

Software Measurement & Lessons from the Masters: Benefits for Industry

Alain Abran

École de Technologie Supérieure – Université du Québec
alain.abran@etsmtl.ca



Egyptian Pyramids

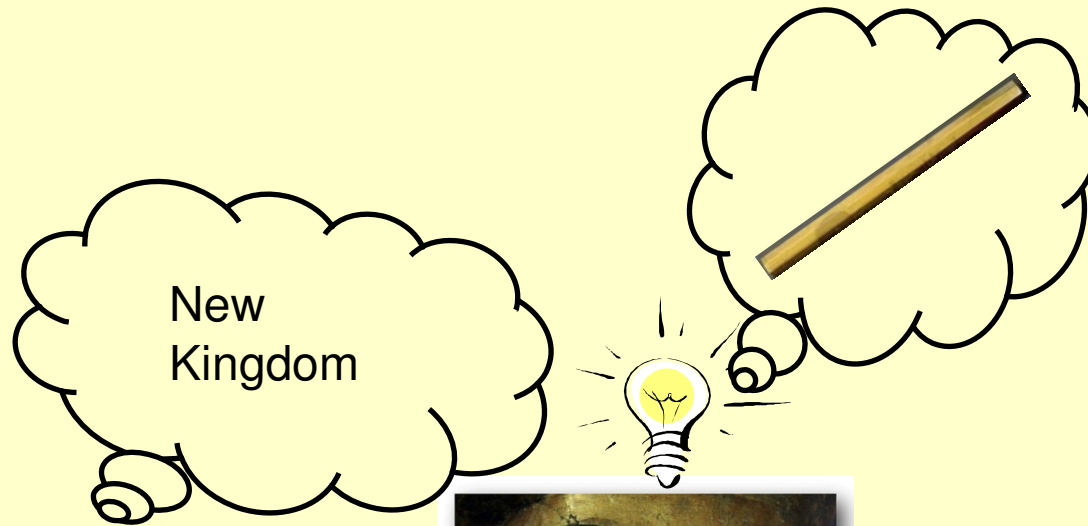




Turin Egyptian Museum

Egyptian Measurement & Tools

New Kingdom Dynasty
XVIII-XX (1550-1070 B.C.)



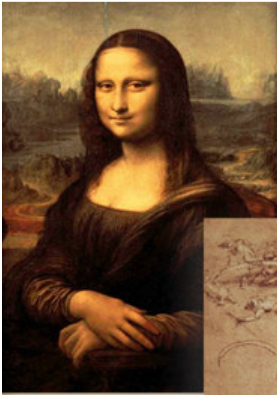
Amenhotec II



Architect Kha



Kha Measurement Tools



Golden étalon

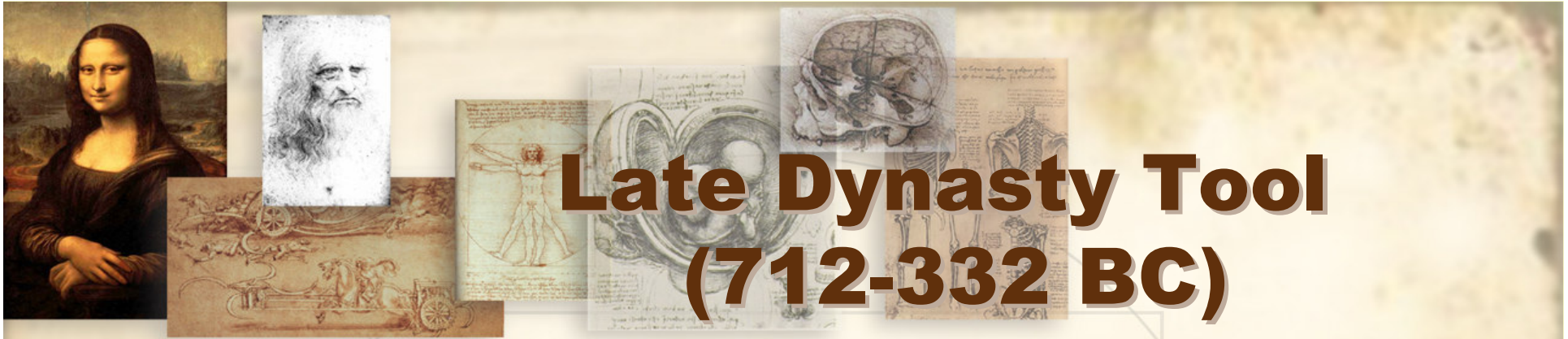


Folding étalon



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Late Dynasty Tool (712-332 BC)

Bronze



Green limestone



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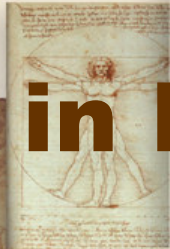
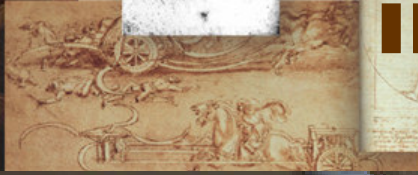
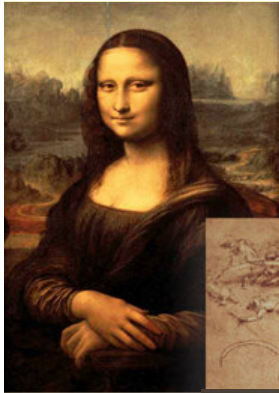
Measurement of Time

Evolution of Time Perceptions,
&
Measurement Concepts &
Tools

Astronomical Calendars



Time Museum in Besancon (France)



The communal local time



Sun shadow



The house sun dial

Time measurement: The “horloge”

Communal Time – XVII Century



Personal time – XVIII century

Personal clock - Minituarization



Mechanical



Quartz



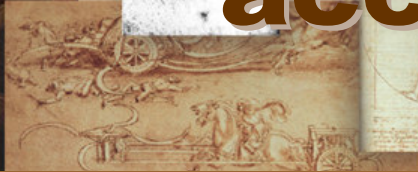
Atomic



Geneva Science Museum



Lack of universally accepted references & Impact



[55]

CONVERSIONS

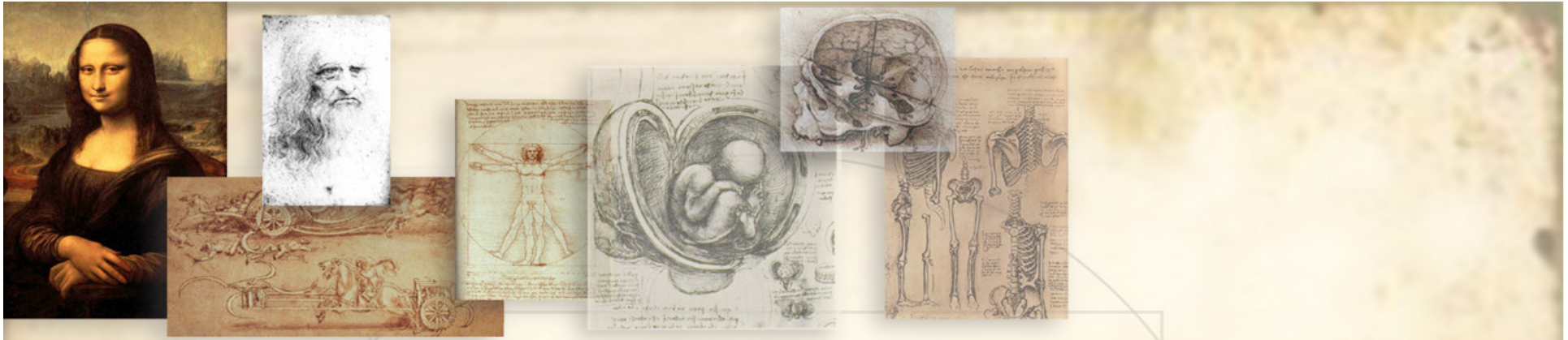
Des Mesures longues anciennes en MÈTRES.

PIEDS.	MÈTRES.	
	Mètres.	Millimètres.
1,000 pieds de roi, sous les départemens,	324'839	
1,000 pieds de Bouenville, Léman	340'110	
1,000 pieds anciens de Bourgogne, Jura,	331'000	
1,000 pieds de chambre, Léman et Mont-Blanc,	340'110	
1,000 pieds dits le comte, Jura,	358'	
1,000 pieds lipraus, Mont-Blanc et Piémont,	514'100	
1,000 pieds de Lyon dits de ville, Rhône,	341'400	
1,000 pieds de Ville-franche, Rhône,	324'839	
PIEDS ÉTRANGERS.		
1,000 pieds d'Amsterdam,	283'	
1,000 pieds anglais,	304'700	
1,000 pieds de Berlin,	309'227	
1,000 pieds de Bernz, Helvétie,	293'257	
1,000 pieds chinois pour l'arpentage,	320'	
1,000 pieds du Rhin,	313'500	
1,000 pieds de Russie,	354'100	
1,000 pieds de Suède,	297'100	
1,000 pieds de Vienne, Autriche,	316'	
1,000 pieds de Zurich, Helvétie,	300'025	

D 4

Tableau de conversion de pieds en mètres

Paris, Instruction sur le système de mesures et poids uniformes pour toute la République Française, l'an 1801.
Bibliothèque de l'Institut National de France.

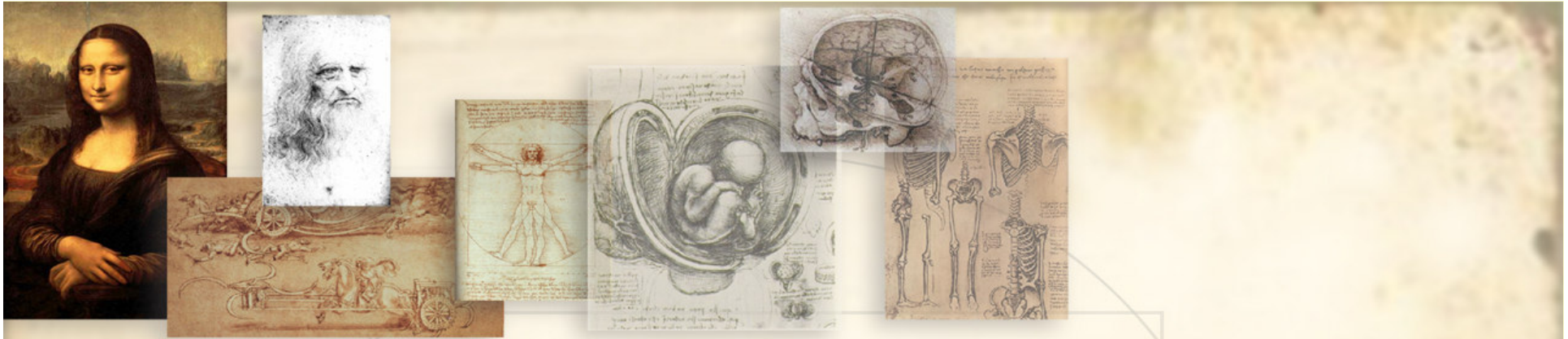


Masters from the Past

Reference:

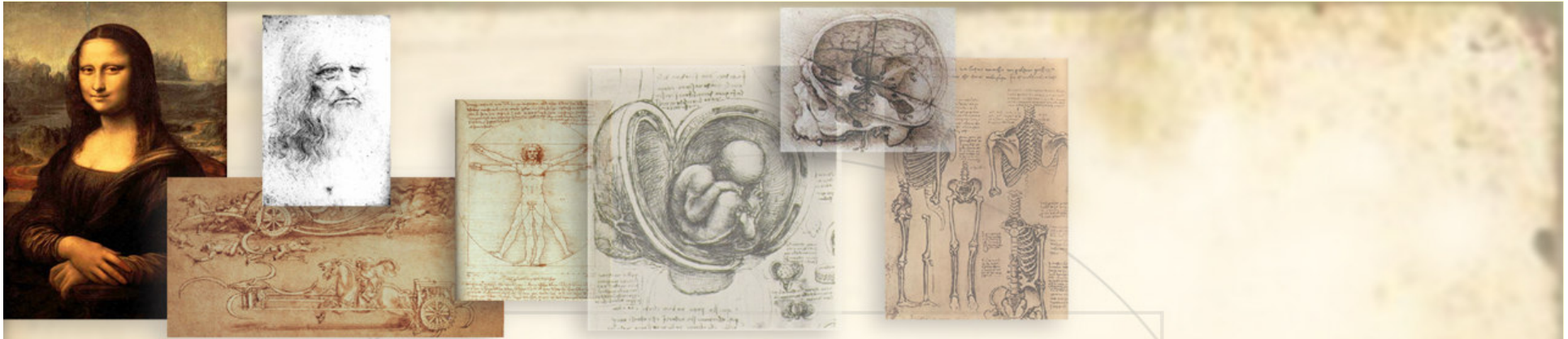
‘Du pied au metre, du marc au kilo – L’histoire des unites des poids et mesures evoquee par quelques objets emblématiques des collections du Musee d’histoire des sciences’.

Musée des sciences de Genève –



Current Masters

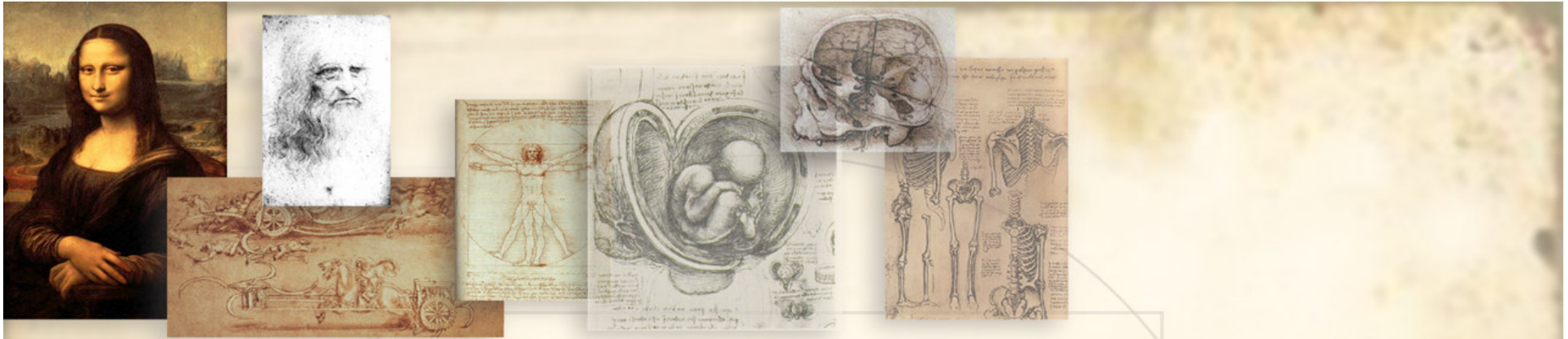
- Front page of the ISO VIM document
- – picture



Current Masters

Joint Committee for the Guide in Metrology:

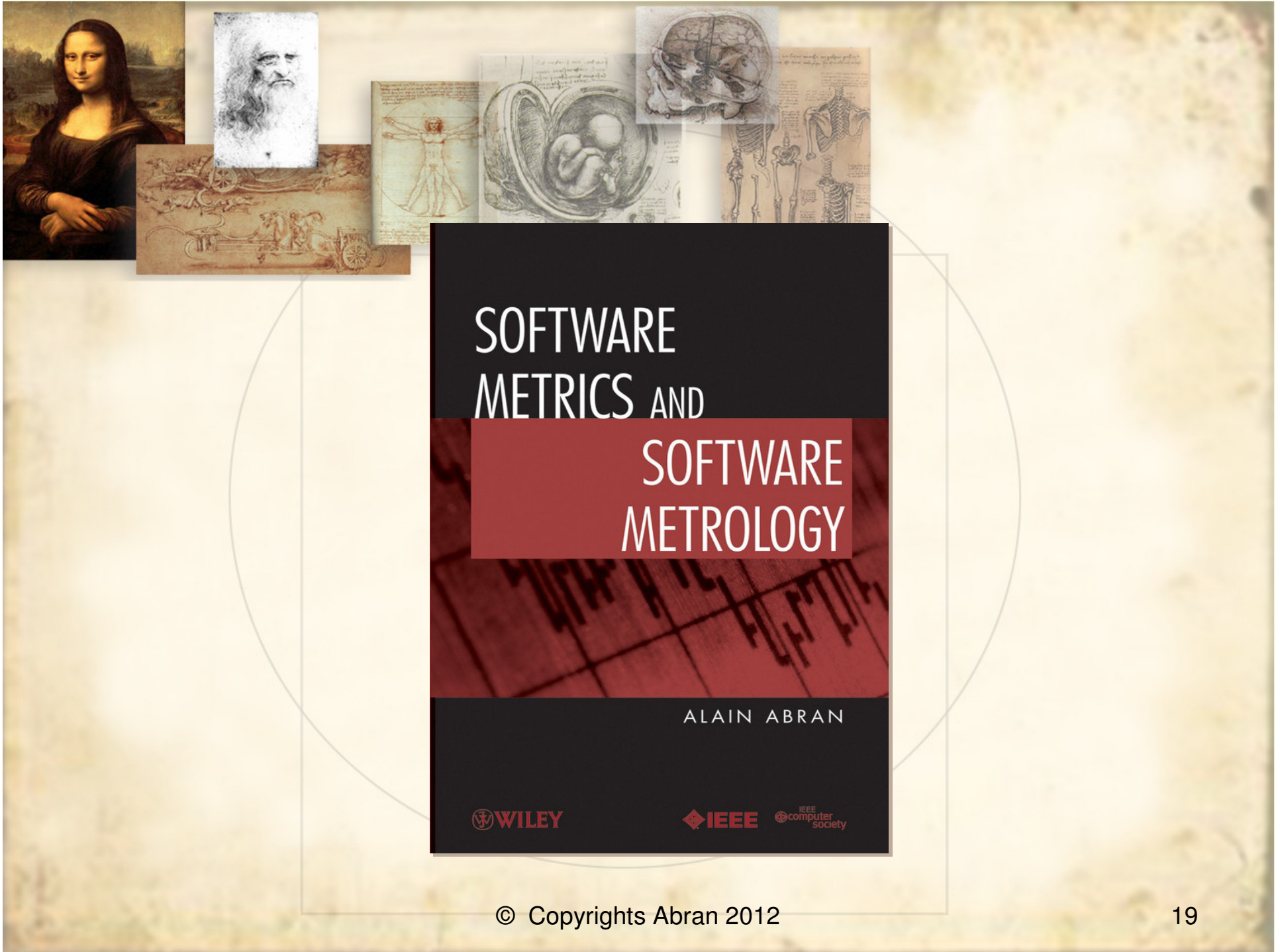
- International Bureau of Weights and Measures,
- International Electrotechnical Commission,
- International Federation of Clinical Chemistry & Laboratory Medicine,
- International Organization for Standardization (ISO),
- International Union of Pure & Applied Chemistry,
- International Union of Pure & Applied Physics,
- International Organization of Legal Metrology,
- International Laboratory Accreditation Cooperation.



Current Masters

Guidelines for setting up structures in metrology & proposed articles for the law:

- 3.1 Definitions
- 3.2. National metrology
- 3.3 Traceability and uncertainties
- 3.4 Legal units of measurement
- 3.5 Transparency of metrological information.
- 3.6 Legal metrology
- 3.7 Application of the Law
- 3.8 Offences
- 3.9 Responsibilities and duties
- 3.10 Conformity assessment procedures



SOFTWARE
METRICS AND
SOFTWARE
METROLOGY

ALAIN ABRAN

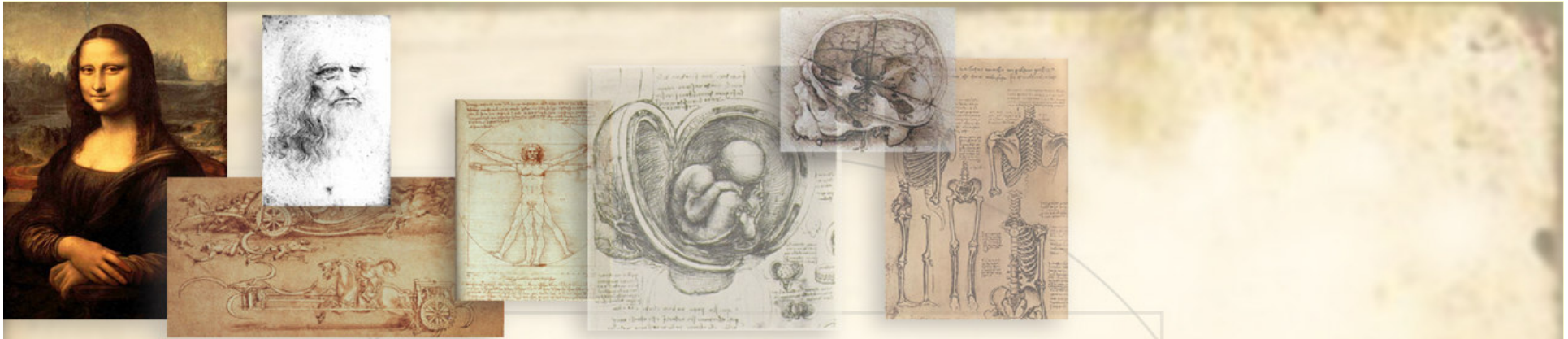
 WILEY

 IEEE 

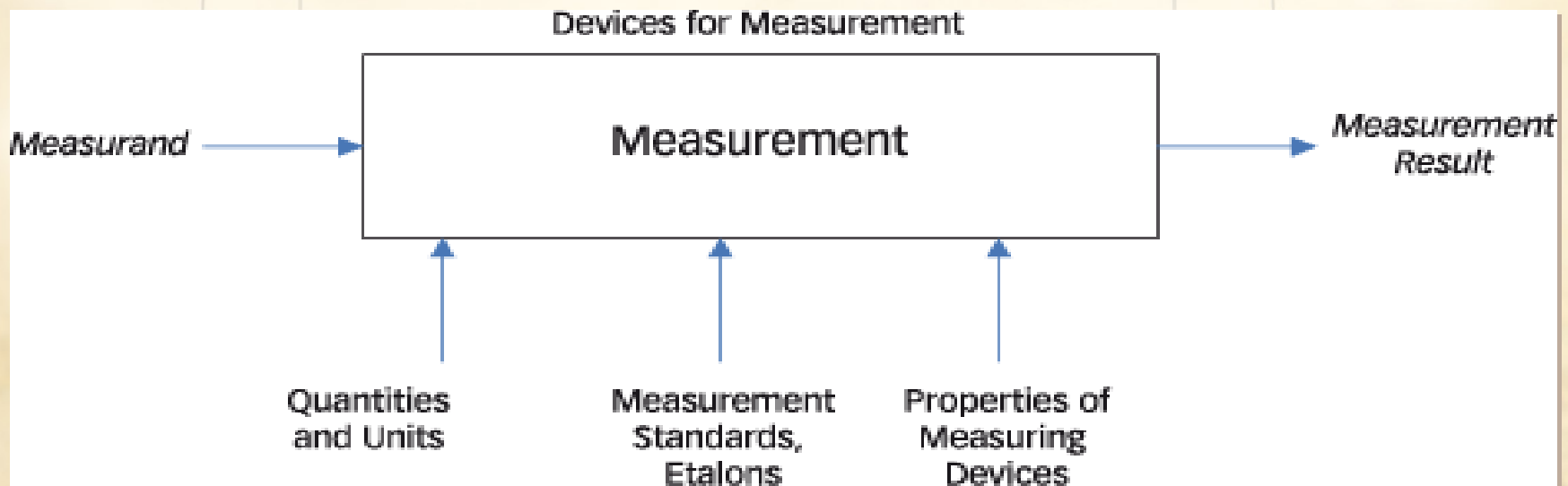


Key Lessons from the Masters

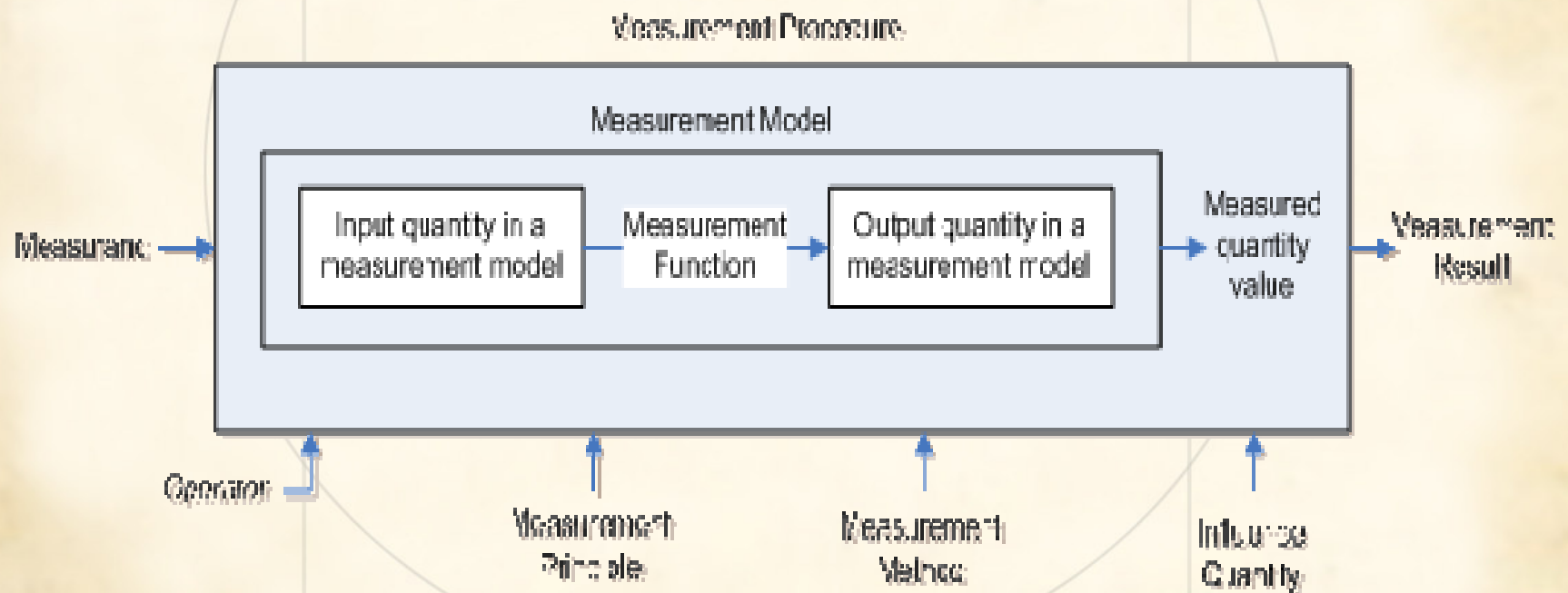
1. Evolutionary societal understanding of measurement concepts
 - Perfection is not expected first: the search for precision – when necessary only!
2. Development of Measuring Instruments
3. Establishment of measurement 'etalons'
4. Specialized measurement training & certification:
 - Land surveyors
 - Accountants,
 - Engineers, etc.



Measurement in Metrology



Measurement in Metrology

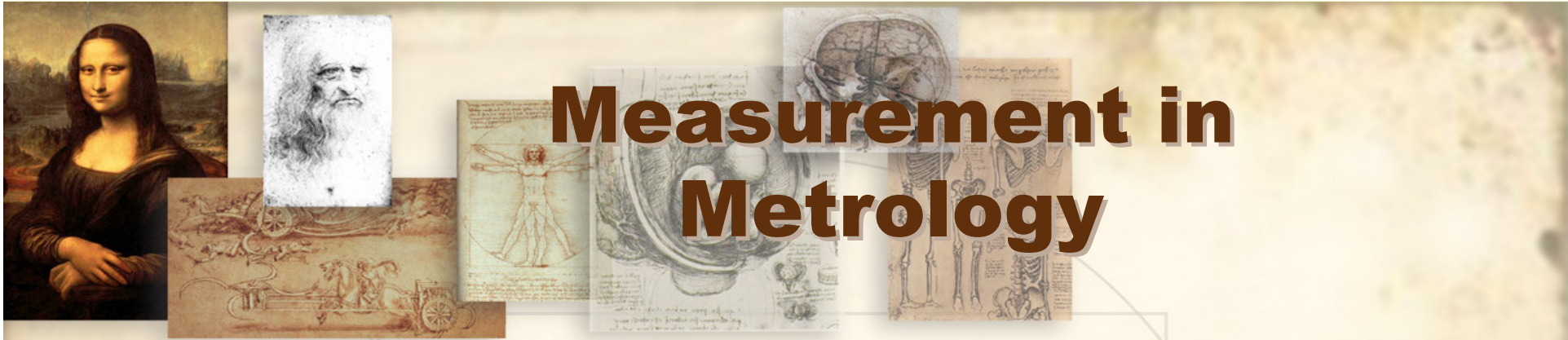




Measurement in Metrology

Table 3: Description of the measurement elements

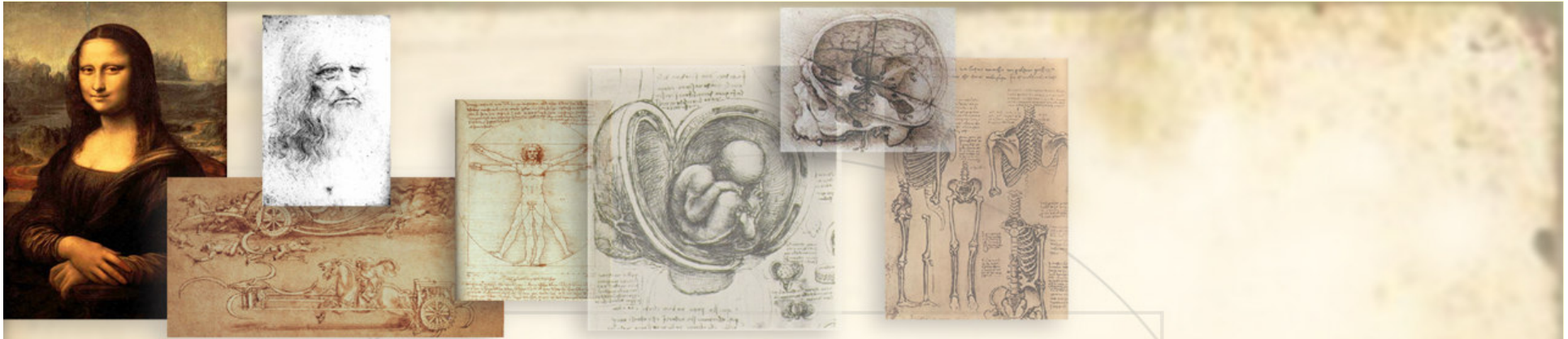
Measurement				
Measurement result	Measurement procedure	Measuring device	<i>Measurement conditions</i>	Measurement error
Measured quantity value	Reference measurement procedure	Measuring system	Repeatability condition of measurement	Systematic measurement error
True quantity value	Primary reference measurement procedure		Intermediate precision condition of measurement	Measurement bias
Conventional quantity value			Reproducibility condition of measurement	Random measurement error



Measurement in Metrology

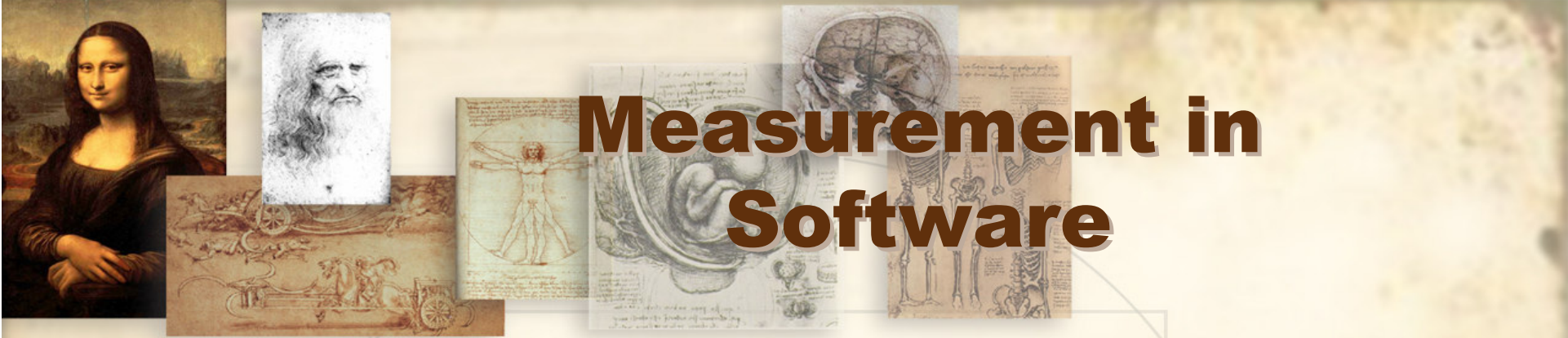
Table 6: Detailed quality criteria for a measurement result

Measurement Precision	Measurement Uncertainty	Calibration	Metrological traceability
Measurement accuracy Measurement trueness Measurement repeatability Intermediate measurement precision Measurement Reproducibility	Definitional uncertainty Type A evaluation of measurement uncertainty Type B evaluation of measurement uncertainty Standard measurement uncertainty Combined standard measurement uncertainty Relative standard measurement uncertainty Uncertainty budget Target measurement uncertainty Expanded measurement uncertainty Coverage interval Coverage probability Coverage factor	Calibration hierarchy Verification Validation Correction	Metrological traceability chain Metrological traceability to a measurement unit Metrological comparability of measurement results Metrological compatibility of measurement results



Measurement in Software

- The academic view & achievements
- The software industry needs & track record



Measurement in Software

Enduring Software Measurement Myths:

- Software is different:
 - It is an intellectual product & it is not material
- Software metrics = an algorithm
 - Foundation = measurement theory! (limited to maths)
- Innovation in metrics = again, another proposal

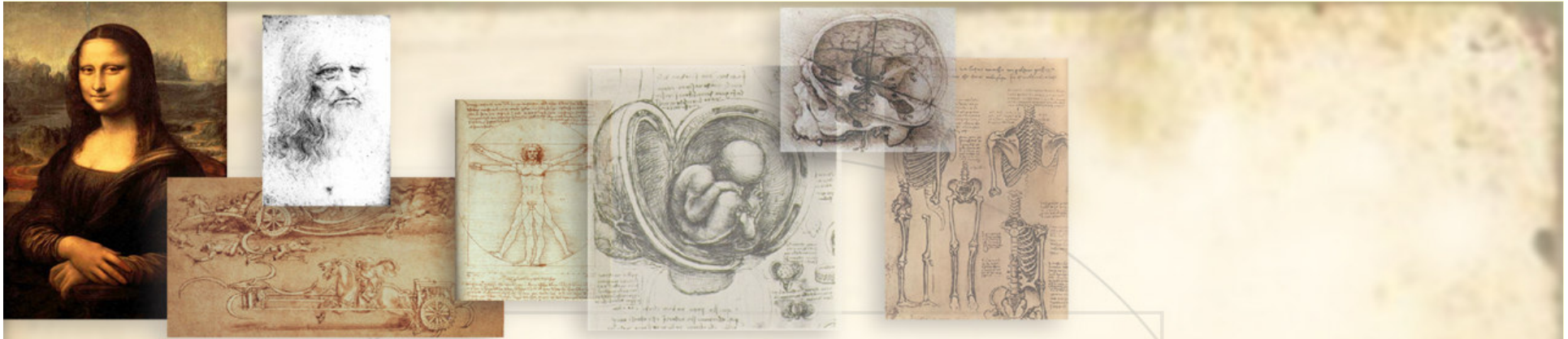
Impact - Examples:

- In the 1990s: already +100 proposals on software complexity
- The vast majority of software metrics from academia not used in industry.....



Measurement in Software

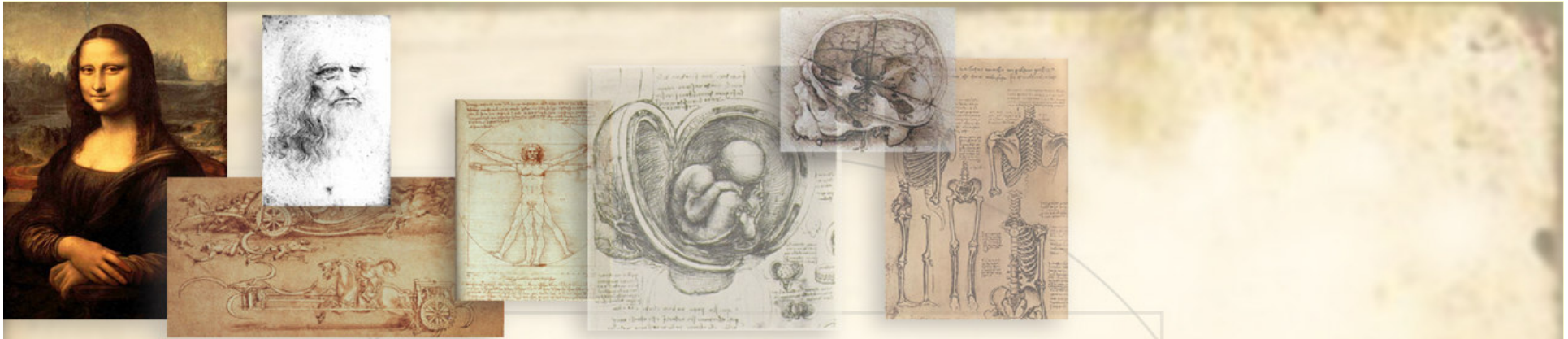
- A typical new software metrics:
 - A modified algorithm
 - Additions of conditions to the algorithms
 - Automatically extracted-calculated from code-files
- Typical empirical analyses:
 - No hypothesis to be tested!
 - As many metrics as can be extracted **automatically**
 -



Software Industry & Measurement

Which 'software metrics' have reached **some maturity** with respect to industry needs?

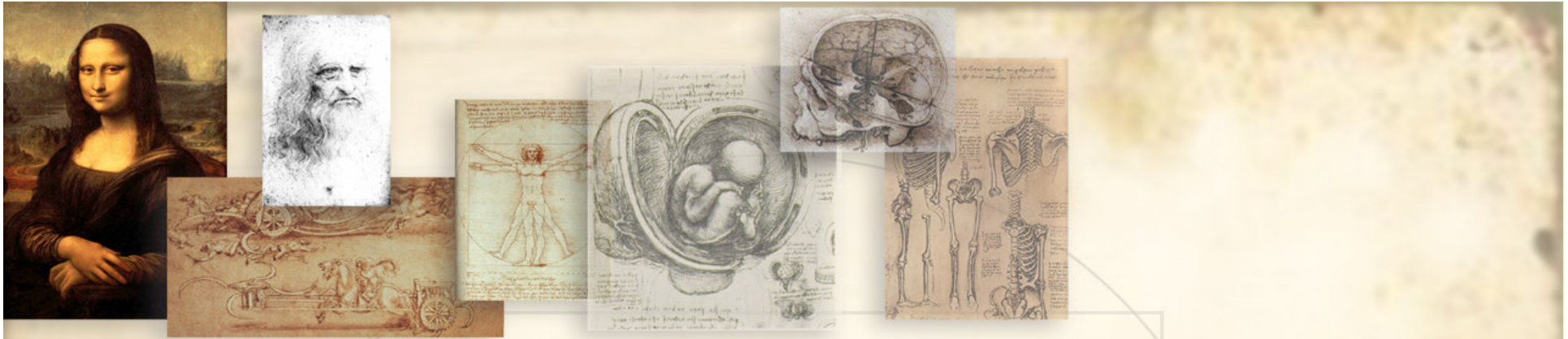
- How do you recognize maturity in measurement?



Software Measurement

Measurement Maturity = Standardization

- Which 'software metrics' are recognized as ISO standards?
- 'Quality Metrics': ?????
-

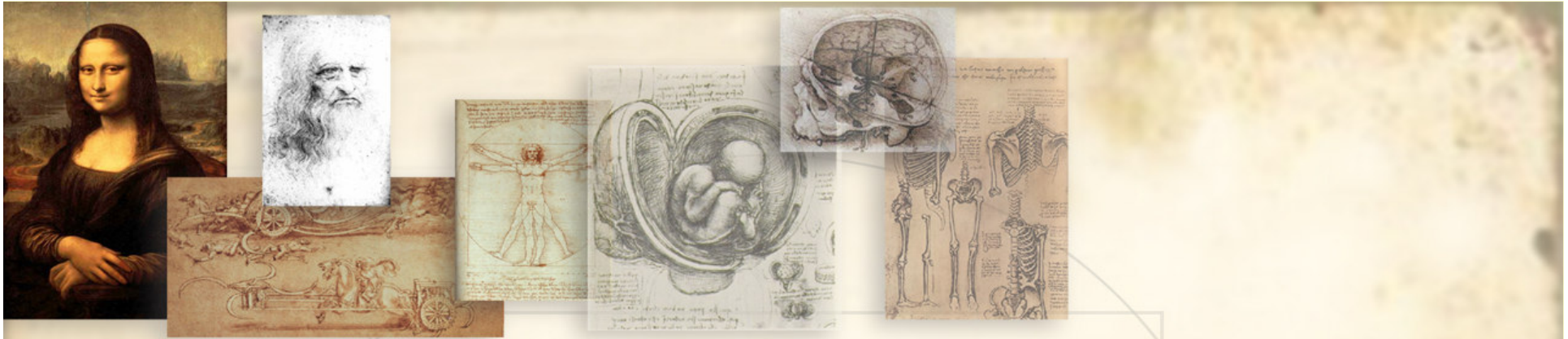


Software Measurement

What is common in their design process?

- ISO 20926 : IFPUG (1979)
- ISO 24570 : NESMA (1985)
- ISO 20968 : MRKII (1988)
- ISO 29881 : FISMA (198?)
- ISO 19761 : COSMIC (1999)

- ISO14143 Parts 1 to 6



Software Measurement

ISO 14143 meta-standard on Functional Size Measurement:

Part 1: Definitions & Concepts

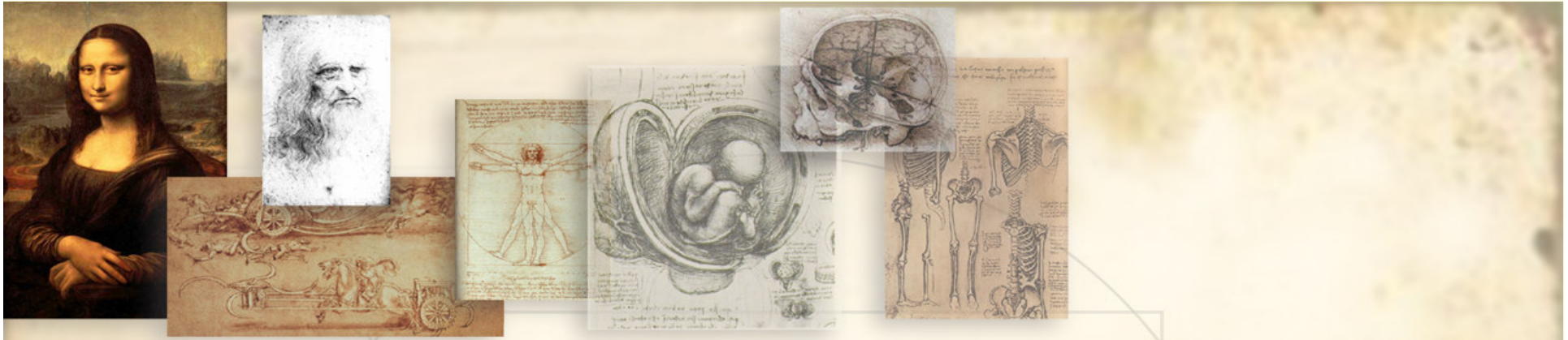
Part 2: Conformity Evaluation of FSM methods

Part 3: Verification Guide of FSM methods

Part 4: Reference Model (but only samples of FUR!)

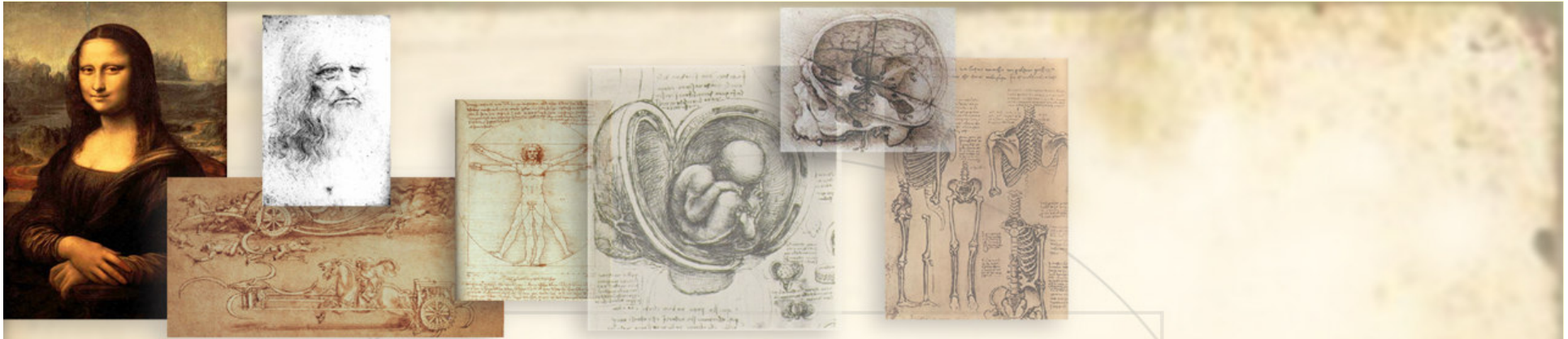
Part 5: Determination of Functional Domains for of FSM methods

Part 6: Guide for the use of ISO 14143!



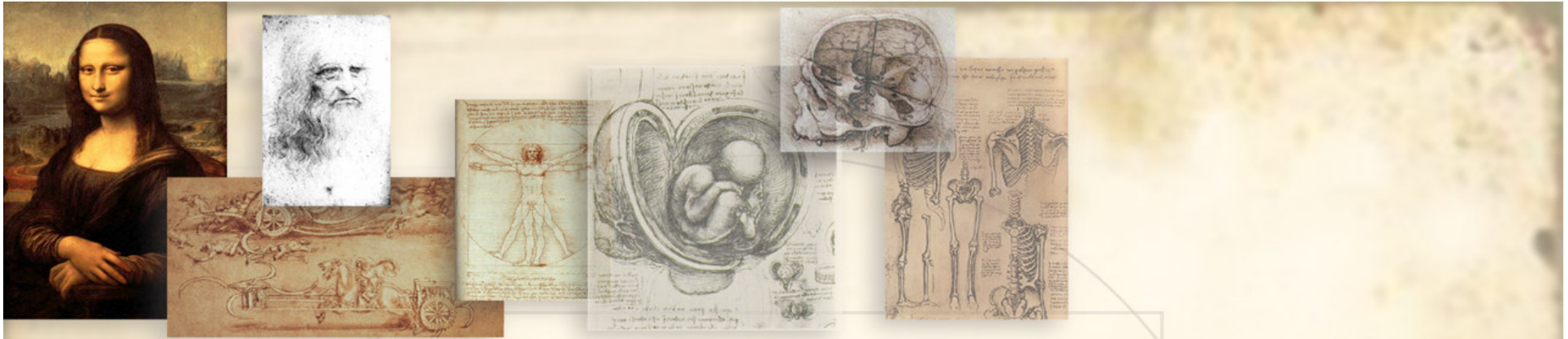
Software Measurement & Industry

- For industry, measurement has little to do with maths!
- Measurement is not maths, but a technology with considerable **consensual knowledge on the concepts to be measured**, credible references for measurement, & expected measurement errors



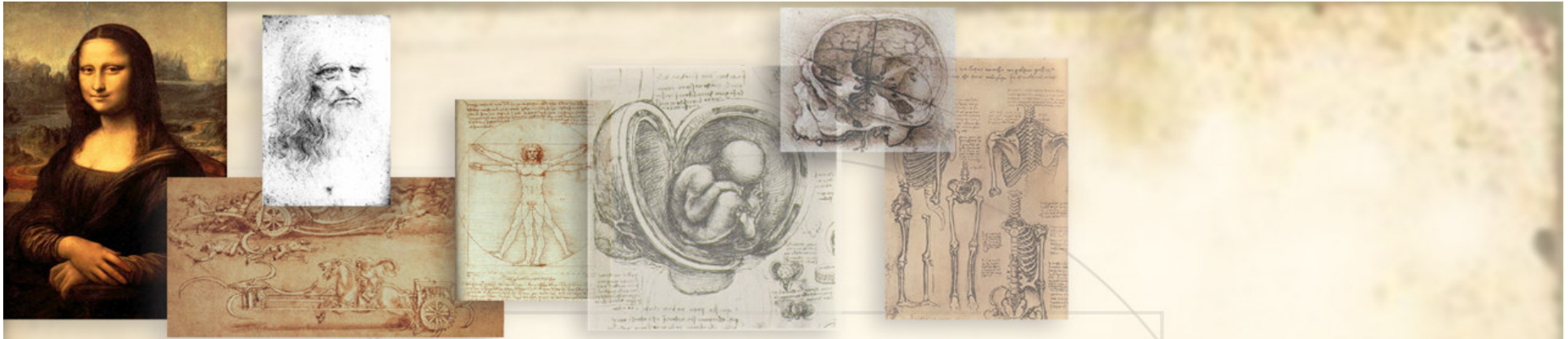
Measurement is a Technology

- Technology is defined as:
 - the set of methods & materials used to achieve industrial or commercial objectives.
- Not limited to materials alone:
 - It also includes processes and the knowledge related to them, referred to as “know-how”.



Measurement as a Technology

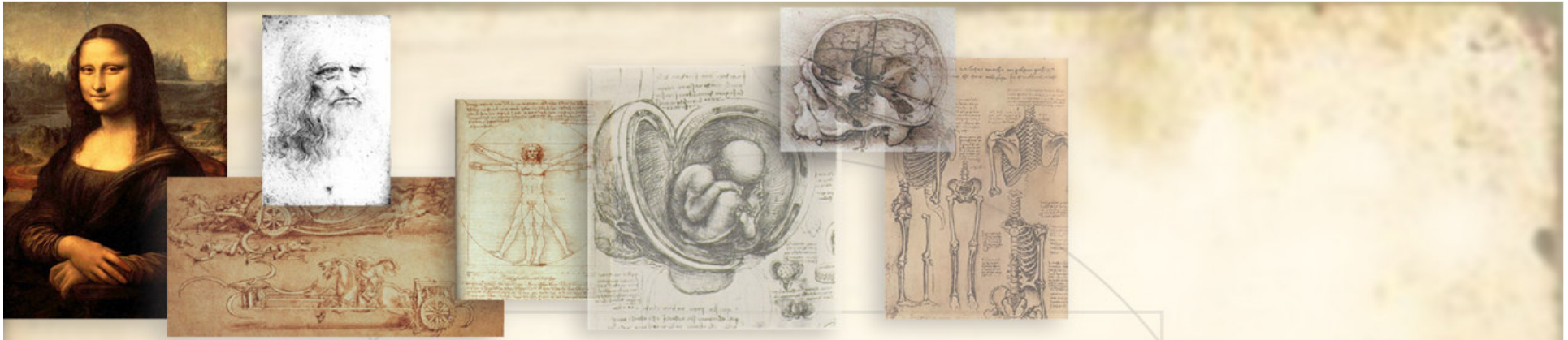
- What does it take for software measurement to be adopted as a new technology?
 - Software measurement must already have been proven to work well in a large variety of contexts:
 - i.e. it must be mature as a technology, or maturing rapidly).
 - Software measurement must become integrated into the technological environment of the software industry.
 - It must become integrated into the business context (which includes its legal and regulatory aspects).



Measurement as a Technology

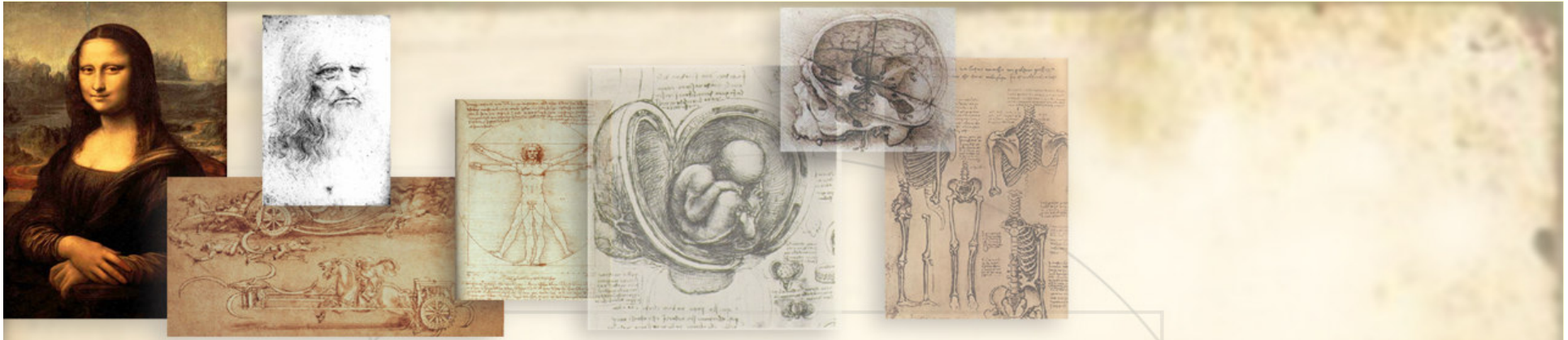
What does it take for software measurement to be adopted as a new technology?

- On the part of a software organization:
 - Software measurement must promise enough benefits to overcome the pain of changing to an initially unknown technology.
 - The organization must have the technological know-how in software measurement to make it work.
 - The organization must be clever enough, and enthusiastic enough, to harvest the benefits, which takes time.



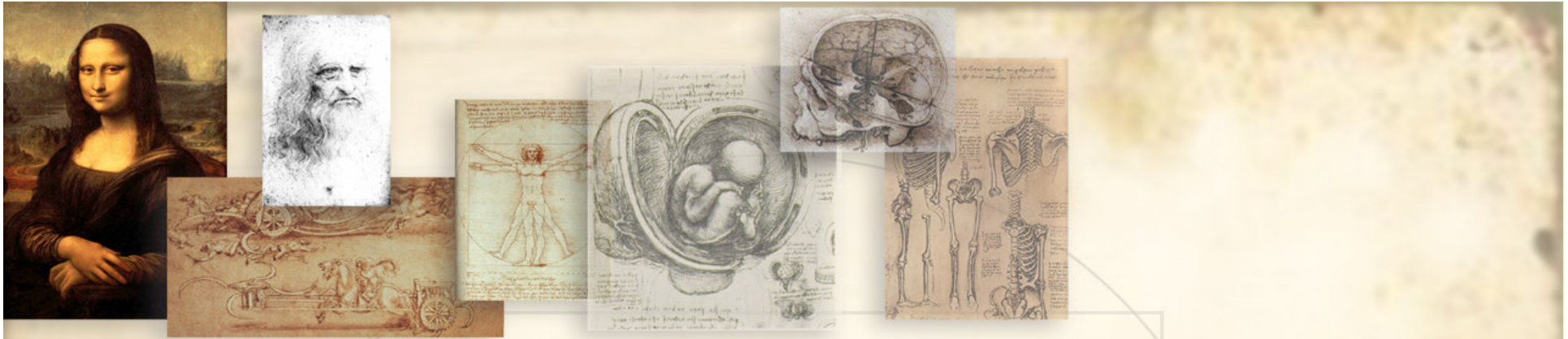
Measurement as a Technology

- What does it take for an industry to promote software measurement as a new technology?
 - Software measurement must have been **proven to work in similar contexts**.
 - Current software measurement practices must be **‘good enough’**.
 - The industry must recognize that the players will not, by themselves, submit to the pain of change (unless the environmental-regulatory context forces such a change).
 - It should want to speed up the transition to quantitative support for decision making.



Measurement is a Technology

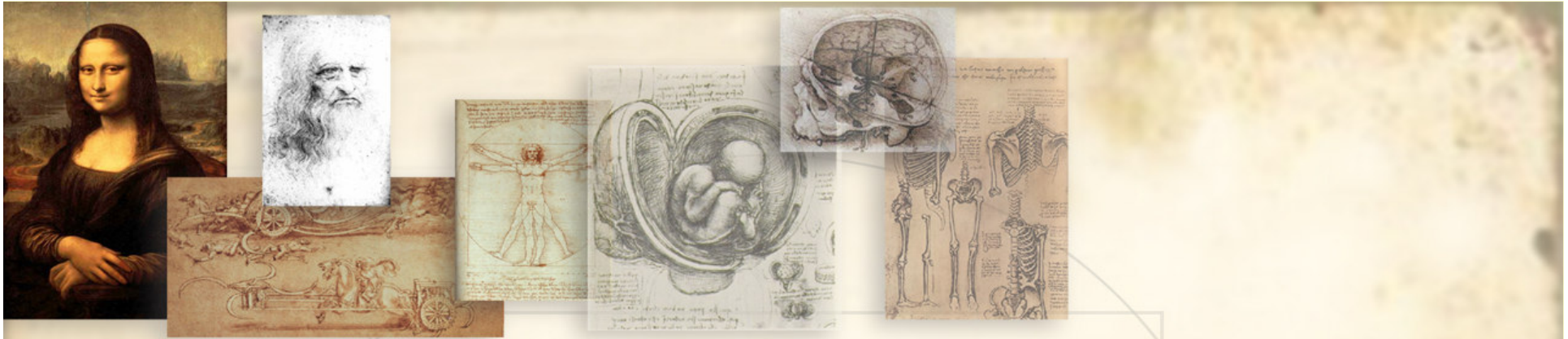
- Out of the +1,000s of software metrics proposed in the literature, **only 5** have been adopted as ISO standards!
- What has been done differently?



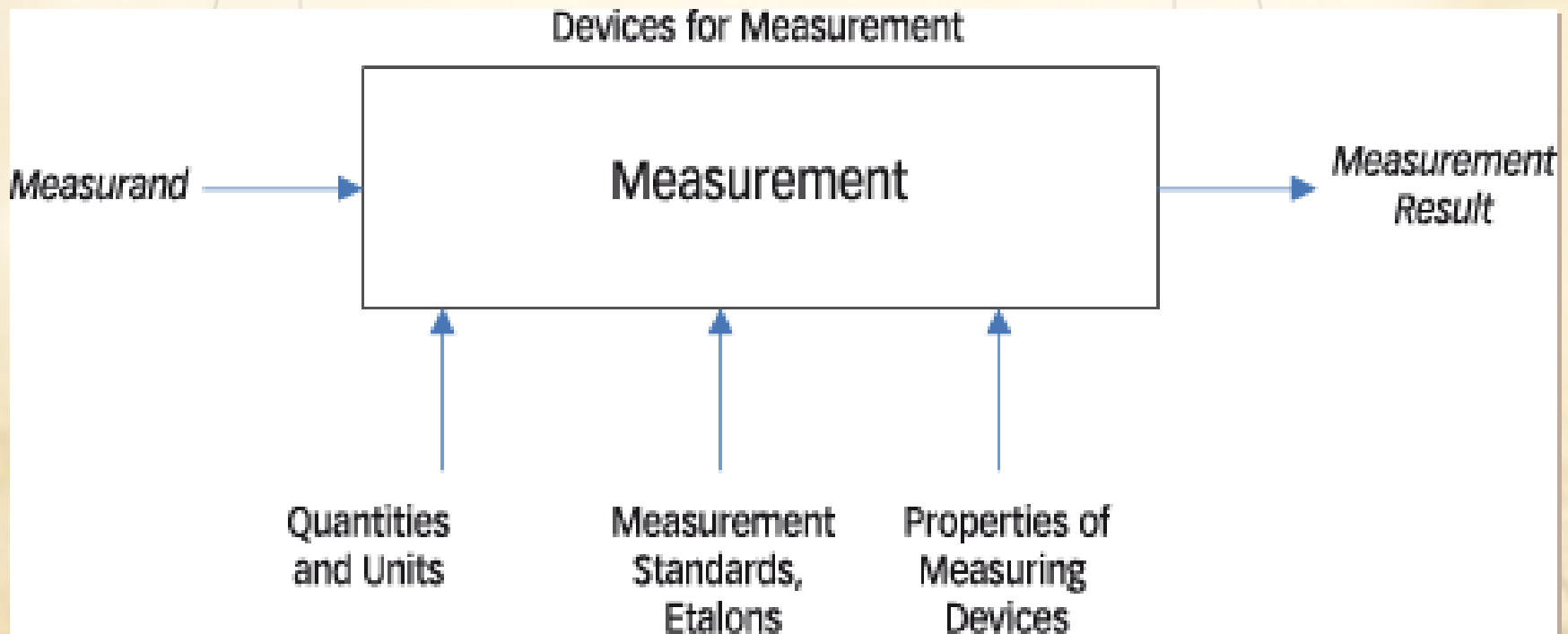
Quality Criteria for Software Measurement

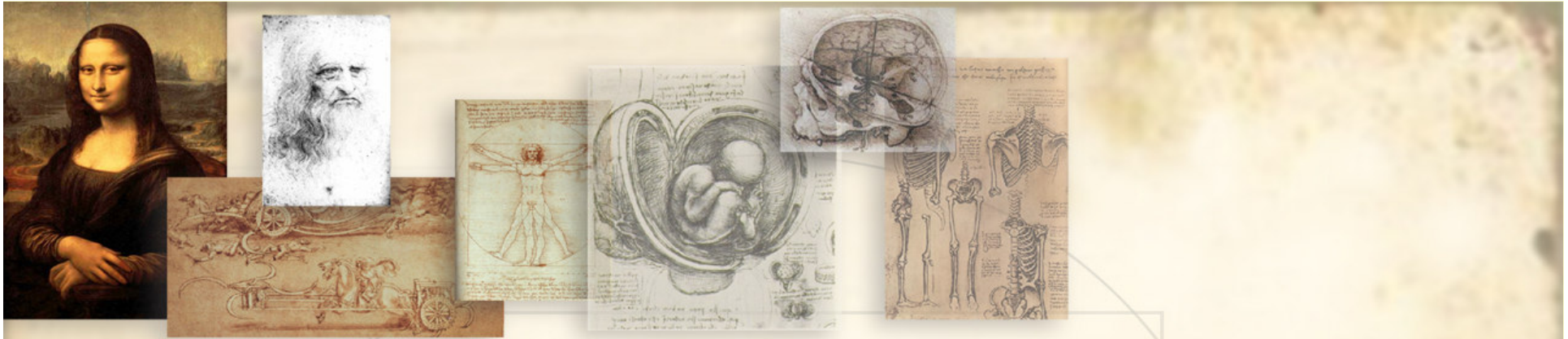
The criteria for the design of measurement are already defined in Metrology:

- The components of a measurement system
- The quality criteria for measurement

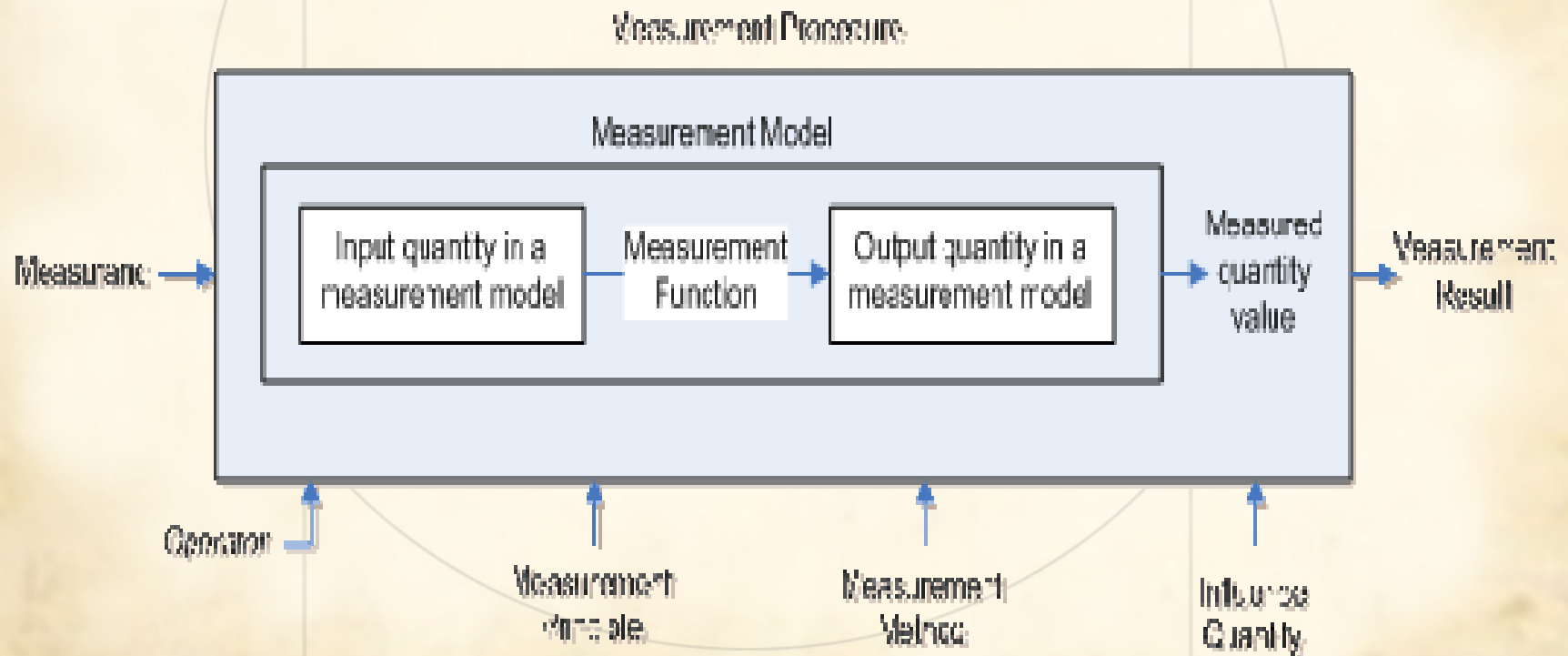


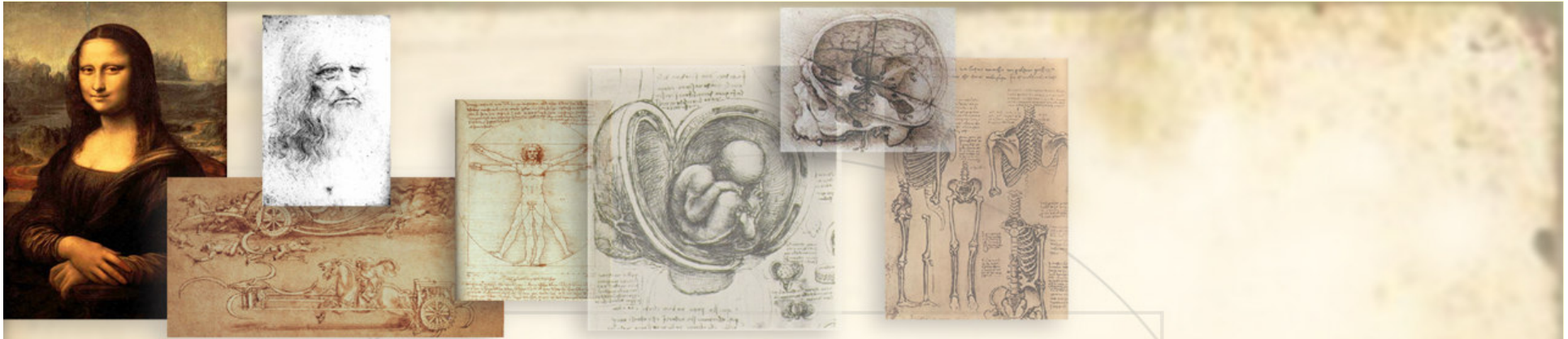
Measurement in Metrology





Measurement in Metrology

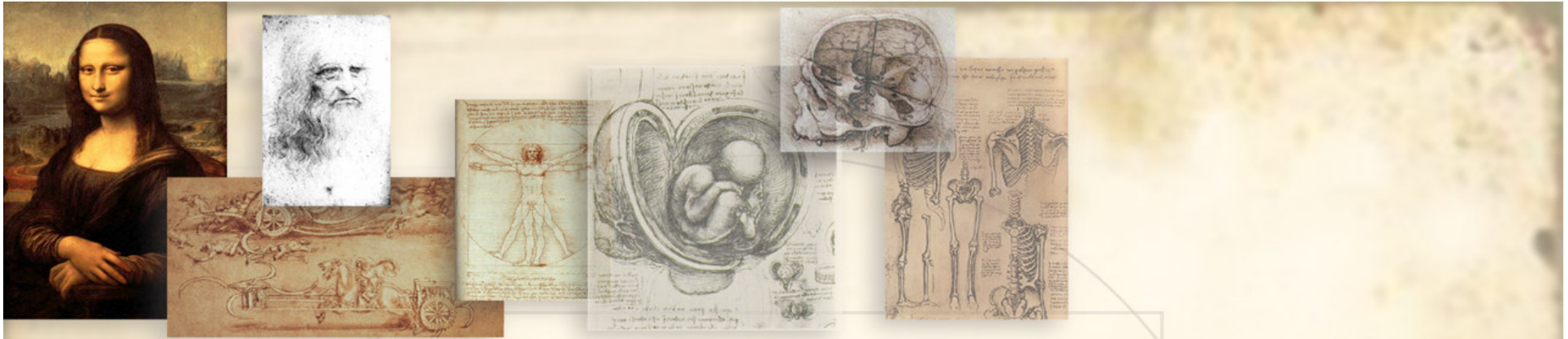




Measurement in Metrology

Table 3: Description of the measurement elements

Measurement				
Measurement result	Measurement procedure	Measuring device	Measurement conditions	Measurement error
Measured quantity value True quantity value Conventional quantity value	Reference measurement procedure Primary reference measurement procedure	Measuring system	Repeatability condition of measurement Intermediate precision condition of measurement Reproducibility condition of measurement	Systematic measurement error Measurement bias Random measurement error



Measurement Infrastructure

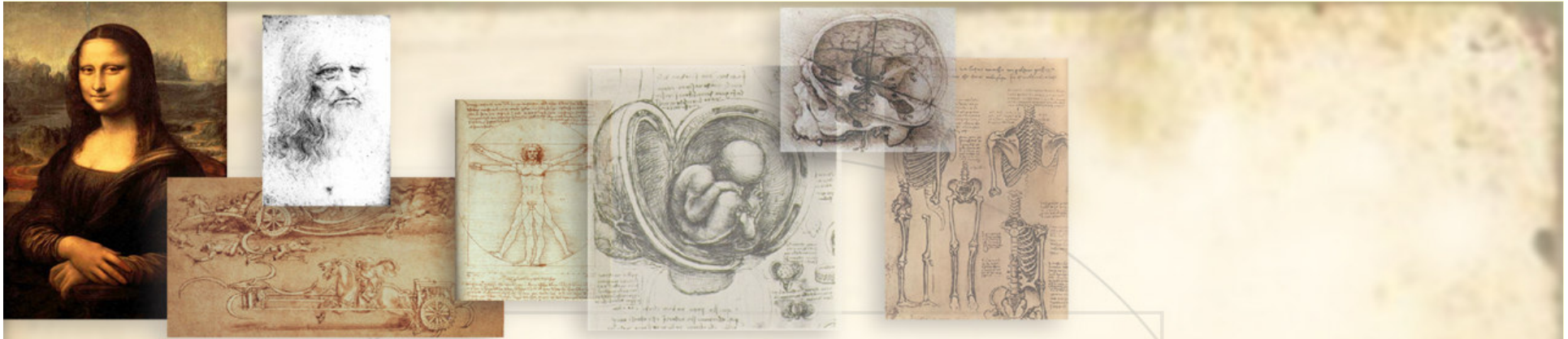
- To increase consensus to ensure repeatability, a measurement practice committee that sets detailed measurement procedures for typical contexts
- When a 'measurement étalon' does not yet exist:
 - Case studies for various topics-contexts
- Outside recognition, through standardization channels (ISO xxx and ISO 90003, ISO 19760, etc)
- Certification process
- Training, specialized guides, etc.



Design through Stages

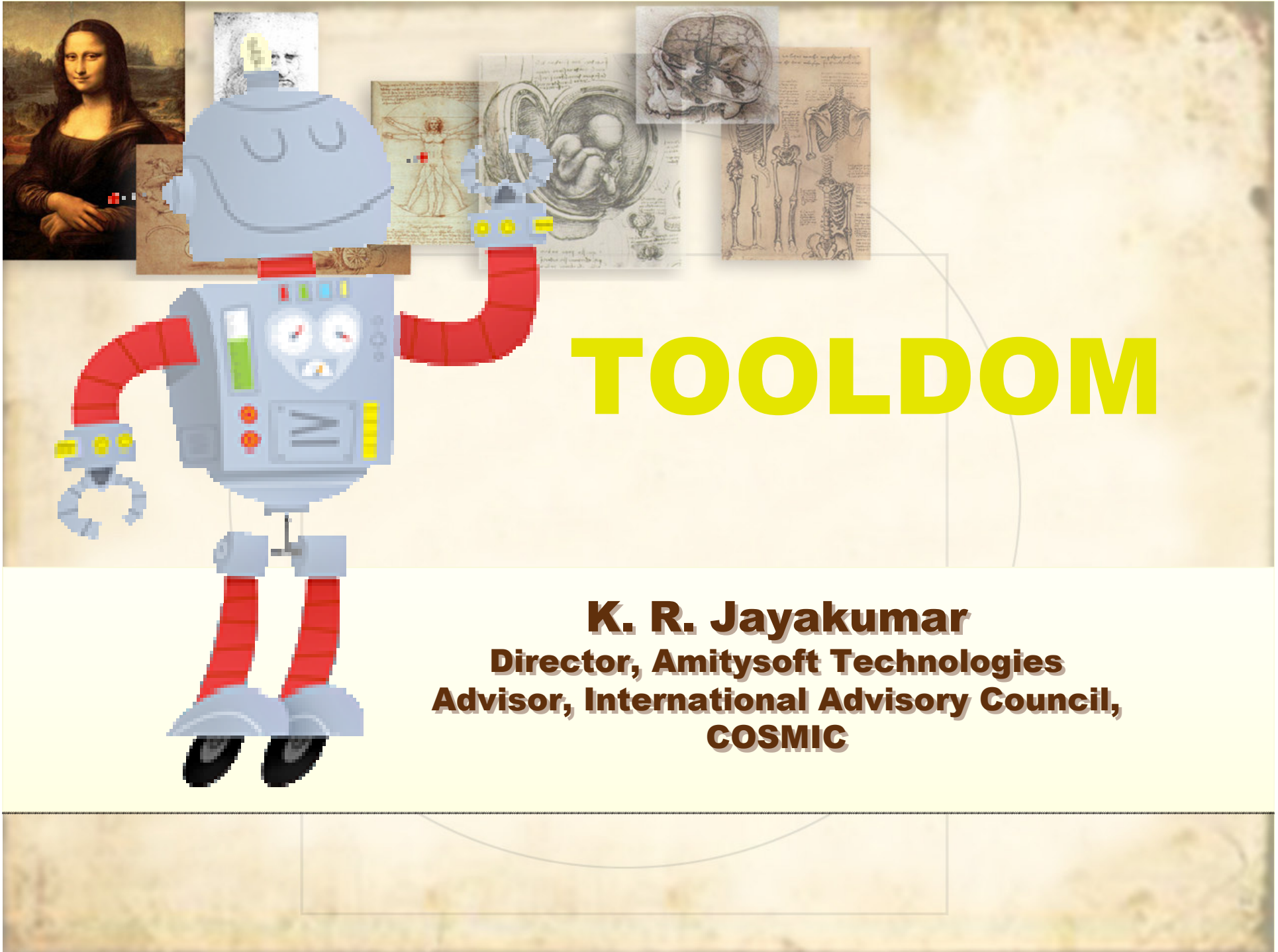
Initial design stage: criteria

- Relevance: must be perceived by practitioners (within a functional domain) as adequately measuring the functional size of the applications in their domain.
- Measurement instrumentation:
 - Automaterd, or
 - is in the form of a measurement standard which documents & clarifies the measurement objectives & perspective, and defines the measurement procedures adopted by a user group.
- Repeatability:
 - different individuals, in different contexts, at different times, and following the same measurement procedures will obtain the same measurement results.
- Measurement results obtained with minimal judgment.
- Measurement results auditable.
- Measurement method in the public domain.



- **Field tests in industry**

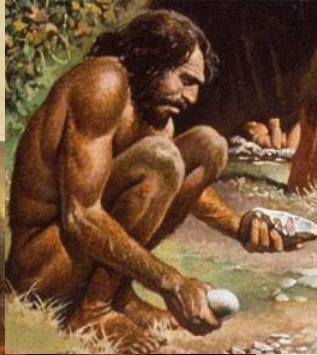




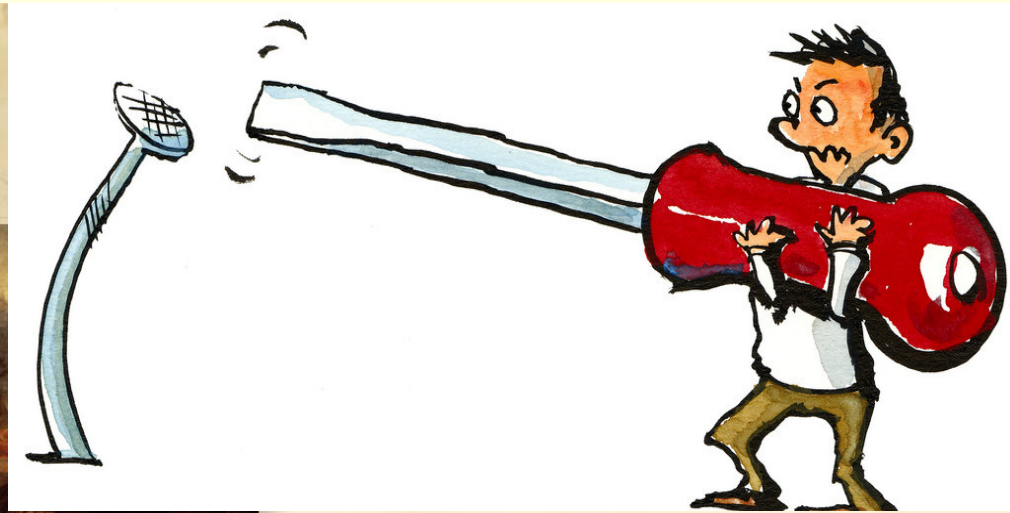
TOOLDOM

K. R. Jayakumar
Director, Amitysoft Technologies
Advisor, International Advisory Council,
COSMIC

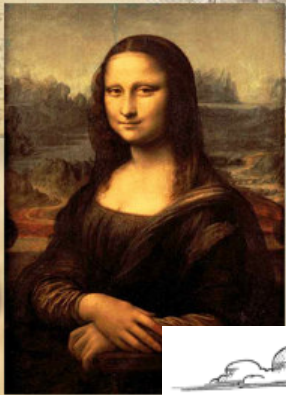
Simple Tools



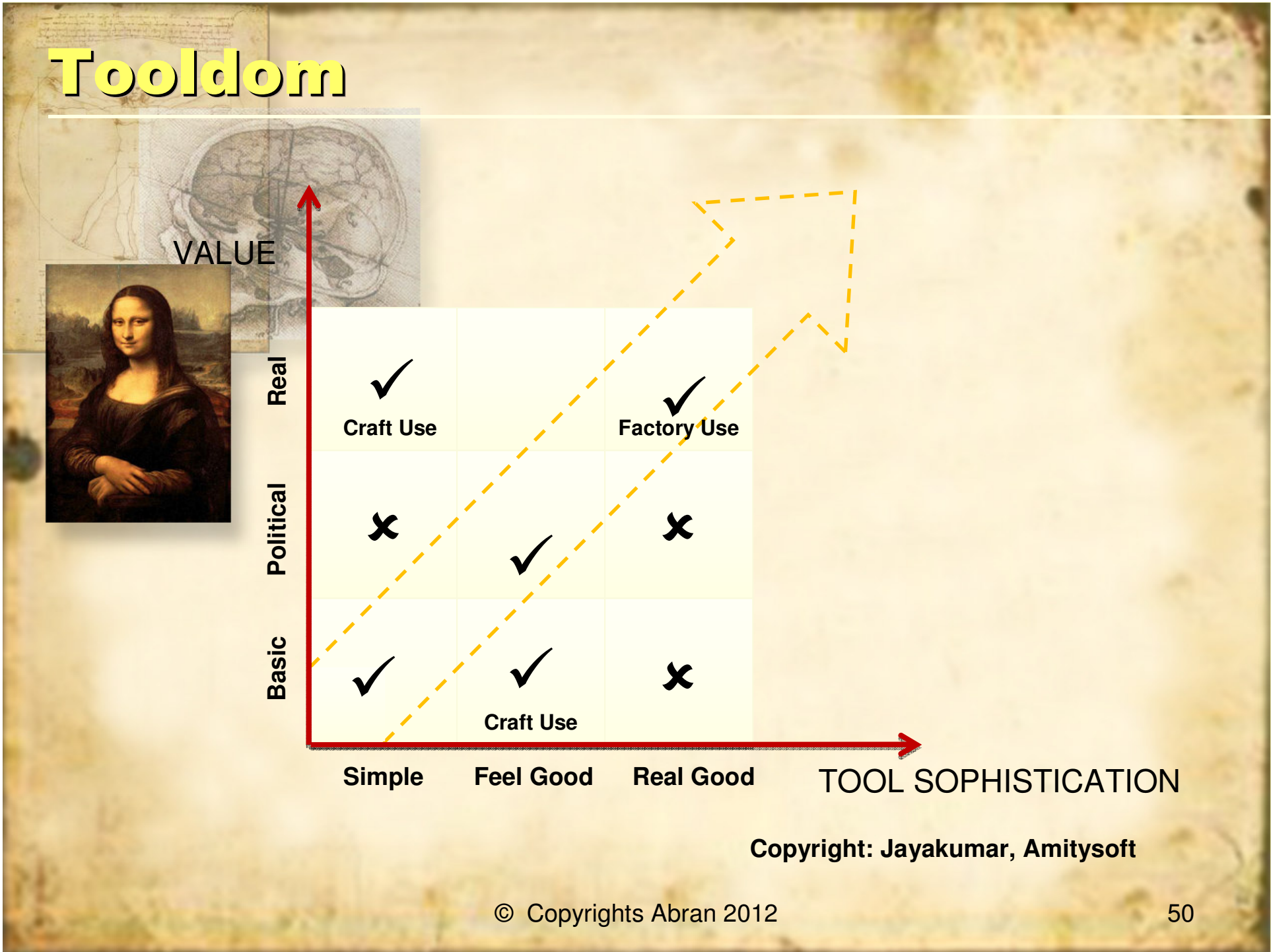
Sophisticated Tools



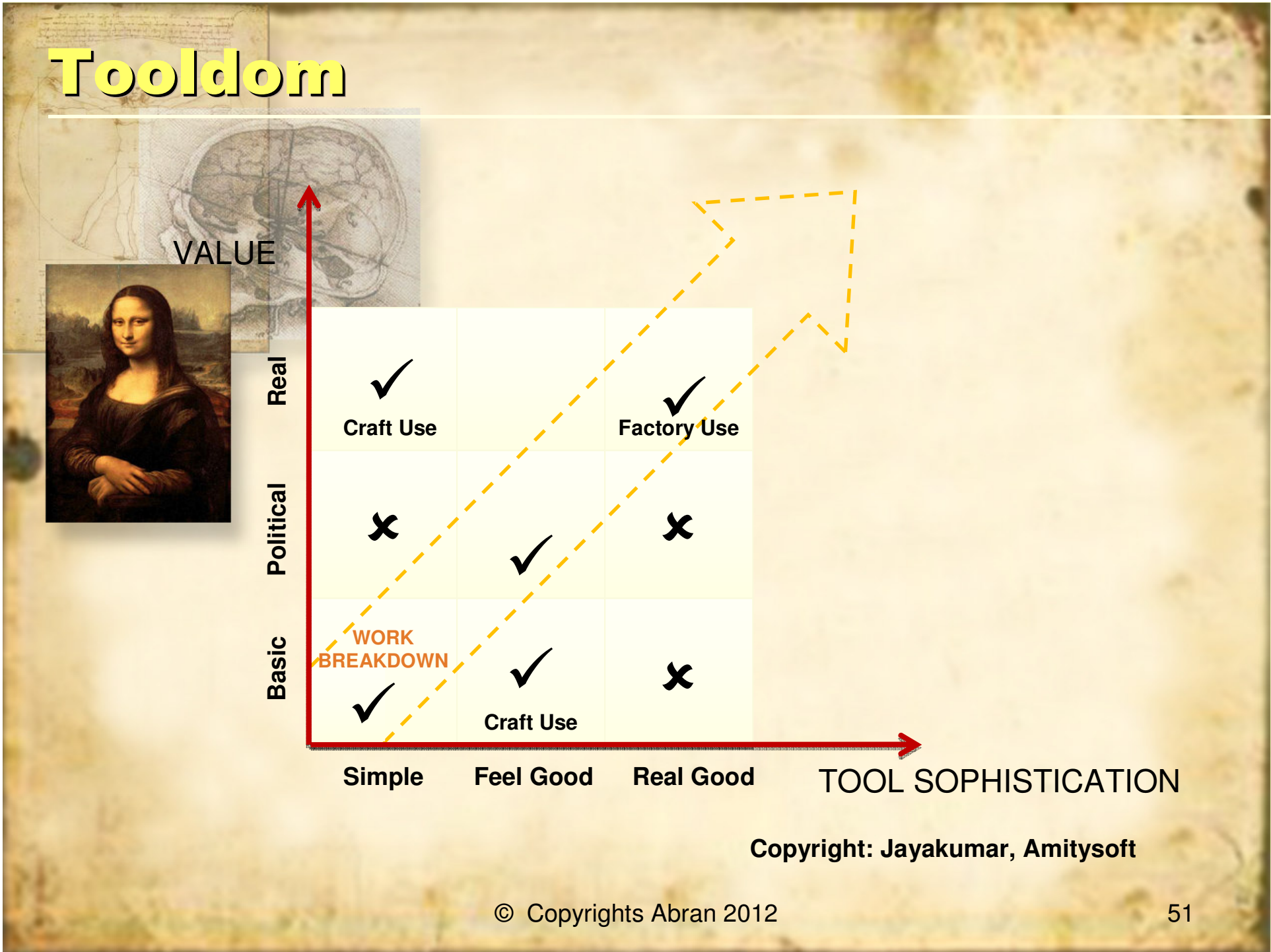
Usage



Tooldom

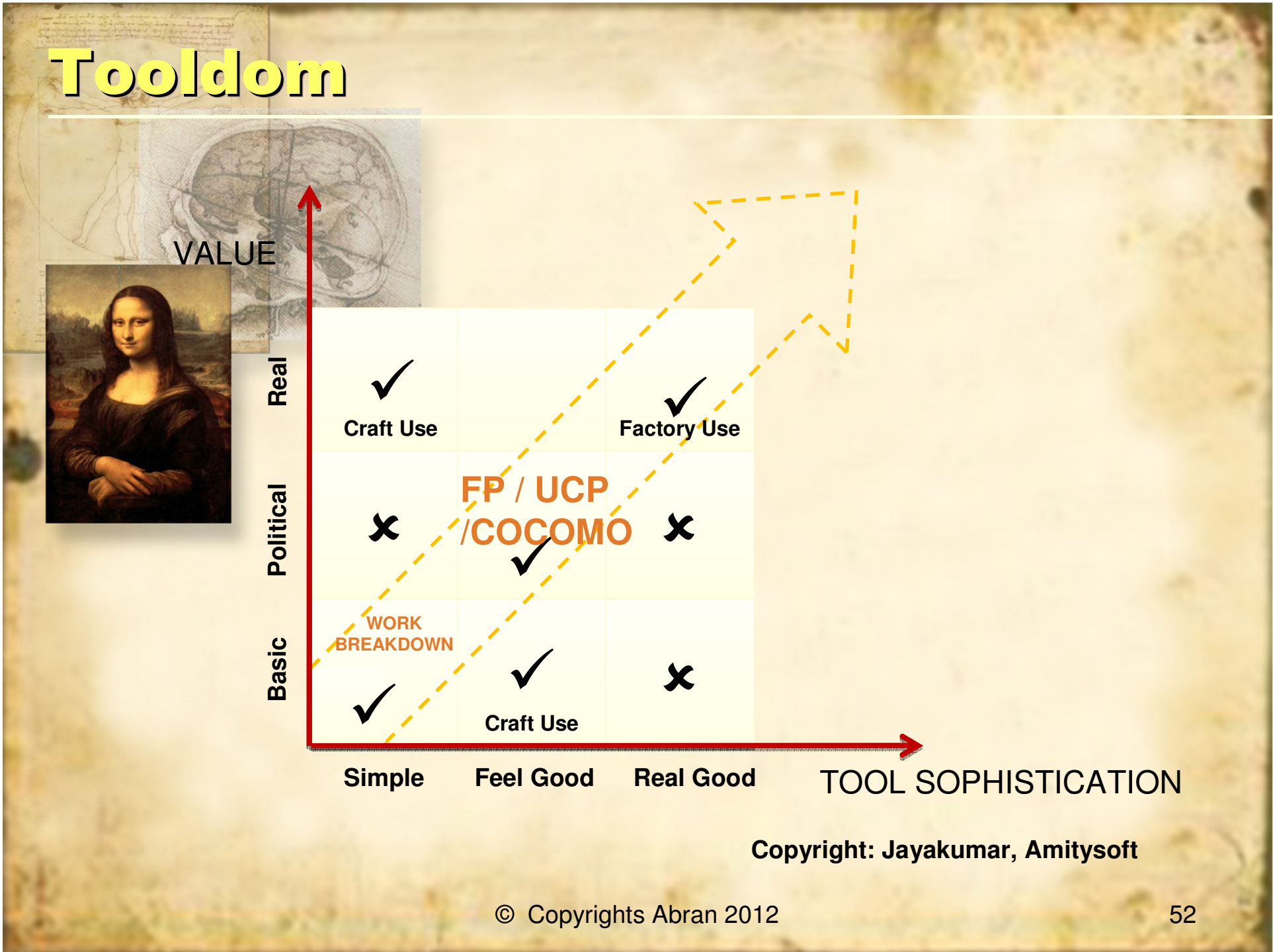


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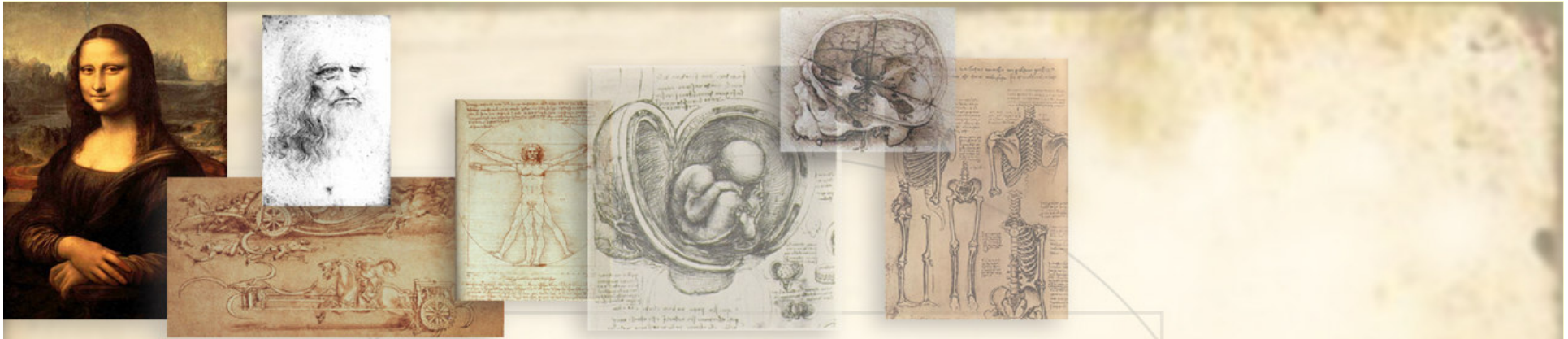


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Tooldom



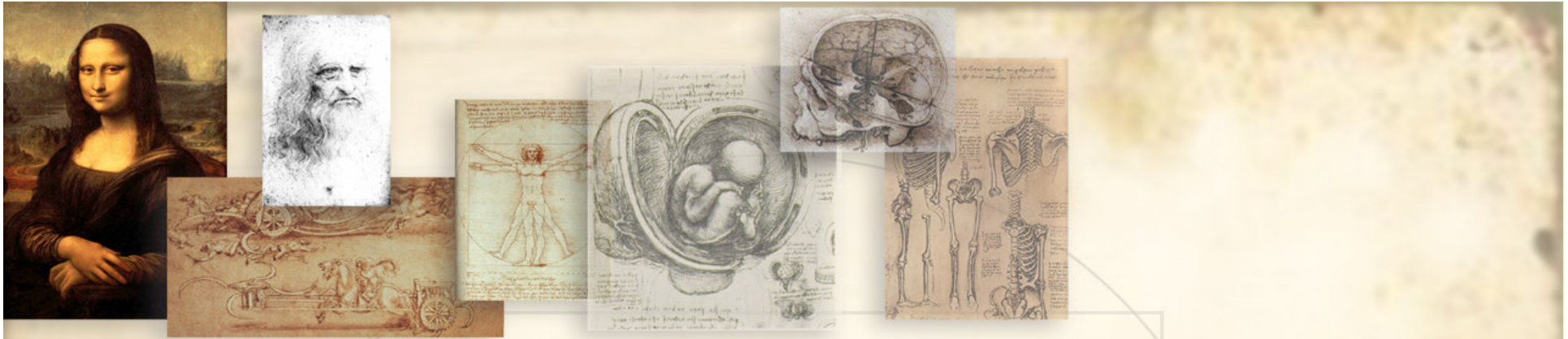
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1st Generation FSM Methods

Weights-like FSM methods:

- Not aligned with the terminology in other fields of measurement (engineering, sciences, etc).
- A number of structural weaknesses pointed out in the literature over the past 30 years:
 - discredited it in academia for almost 20 years.
- Not fully aligned with the ISO criteria in ISO 14143 series (which, for instance, rejected the VAF)

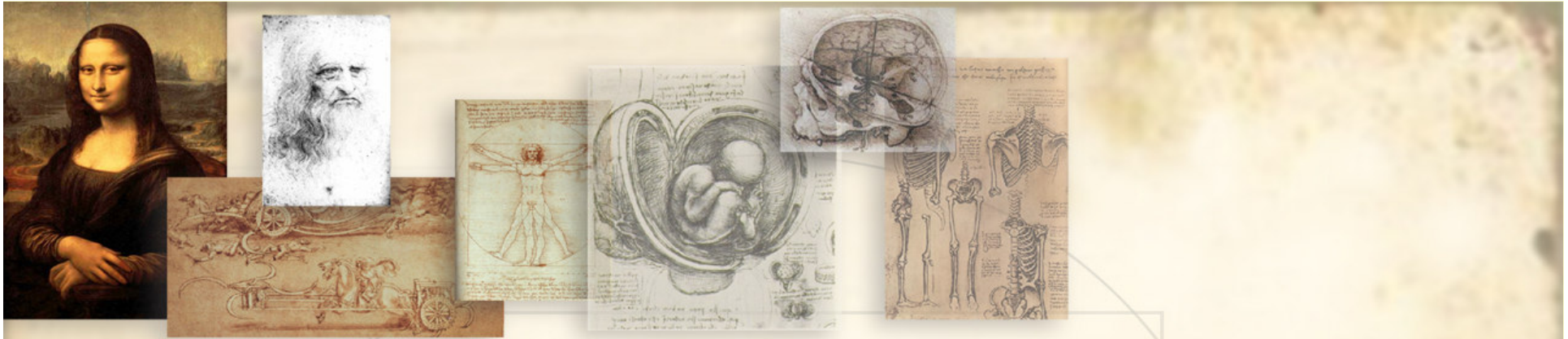


1st Generation FSM Key Contributions

User Groups built the essential metrology support infrastructure:

- Procedural Measurement Manuals
- Central technical authority:
 - Measurement Practice Committee
- Certification criteria & exams
- Case studies for reference materials





1st Generation FSM Key Weakness

1- A structure with weights to integrate multi variables:

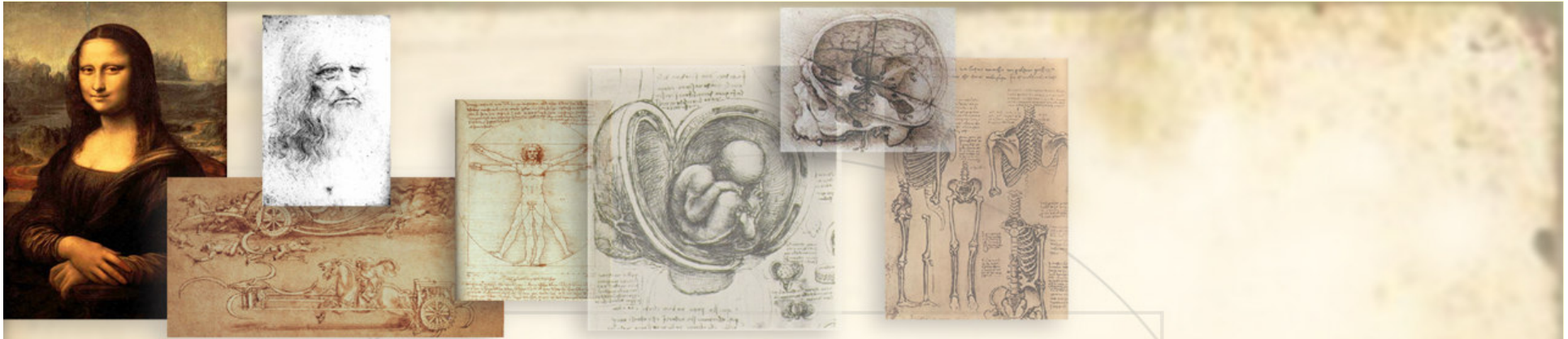
- An end number with a symbol (FP) but without a well defined measurement unit!

2- User groups:

- The initial designs considered as a 'bible' by many: 'bible-type' designs cannot be changed, by definition!

3- Researchers:

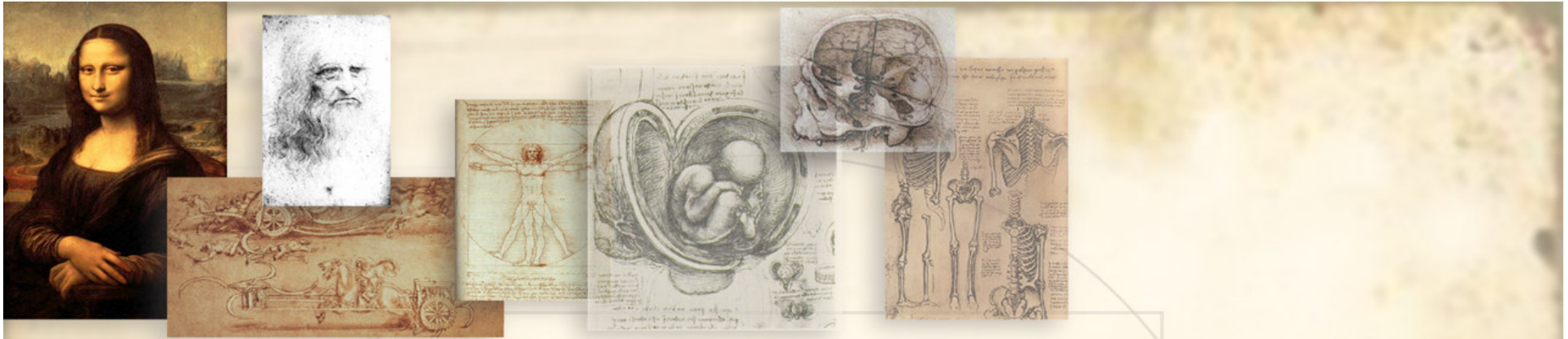
- Tweaking the structure, rather than radical re-design.



2nd Generation FSM criteria

1- Adoption-Addition of the concepts from ISO Metrology

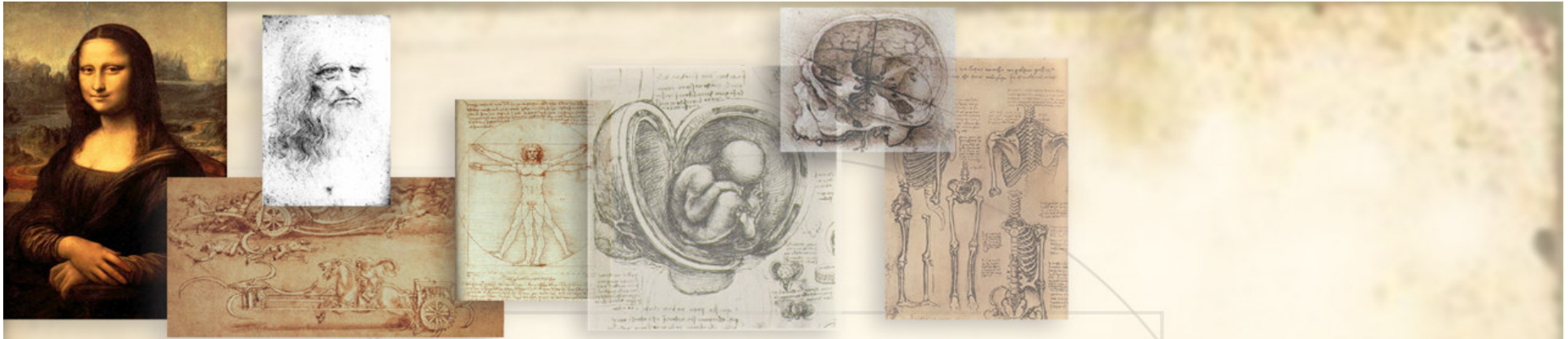
- measurement method,
 - measurement procedure,
 - base quantity,
 - derived quantity
 - measurement unit, etc.
- Many of the ISO definitions explicitly quoted ‘as is’ in the COSMIC glossary.



2nd Generation FSM criteria

2- Correction of all known structural weaknesses:

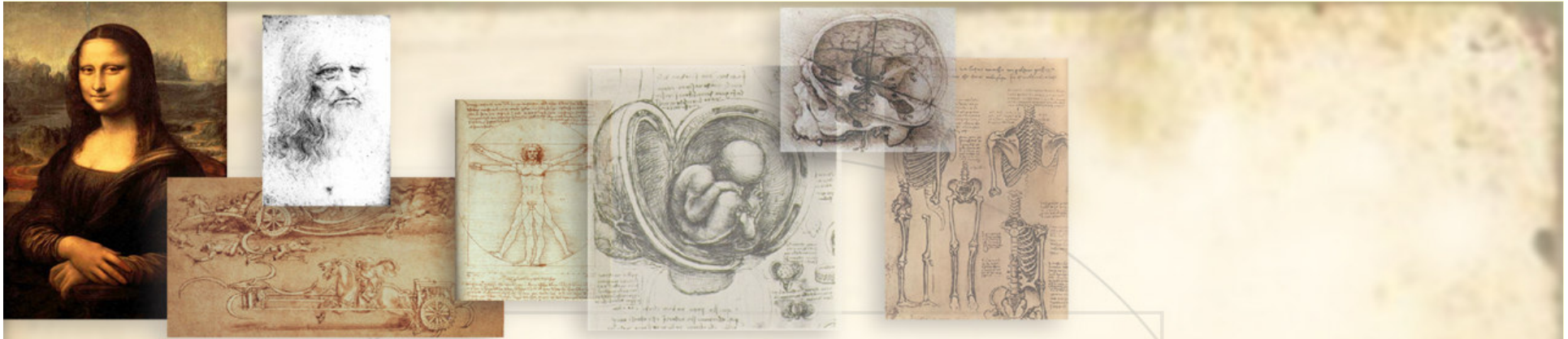
- adopting **a clear & unique 'measurement unit'**:
 - 'a data movement of a single data group' to which a size unit of 1 is assigned, together with the 1CFP as its measurement symbol.
- Making sure that it did not included any valid mathematical operations.
- Similarly, the CFP represents **a single measurable concept**, size of a FUR, making it a true **'base quantity'**.



2nd Generation FSM criteria

3- Designed to entirely meet the ISO 14143-1 FSM requirements:

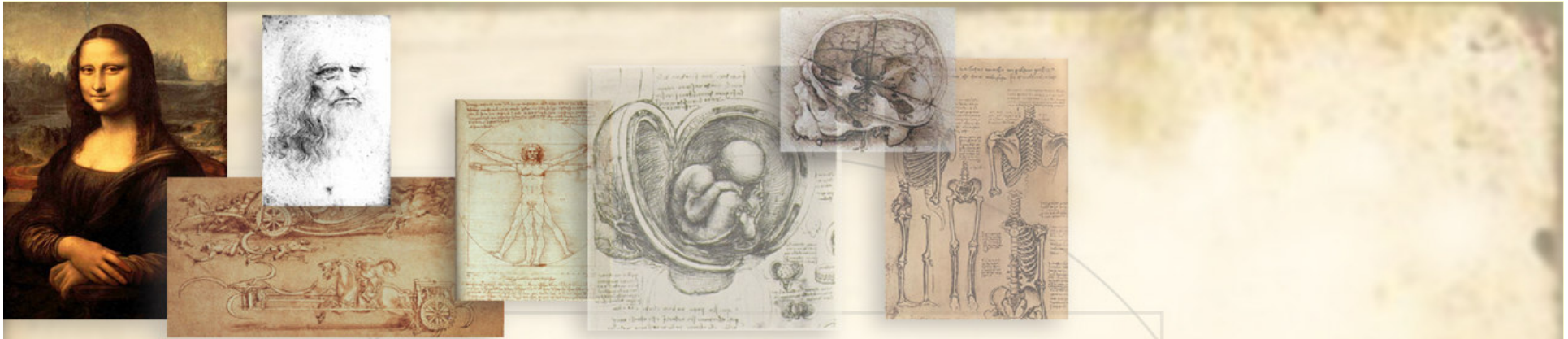
- Measurement of FUR
- No reference to technical & quality characteristics, &
- No reference to effort



2nd Generation FSM criteria

4- A collective effort with practitioners, including:

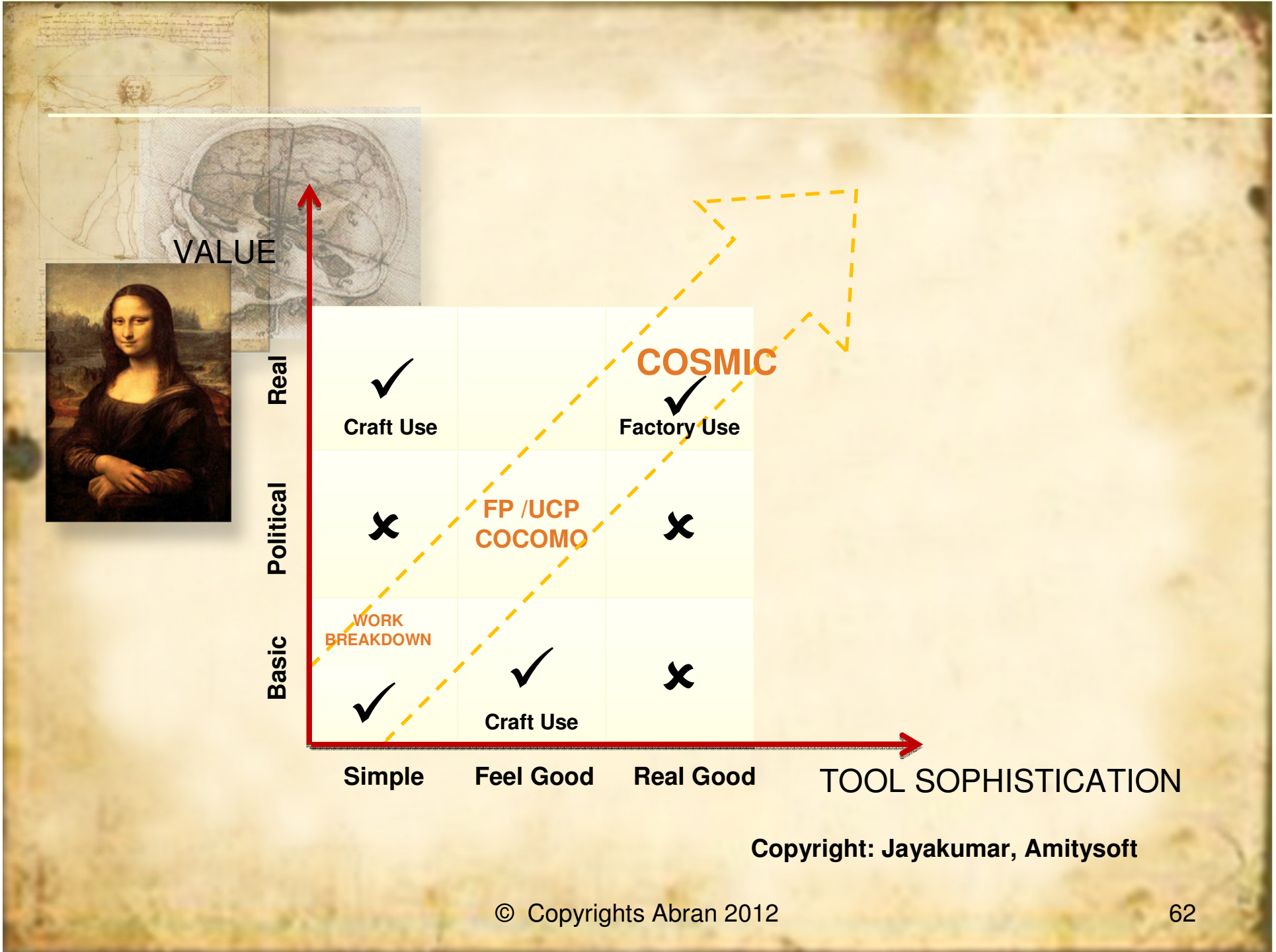
- Fields trials in industry
 - Ensuring relevance of measurement results: Does it capture quantitatively well the expected functionality?
 - Measurement procedures to ensure repeatability & reproducibility of measurement results
- ‘Good enough’ criteria met
 - In estimation models, the other major variable (effort) typically has a much larger range of variation!

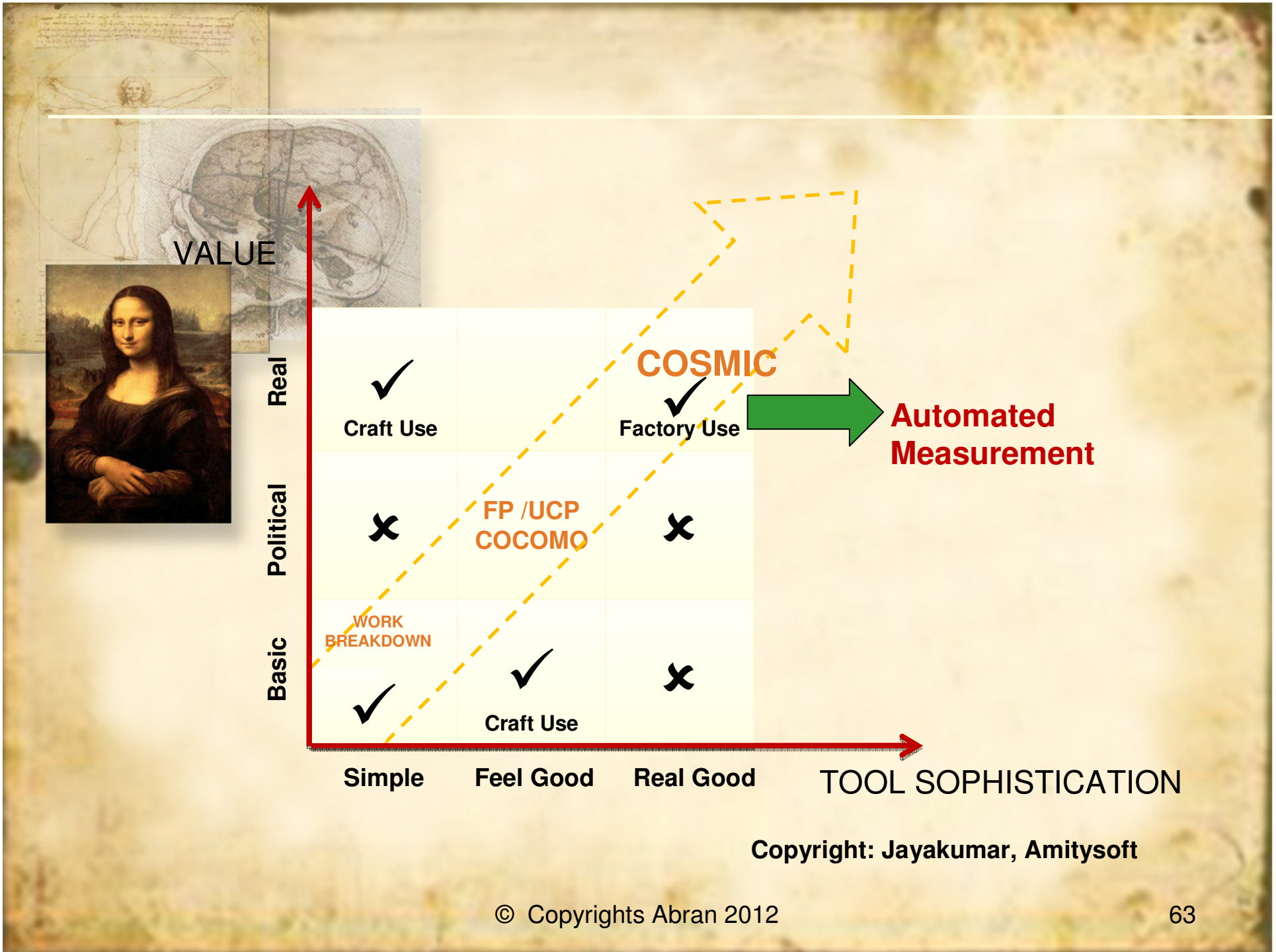


2nd Generation FSM criteria

5- Design to be application domain independent

6- Open access





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COSMIC v3.0 Documentation

ISO/IEC 19761:2002 COSMIC- A functional size measurement method

Method
Overview

Measurement
Manual

Advanced &
Related Topics

← Beginners →

← Practitioners →

← Experienced Practitioners →

DOMAIN-SPECIFIC SUPPORT DOCUMENTS:

Guidelines

- Business V1.0
- Real-time

Case Studies

- Business
- Real-time



Conclusions



Do you have your golden measurement *étalon* for software design & control?





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Questions?