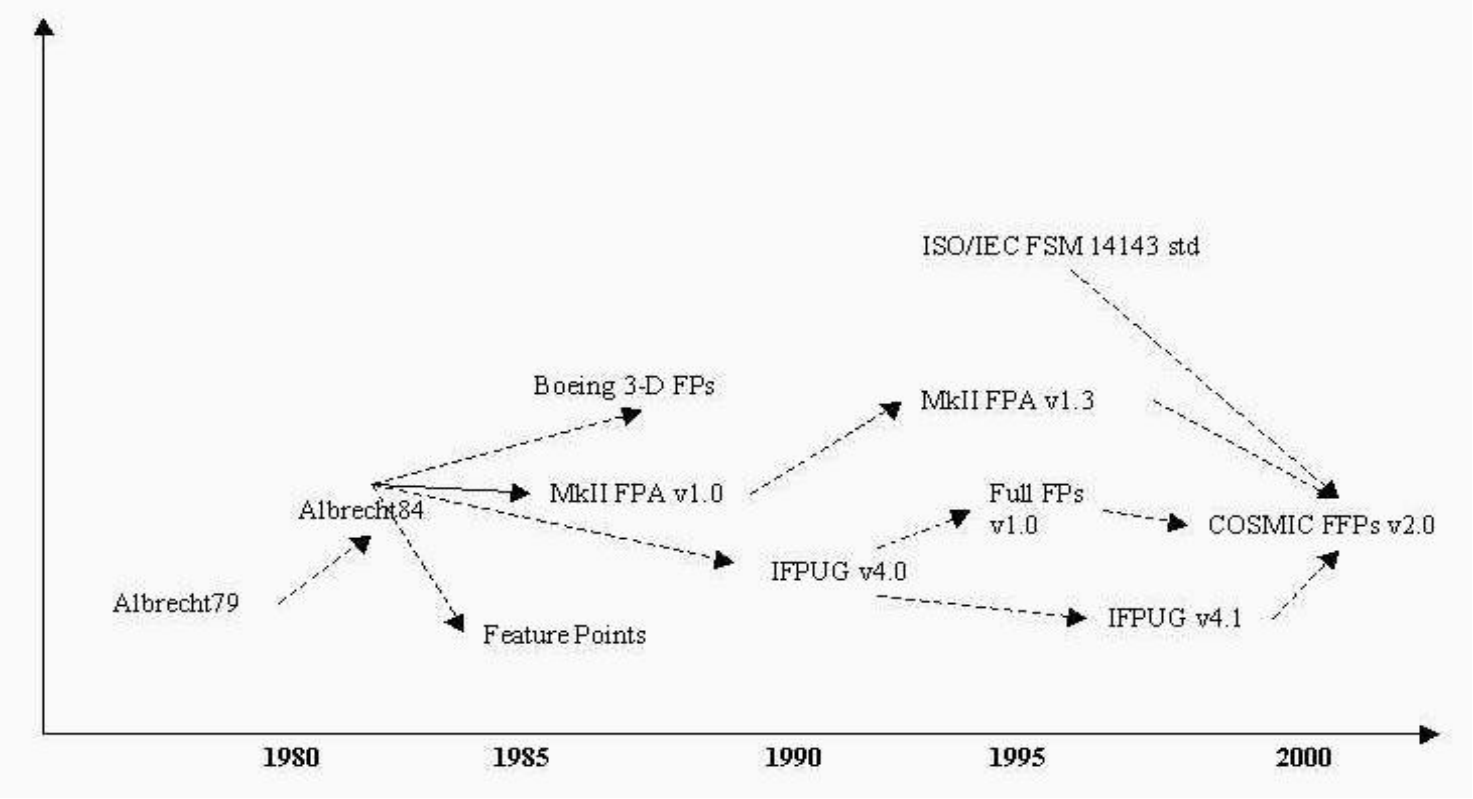
By figuring out how to measure the number of production units in software;

Proposed Solution:

- Functional Size Measures (FSM) such as:
  - Function Points FPs - IFPUG
  - COSMIC-FFP – ISO 19761
- They measure the appropriate concepts and have the appropriate properties.

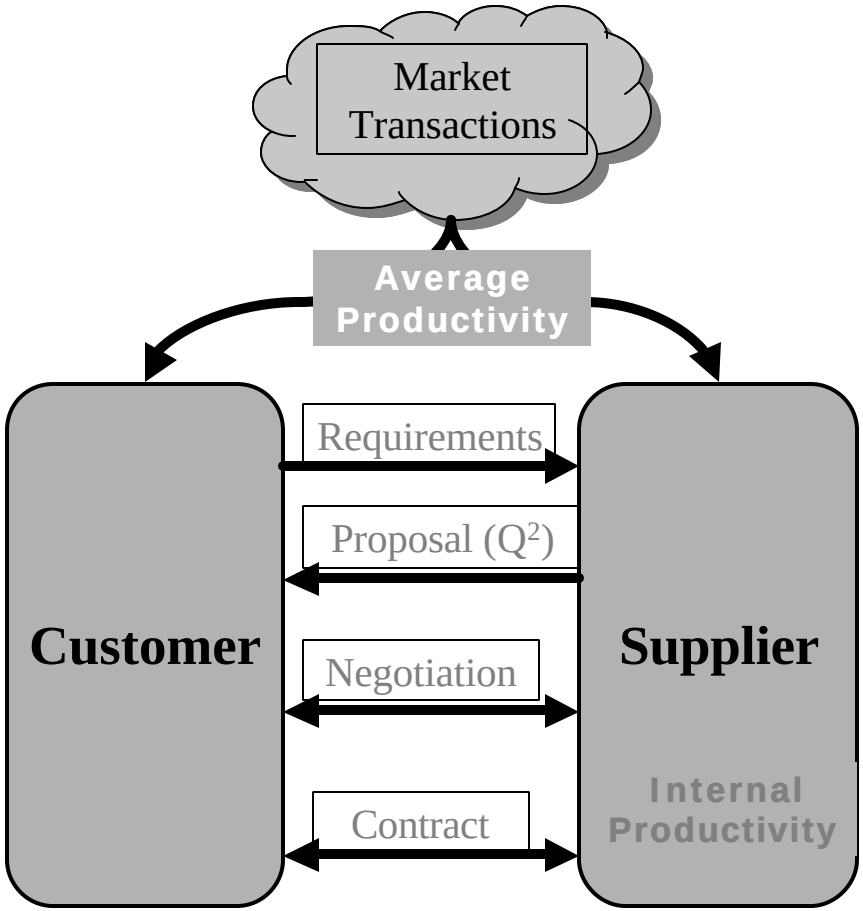
Functional Size Measurement

Evolution of FSM methods



ISO 19761 = COSMIC-FFP

- *Functional Size measures provide a mean to measure software from the external user point of view and is particularly effective in supporting contractual aspects.*



FSM-based measures and BSC perspectives

	GOAL/OBJECTIVE	DRIVER	INDICATOR	COMMENTS / EFFECTS
FINANCIAL				
	Asset Management	Existing asset utilisation	• Total Assets (FSAV) / # employees ($)	
			• **FSAV – FS_{units} Asset Value**	
			• **PS – Portfolio Size**	
	Revenue & Profitability	Revenue Growth	• Revenues / FSAV (%)	
			• Revenues from new customers / Total Revenues (%)	• *New customers acquired using FSM as a contractual condition for measuring the project – Derived (Improve project governance)*
		Profitability	• Profits / FSAV (%)	
	Financial Management	Organisational Investments	• Investments in IT	
		Project Investments	• **PCFS – Project Cost per FS_{unit}**	
			• **ECFS – Enterprise Cost per FS_{unit}**	
			• **AMCFS – Application Maintenance Cost per FS_{unit}**	

FSM-based measures and BSC perspectives

	GOAL/OBJECTIVE	DRIVER	INDICATOR	COMMENTS / EFFECTS
CUSTOMER				
	Customer partnership and involvement	Collaboration	• % projects using integrated teams	
			• **SR – Stability Ratio**	
	Customer satisfaction	SLA	• % SLA met	• *if the agreement uses FSM as a basis for the contract*
	Business Process Support	Innovation usage	• % IT solutions supporting process improvement projects	• *project measurement using FSM*
		Requirements Management	• Requirement Turnover Index [MELI01] RTI = $[(\Sigma_j \text{ CRFS}_j)/ \text{ Final FS}_{units}] * 100$ • CRFS = Change Request Function Size units	• *Showing the level of turbulence in requisites during the development phase*
		Problem Management	• **DR – Defect Ratio**	
			• **AR – Application Reliability**	
	Business Growth	Market Share	• % Market share	• *increasing % using FSM as an initial contract condition*

FSM-based measures and BSC perspectives

	GOAL/OBJECTIVE	DRIVER	INDICATOR	COMMENTS / EFFECTS
PROCESS				
	Application Development & Maintenance	Size	• **FS_{unit} – Functional Size unit,**	*According to the FSM method used, it can be expressed for instance by:* • ***FP –*** *Function Points* • ***C_{fsu}*** *- COSMIC functional size units –*
			• **PS – Portfolio Size**	
		Effort	• **WE – Work Effort**	
		Productivity	• **PDR – Project Delivery Rate**	
			• **EP – Enterprise Productivity**	
		Support	• **ASR – Application Support Rate**	
			• **DDR – Duration Delivery Rate**	
			• **AMPL – Application Maintenance Load per Person**	
		Defectability & Test	• **RCR – Repair Cost Ratio**	
			• **SR – Stability Ratio**	
			• **DR – Defect Ratio**	
			• **TPR – Testing Proficiency Ratio**	
			• **MTTR – Mean Time To Repair ratio**	
			• **AR – Application Reliability**	
			• **DER – Defect Detection Ratio**	
			• # defects / 100 **FS_{unit}** according to user acceptance	
		Reuse	• **FR – Functional Reuse %**	
			• **TR – Technical Reuse %**	

FSM-based measures and BSC perspectives

	GOAL/OBJECTIVE	DRIVER	INDICATOR	COMMENTS / EFFECTS
PEOPLE				
	Core Competencies & Skills	Core Competencies & Skills	• Feedback from FSM-based courses (I&I)	
		Effects of Training	• **DER – Defect Detection Ratio**	

FSM-based measures and BSC perspectives

	GOAL/OBJECTIVE	DRIVER	INDICATOR	COMMENTS / EFFECTS
INNOVATION & INFRASTRUCTURE				
	Workforce Improvements	Workforce Competency and development	• IT expended on Training / IT expenses (%)	• *Leverage on the increased forecasting ability of Project Managers (Process perspective) and on their increased satisfaction (People perspective)*
			• % of staff trained in relevant standards or new technologies	• *Training in functional measurement for planning and governance*
			• % employees skilled in advanced application measurement methods	
		Tools & Products	• Investment in new product support and training ($)	• *For FSM-based tools or for courses about FSM-based techniques*
	SPI Improvements	Methodology currency	• % projects measured using recognised methods	
		Support	• **PDR – Project Delivery Rate**	
			• **ASR – Application Support Rate**	
			• **DDR – Duration Delivery Rate**	
			• **AMPL – Application Maintenance Load per Person**	
			• **RCR – Repair Cost Ratio**	

FSM-based measures & BSc perspectives

FSM-based measures can contribute to the multidimensional nature of a BSc, providing ratios for all the BSc perspectives

- Most impacted perspectives: Process and Financial
- Less impacted perspectives: Customer and People

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Structure of QEST Model

Most current performance models:

- *A single dimension at once:*
  - *with representation into a single dimension, even with Kiviat diagrams*

How to take into account many dimensions?

- *By using geometry to:*
  - *Integrate multiple concepts*
  - *Represent multi-dimensions*

Structure of QEST model

Its three dimensional format:

- ***Economic dimension (Management)***
- ***Social dimension (Users)***
- ***Technical dimension (Developers)***

The QEST model provides a multidimensional structured shell, which can then be filled according to management objectives for any specific project

- ***Referred to as an open model.***

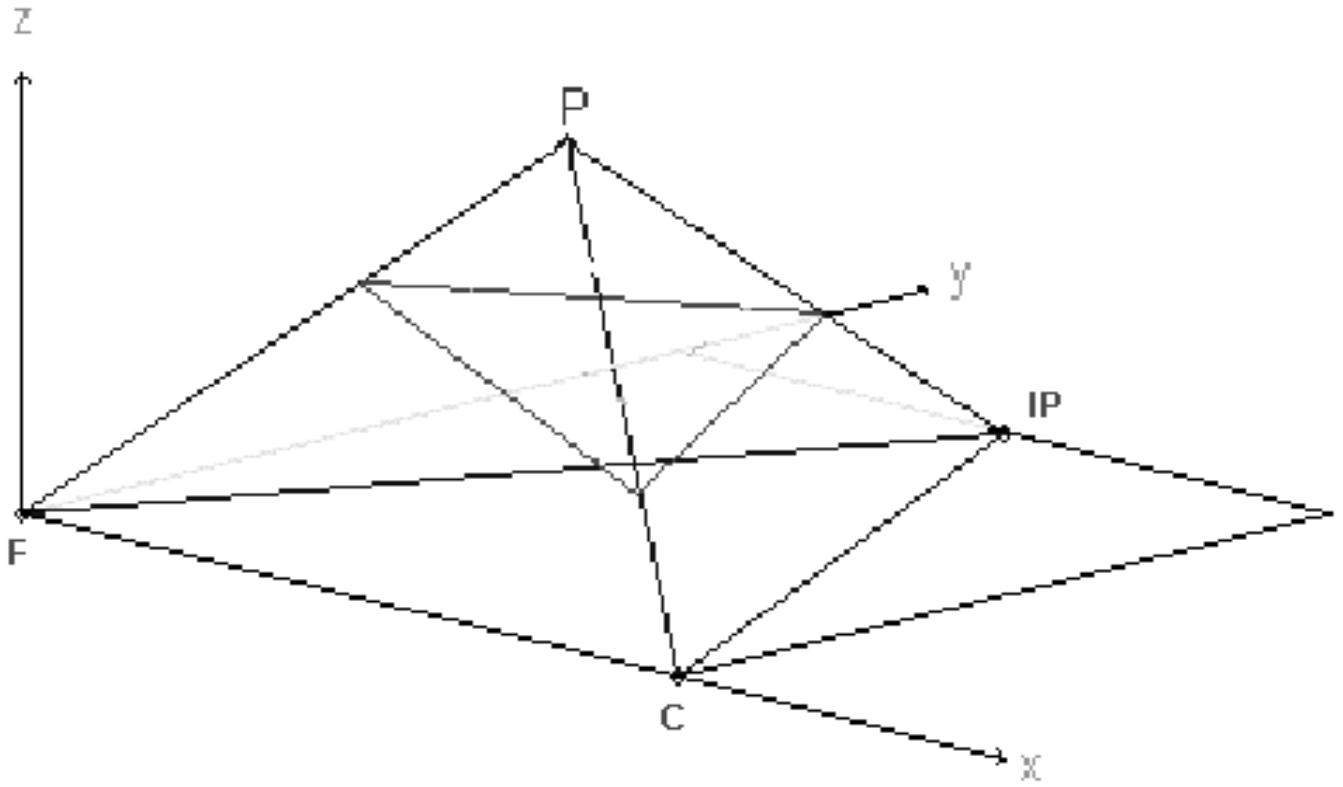
The three dimensions (E, S, T) in the space correspond to the corners of the pyramid's base, and the convergence of the edges to the P vertex, which describes the top performance level.

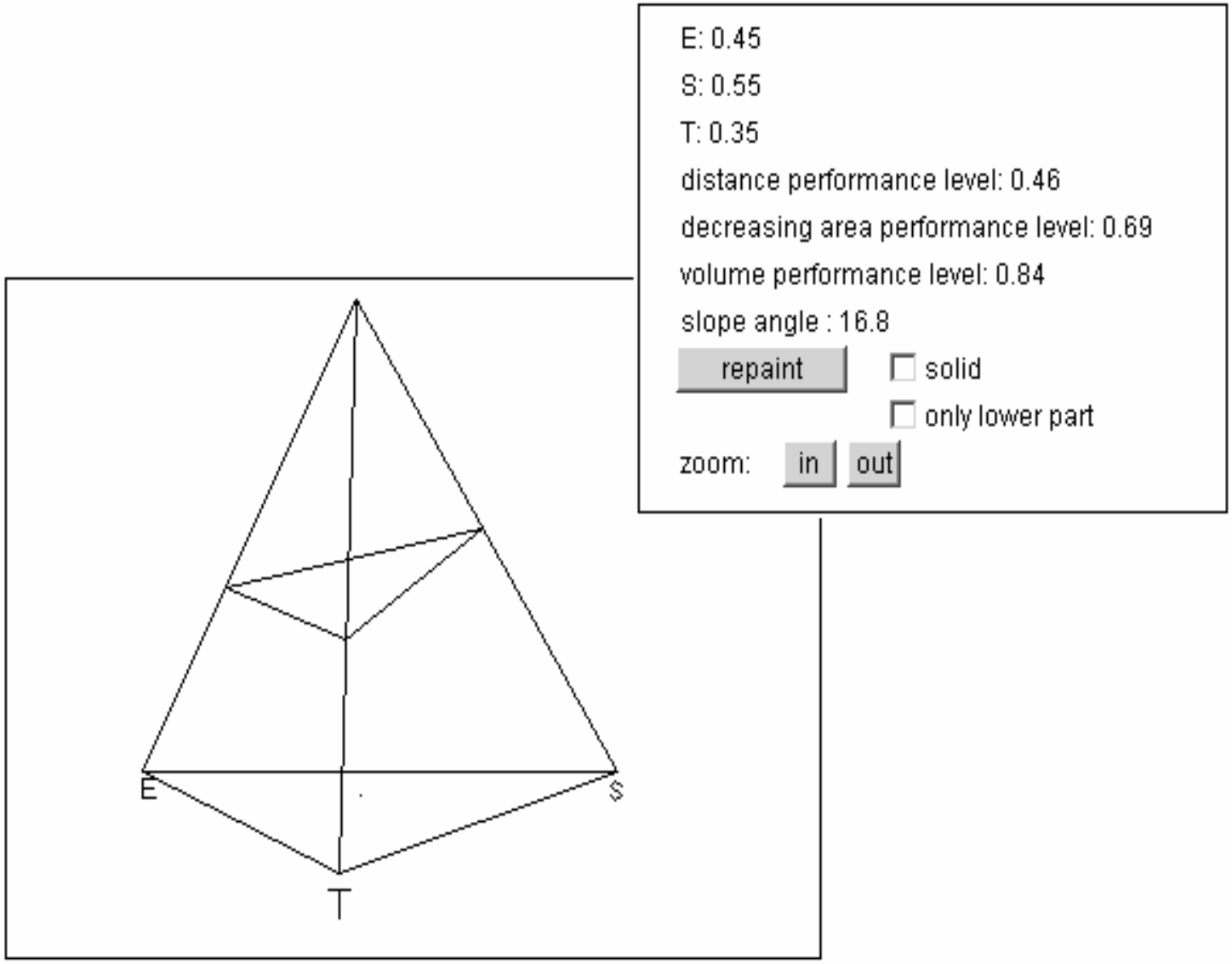
Thetrahedron = Pyramid (all side equal)

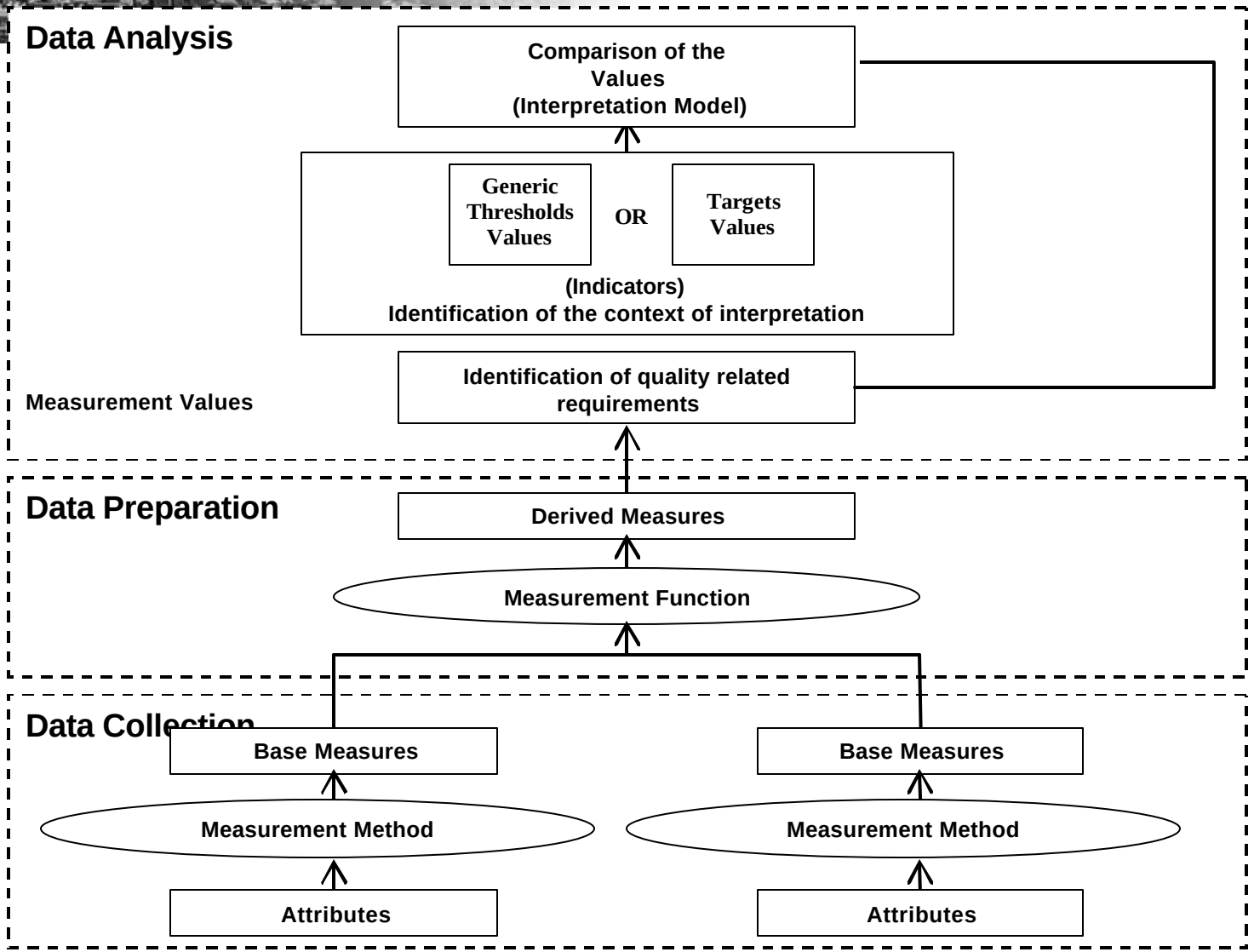
The tetrahedron supplies several performance indices:

- **Distance (between the tetrahedron base and the plane)**
- **Area (of the sloped plane section)**
- **Volume of the lower part of truncated tetrahedron**

QEST Model



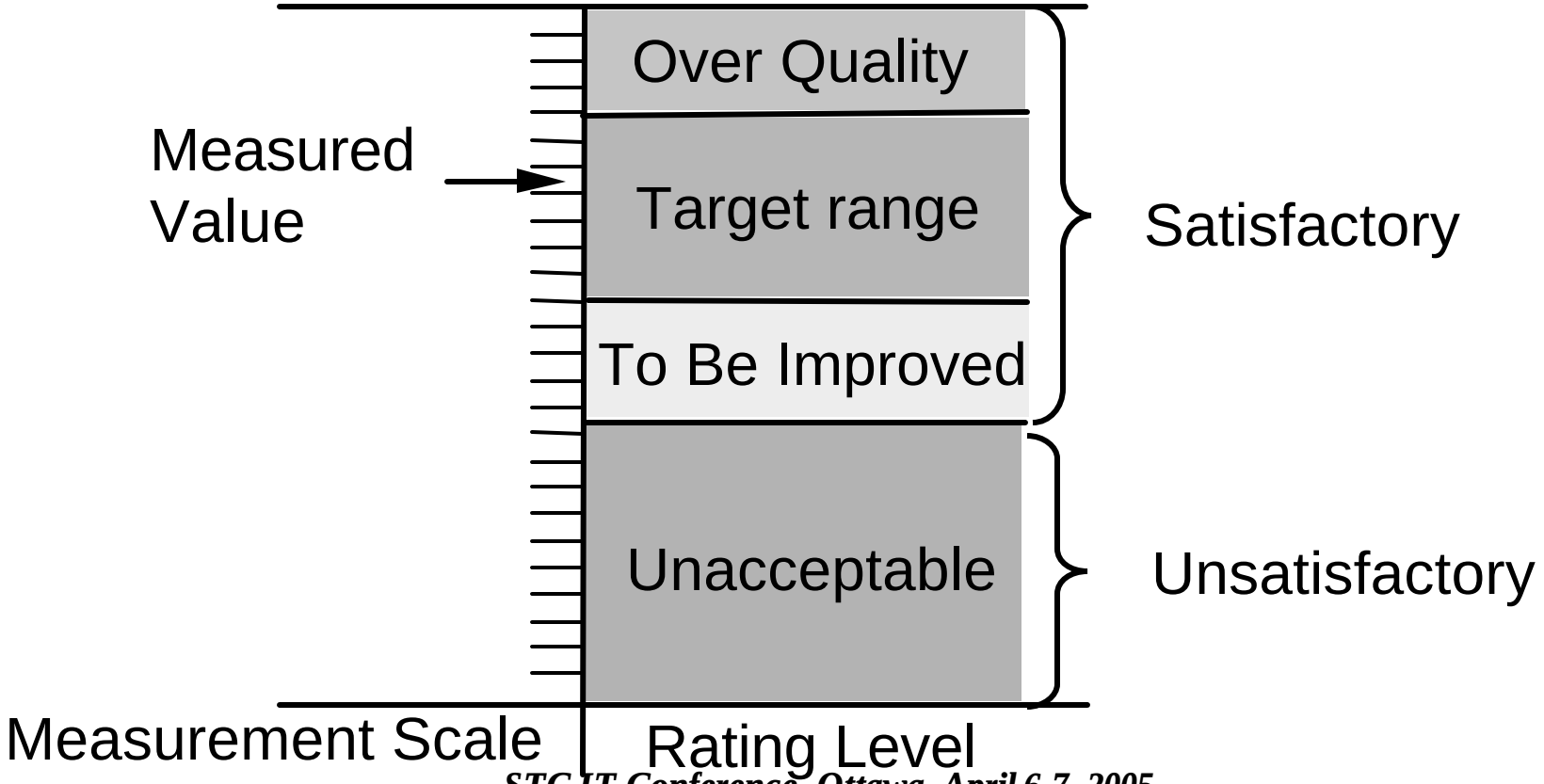

E: 0.45
S: 0.55
T: 0.35
distance performance level: 0.46
decreasing area performance level: 0.69
volume performance level: 0.84
slope angle : 16.8
repaint
solid
only lower part
zoom:
in
out
E
S
T


Data Analysis
Comparison of the Values (Interpretation Model)
Generic Thresholds Values
OR
Targets Values
(Indicators)
Identification of the context of interpretation
Identification of quality related requirements
Measurement Values
Data Preparation
Derived Measures
Measurement Function
Data Collection
Base Measures
Base Measures
Measurement Method
Measurement Method
Attributes
Attributes

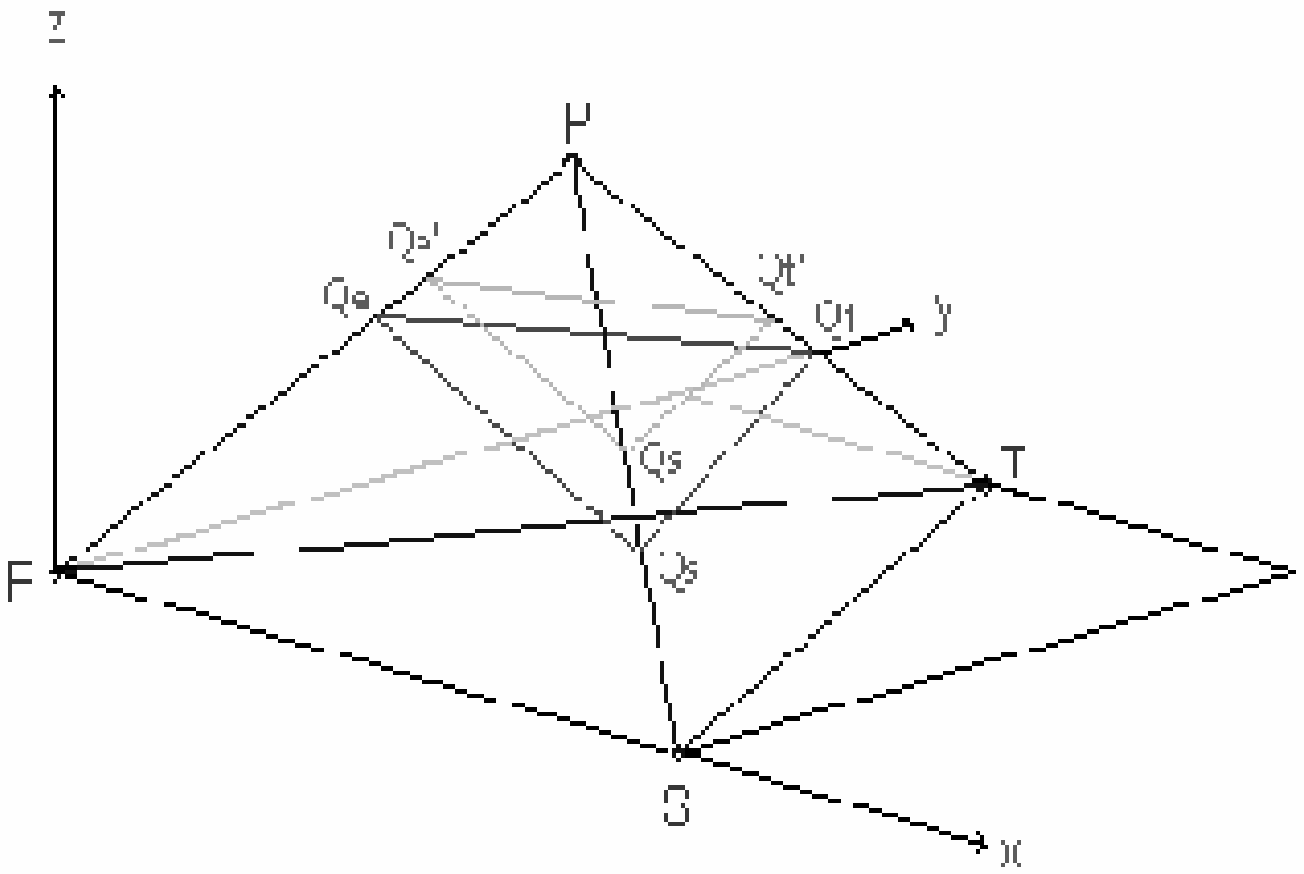
ISO 9126 Rating Levels

(Azuma 2002)

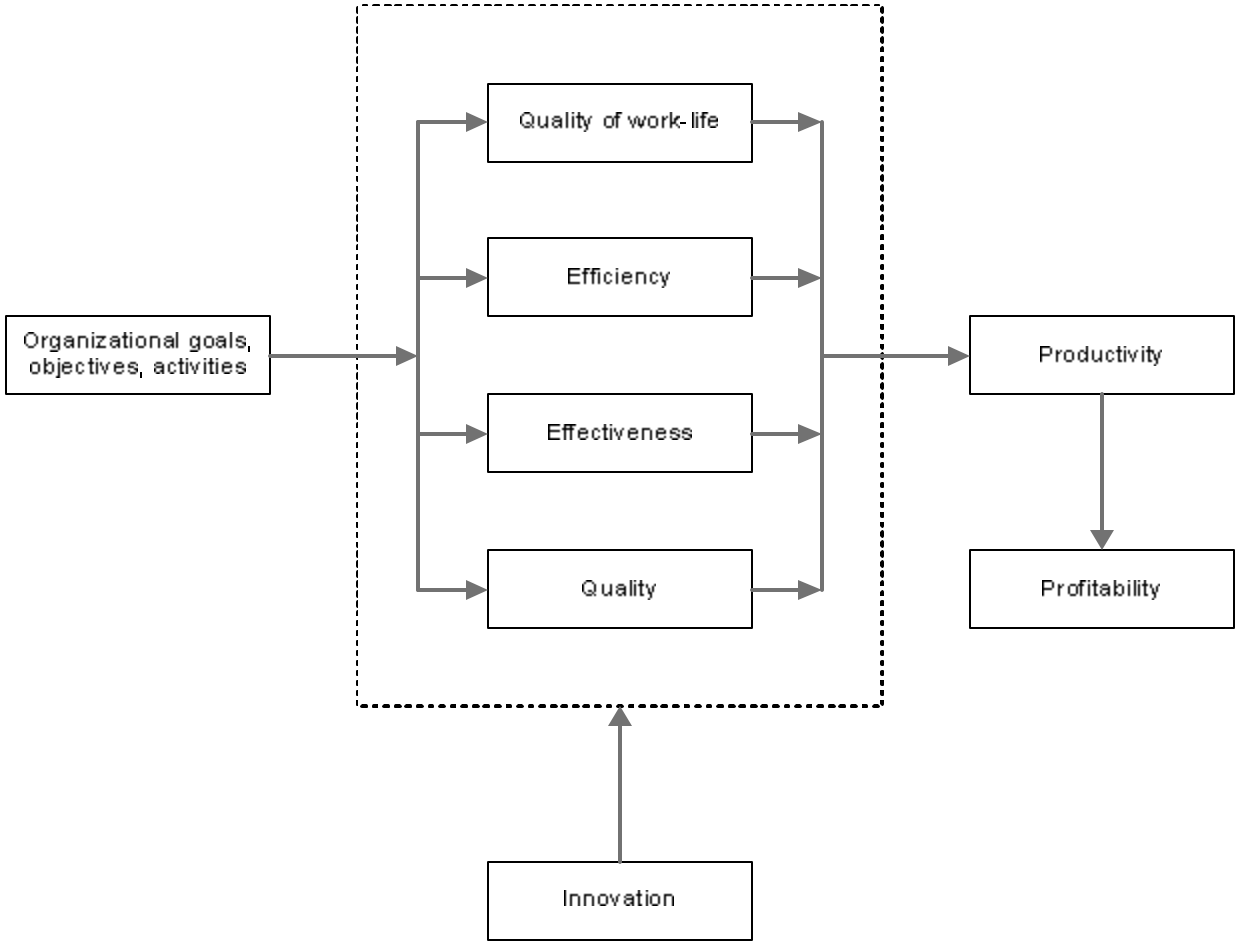
- *To make judgement on how good the attribute is.*
  - *Normalize the measure (assigned value)*



QEST Model

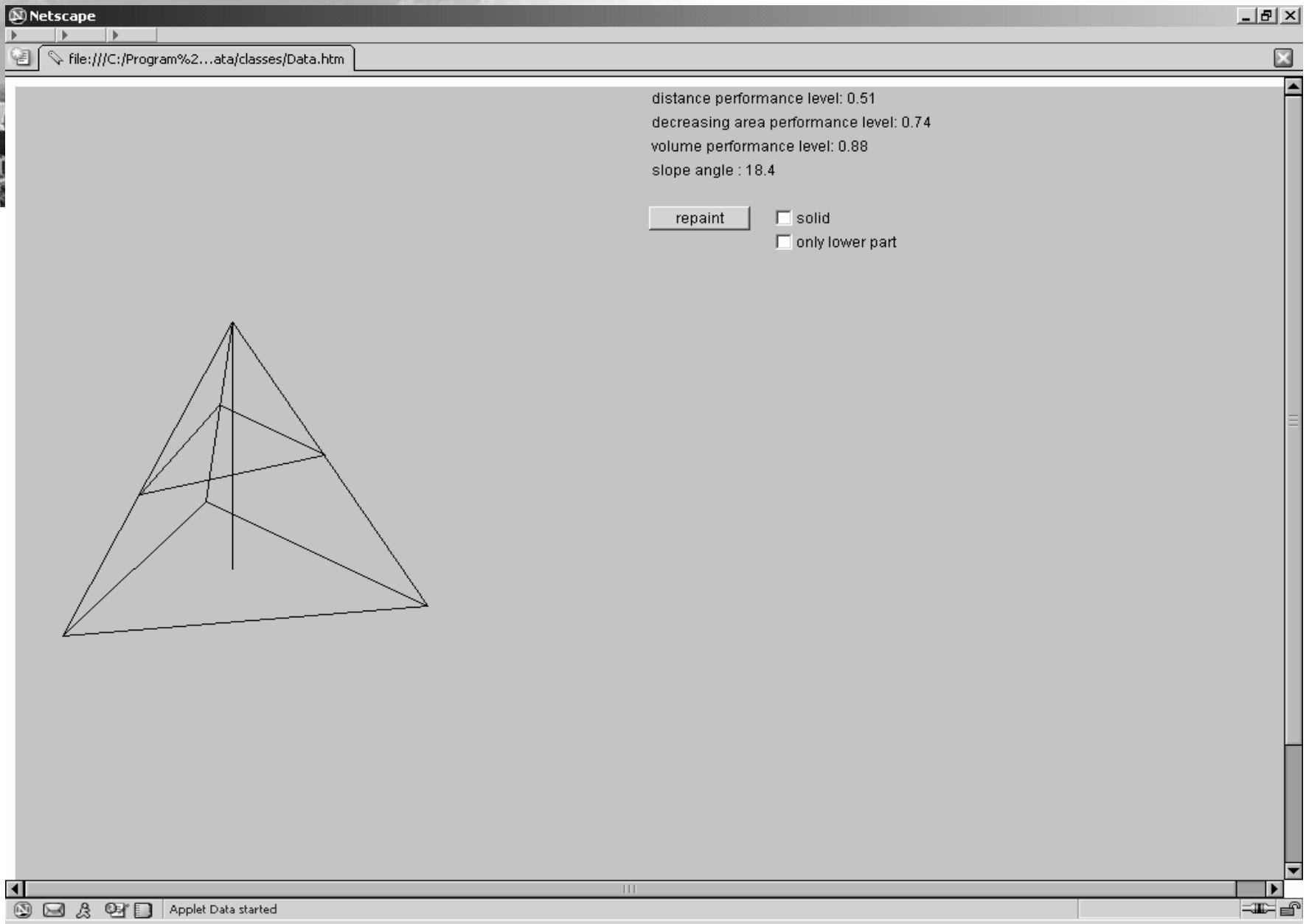


Econometrics Models



Work in progress

- *Development of measurement models adapted to software organizations*
- *Multi-dimensional representation of business views*
- *Analysis of impact of innovations*
- *Building prototypes to integrate contributions of multiple projects*
- *Automation of all steps for a BSc*


Netscape
file:///C:/Program%2...ata/classes/Data.htm
distance performance level: 0.51
decreasing area performance level: 0.74
volume performance level: 0.88
slope angle : 18.4
repaint
solid
only lower part
Applet Data started

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- **Conclusion**

Conclusion

- *Why is BSc not yet wide spread?*
  - *People reluctance?*
  - *Organizational reluctance?*

Conclusion

Research Lab. in Software Engineering

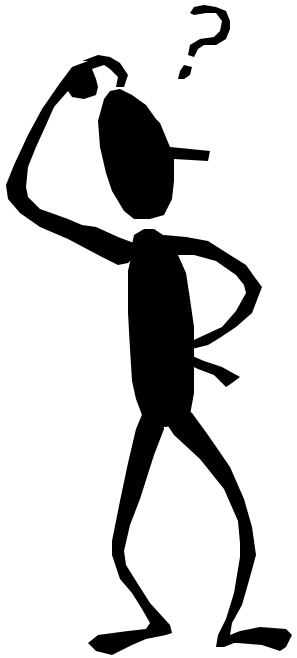
- *Focus:*
  - *Measurement for decision-making*
  - *Measurement as a technology*

- *Approach:*
  - *Which pieces of the measurement technology puzzle are missing?*

Conclusion

- *We are working at what is missing for implementation*
  - *Getting it ready for the practitioners*
    - *Building prototypes (procedures & software tools)*
  - *Improving it before deployment*

Question Time



Thank you for your attention!

Thank You !

aabran@ele.etsmtl.ca