Software Measurement is Maturing to International Standards

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Objectives of the Presentation

- What do we know about measures?
- What do we know about Software Metrics?
- Software engineering and Measurements ?
- Identification of the gaps where further research on software measurement is required

List of topics

- Motivations and Objectives
- Software Metrics
- Models for Designing Measures
- What is Generally Accepted?
- International Standards
- Conclusions and Future Work

Motivations

- Measurement is fundamental in:
  - In day to day life
  - In business
  - In sciences and engineering
- Measurement **instruments** are key to all
- What is the status (*maturity*) of measurement in software?

Why do you measure?

- To understand:
  - To know – to learn
- To plan:
  - To set targets
- To control:
  - To monitor - To compare
  - To make adjustments

Measurements

Everywhere in sciences and engineering

- Where do they come from?
- How do you know that our measures are valid?

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Software Metrics

The dominant view in software measurement =

« **Software Metrics** »

Software Metrics

- Lines of code
- McCabe
- Function Points
- Halstead
- COCOMO
- Software quality metrics: Hundreds +
- Software complexity metrics: Hundreds +
- OO metrics: Hundred ++
- Estimates and Estimations models....

Quality of 'metrics'

- Do you get:
  - Reproducible results?
  - Repeatable results?
  - Accurate results?
  - Results that you can trust?

- Who design these metrics?
  - How qualified are they?
  - Who verifies their metrics proposals?

Software Metrics

How are they designed?

- Anything that can be ‘counted’

⊙ How are they defined:

- Often labels
- An algorithm

⊙ How do we know if they are valid?

- Sometimes claims of validation based on measurement theory
- Sometimes on claims of ‘usefullness’

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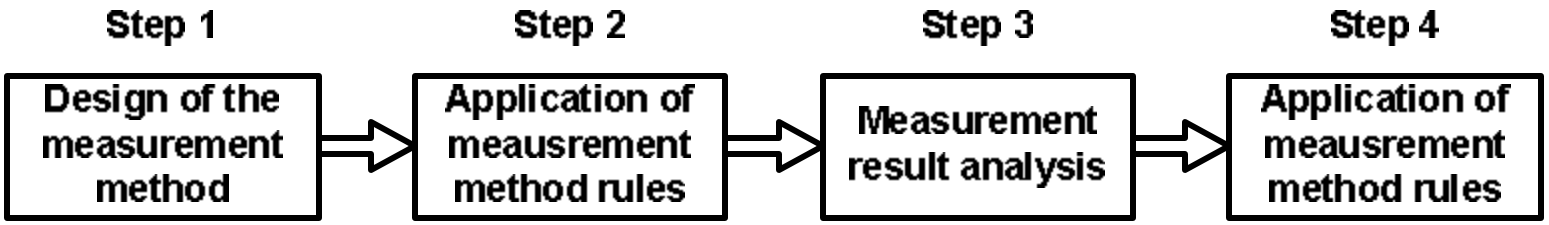
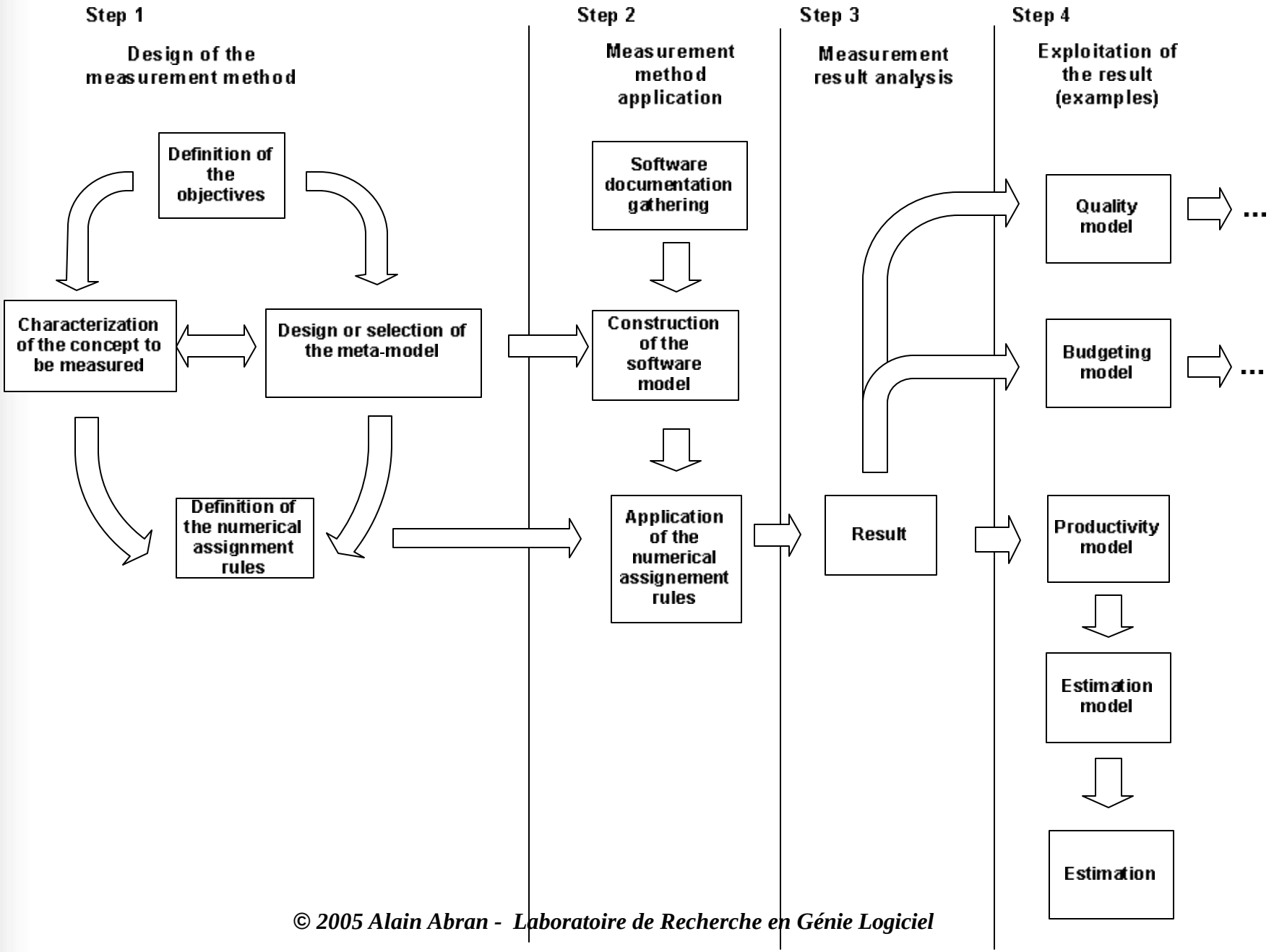
Analytical Tools of Measurement

- **Measurement Process model**
  - **Abran & Jacquet**
- **Metrology:**
  - **ISO International Vocabulary in Metrology**

Measurement Process Model

High-level measurement process model





Metrology

- The long-standing international consensus on measurement terminology
- The basis of the International System (IS) of measurements
- National Metrology Agencies
  - The legal framework for weights and measures in industrialized countries

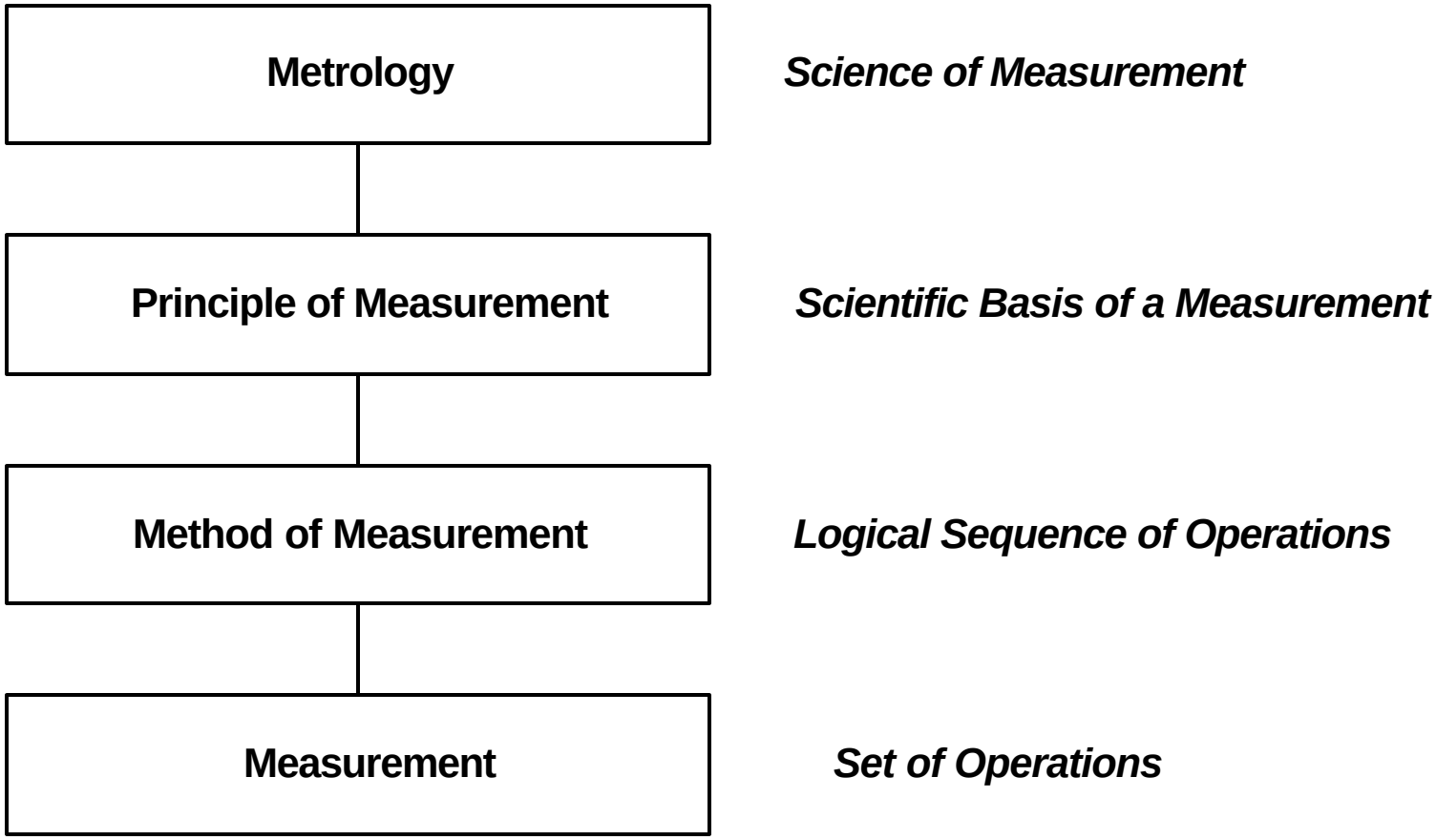
Metrology Vocabulary

- Six categories of terms
  - + 120 terms
    - In increasing order of complexity!

- Most challenging to grasp relationships across terms, understand, and remember!

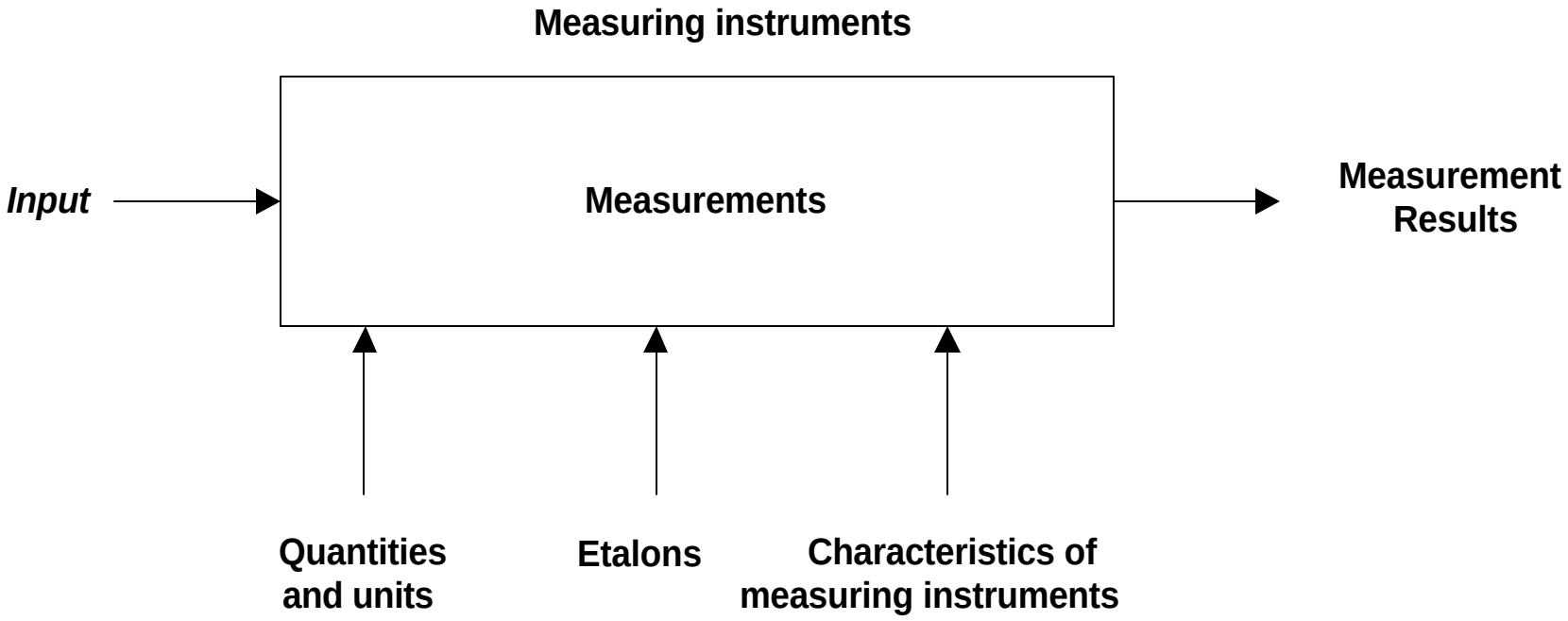
Metrology Model

Measurement foundations



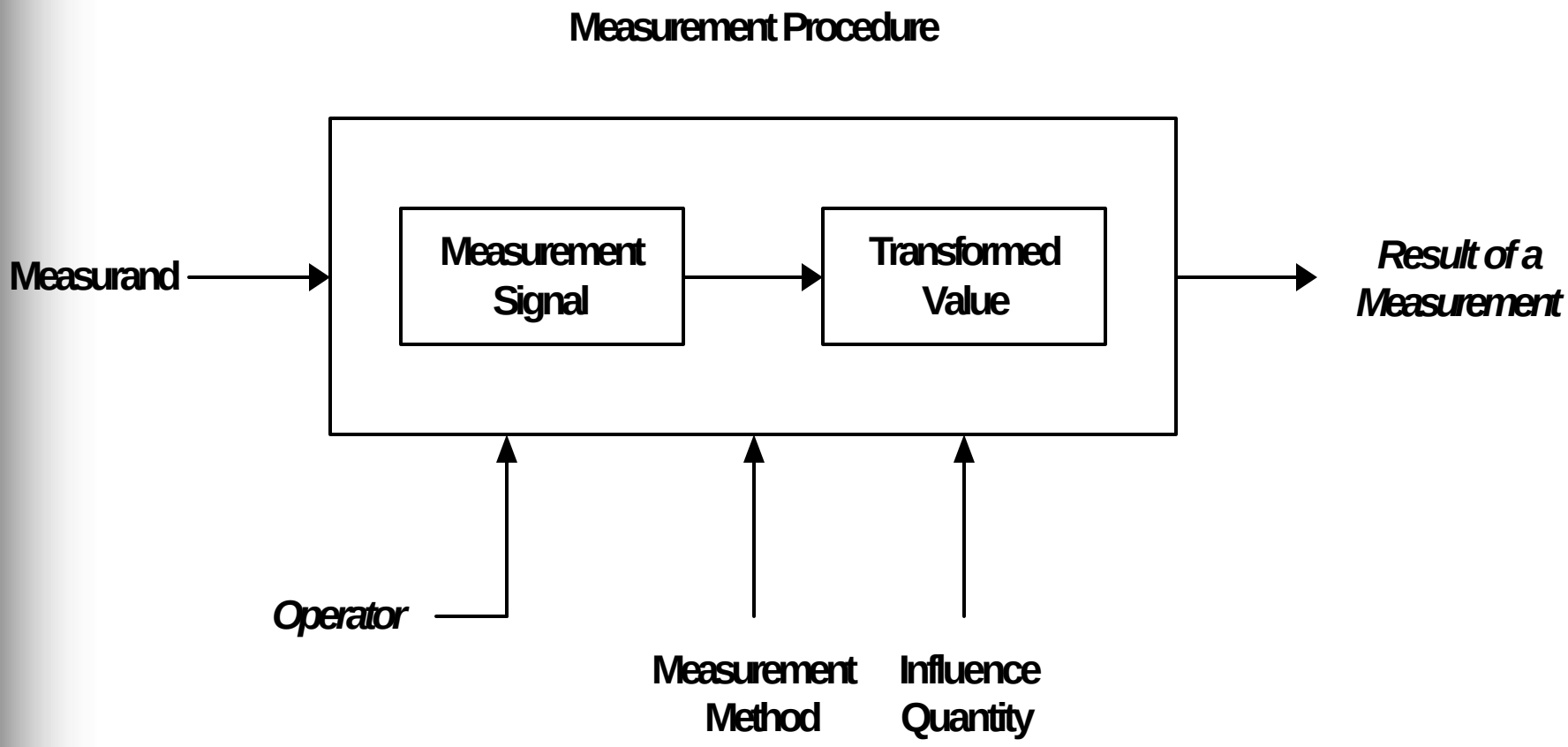
Metrology Model

High-level model of the ISO Vocabulary



Metrology Model

Measurement Procedure



Metrology Model

Measurement results

Types of measurement results	*Modes of verification of measurement results*	Uncertainty of measurement
Indication (of a measuring instrument) Uncorrected result Corrected result	Accuracy of measurement Repeatability (of results of measurements) Reproducibility (of results of measurements)	Experimental standard deviation Error (of measurement) Deviation Relative error Random error Systematic error Correction Correction factor

Mapping between models

Alignment of metrology concepts with the measurement process model

Measurement process model	Design of measurement methods	Application of measurement method rules	Measurement results analysis	Exploitation of measurement results
ISO metrology model	Quantities and units	Measuring instruments Characteristics of measuring instruments	Measurement results	

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SWEBOK

- Generally Accepted:
  - What applies most of the time, to most projects, and which value has been validated by the community of peers
    - Project Management Institute
- Software Engineering Body of Knowledge - SWEBOK

Measurement within SWEBOK

SWEBOK KA	Topics	Step 1 Design	Step 2 Measuring	Step 3 Results	Step 4 Uses
Software engineering requirements	Process support and management				×
	Requirements negotiation				×
	Document quality				×
	Acceptance tests				×
	Requirements tracing				×
Software engineering design	Measures			×	
Software engineering testing	Evaluation of the program under test				×
	Evaluation of the tests performed				×
Software engineering maintenance	Software Maintenance Measurement				×

Measurement within SWEBOK

SWEBOK KA	Topics	Step 1	Step 2	Step 3	Step 4
Software configuration management	Surveillance of software configuration management				×
Software engineering management	Goals				×
	Measurement selection				×
	Measuring software and its development				×
	Collection of data		×		
	Software Measurement Models			×	
Software engineering process	Methodology in process measurement		×		
	Process Measurement Paradigms				×

Measurement within SWEBOK

SWEBOK KA	Topics	Step 1	Step 2	Step 3	Step 4
Software engineering quality	Measuring the value of quality				×
	Fundamentals of Measurement	×			
	Measures			×	
	Measurement analysis techniques				×
	Defect characterization				×
	Additional Uses of SQA and V&V data				×

Generally accepted knolwedge about software measurement?

Strong recognition of benefits:

⊙ to understand, plan, monitor and control

⊙ Foundations = ??

⊙ And little metrology strengths

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- What is Generally Accepted?
- **International Standards in Software Measurement**
- Conclusions and Future Work

International Standards

Currently, only for:

- Software Products Quality
- Software Functional Size

How to Measure Software Quality?

ISO 9126 on Software **Products** Quality

- Part 1: Quality Models and Definitions

- Parts 2 to 4: **Technical Reports**

- Over + 120 Metrics !
- with little about:
  - measurement method for each (labels & algorithms)
  - Validity & Quality of these ‘metrics’ ??

  - Then (if used in a non consistent manner), how do figure out how measurement results compare across contexts, across time, and across measurers?

Software Functional Size

How do you measure software size?

- The technical size = ?
- The functional size = ?

Functional Size

A unique set of measures in software engineering:

- Designed in the late 1970's:
  - By Albrecht, from IBM, using 24 MIS projects
- Published in the early 1980's
- User group in the mid 1980's
  - Measurement Manual
  - Training & Certification

Functional Size

Does it withstand the test of time?

- Still in use and referenced

But

- The basic method has not evolved significantly since the early 90's
- Software has changed considerably
- Oustide of MIS domain = ?
- In the early 90's: + 30 variations to tackle weaknesses

Functional Size

Innovation in software measurement:
Standardization through ISO

First a meta-standard to layout the ground rules about functional size measurement: ISO 14143

- Part 1 = Definitions of Key Concepts
- Part 2 = Conformity Assessment
- Part 3 = Verification Guide
- Part 4 = Set of References
- Part 5 = Functional Domains

Functional Size

Four specific methods approved by ISO

- ISO 19761: COSMIC-FFP
- ISO 20926: IFPUG
- ISO 20968: MKII
- ISO 24570: NESMA

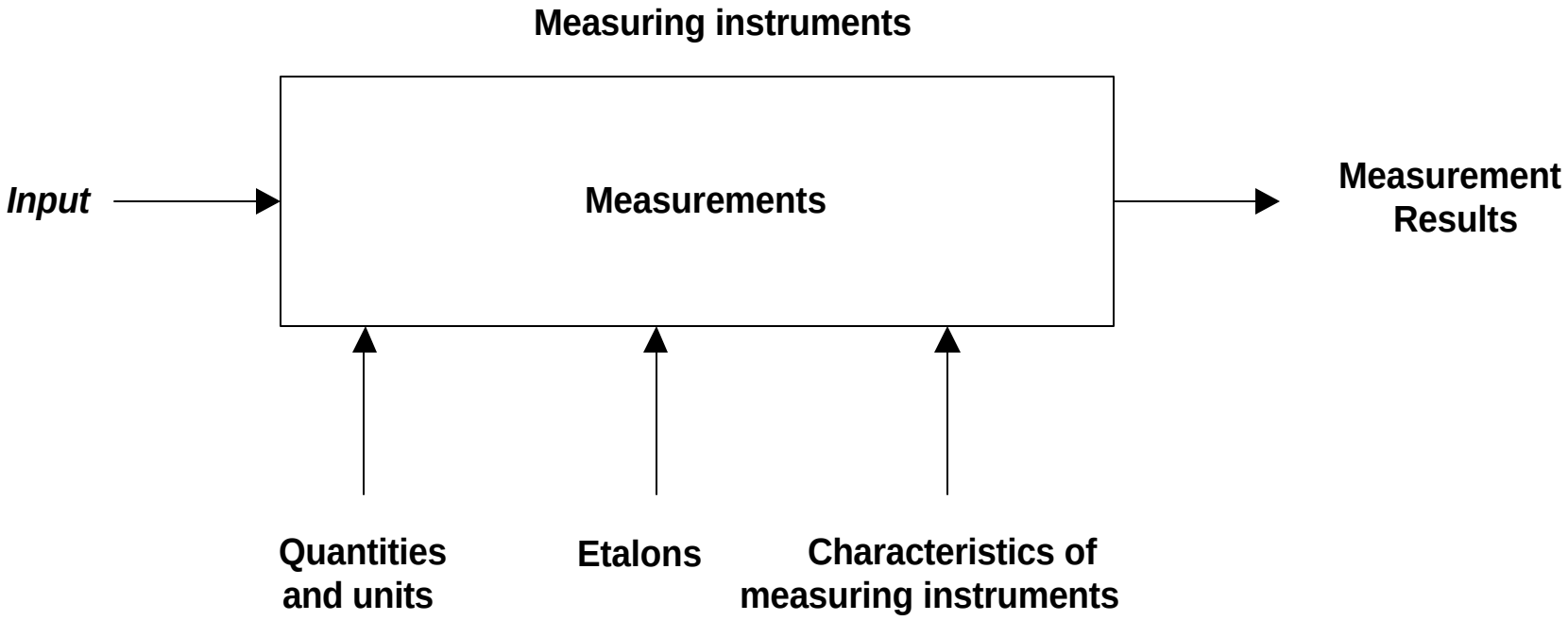
Will they withstand the test of time as measurement methods?

Will a consensus emerge?

Do they meet ‘metrologoy’ criteria?

Metrology Model

High-level model of the ISO Vocabulary



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Summary & Conclusion

Generally accepted knowledge about Measurement in software:

- **Extensive set of references on the use of measurement results in assessment and predictive models.**
- **Little discussion on:**
  - **Quality of measurement results**
  - **Quality of measuring instruments**
- **Limited knowledge on the design of measurement methods**

Conclusions - Next

- Where is the field of « software metrics » going after 30 years of research?
  - Why not learn from the masters in measurement?
- Most majors R & D contributions still waiting for you!
- Standardization is critical for measurement!

Conclusions

Metrics or Measures ?

- Which one would you trust better?

Questions

?