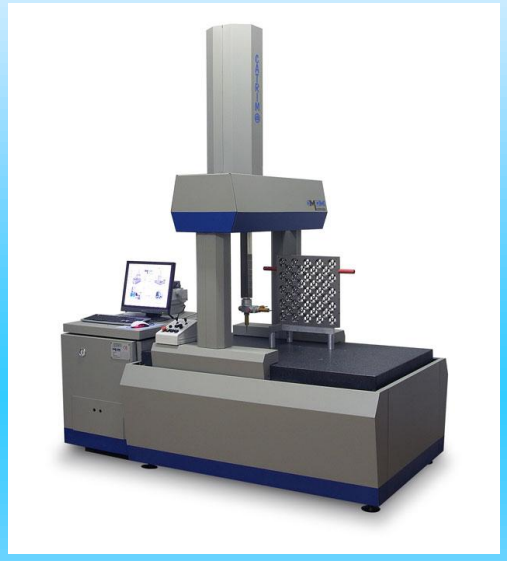
GPS

Metrosoft
Metrology software and Special Applications

The GPS Philosophy and the Globalisation of Industrial Products



Dott. Ing. Michele Deni

ISO/TC 213/WG 10
Coordinate measuring machines
http://ds.dk/isotc213
E-mail: hhk@dk

ISO/TC 60/WG 2
Gears

International Organisation for Standarization
Organisation Internationale de Normalisation
International Normenorganisation

American Society for Precision Engineering

Member

CMA Coordinate Metrology Association
NPL CMA IS AN NPL CLUB OPERATED BY SIRA TEST & CERTIFICATION Stec

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Precision Engineering

Associate Editor

G.P.S.

Geometrical Products Specifications

The ISO GPS is a new approach to provide basic tools to develop a common language to be adopted in the:

- **Design Geometrical Definitions**
- **Specification Limits(Tolerancing) Classification**
- **Inspection methods**
- **Final, Conformity Assessment Rules of Acceptance**

ISO/TC 3-10-57/JHG

Harmonization of ISO/TC 3, ISO/TC 10 and ISO/TC 57 definitions on:

Limits and fits, technical drawings, product definitions, dimensioning, toleracing, propierties of surfaces and metrology

Secretariat: Danish Standars Association

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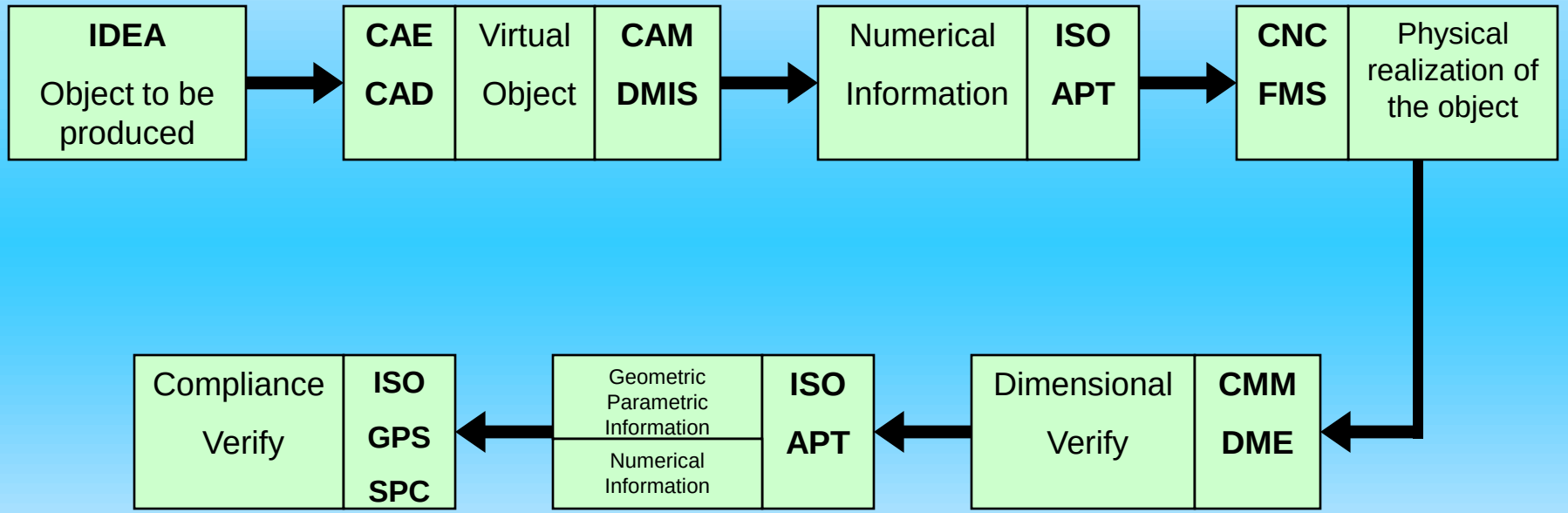
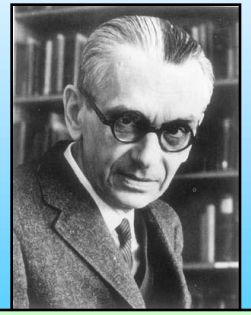
THE NEEDS


IDEA
Object to be produced
CAE
CAD
Virtual
Object
CAM
DMIS
Numerical
Information
ISO
APT
CNC
FMS
Physical realization of the object
Dimensional
Verify
CMM
DME
Geometric
Parametric
Information
Numerical
Information
ISO
APT
Compliance
Verify
ISO
GPS
SPC

THE REVOLUTION

THEOREM OF INCOMPLETENESS

POSTULATE OF COMPLETENESS



DAVID HILBERT

KURT GÖDEL

METROLOGISTS

specifications on the "blue print" are self consistent, and following those specifications gives the acceptability of the final product

GPS METROLOGISTS

specifications on the "blue print" are incomplete, as the acceptability of the final product pass through an unavoidable Verification

The revolution is thinking that, any Design Specification is "Incomplete" as due to unavoidable Verification processes, that could be Functionality, Moutability, or Measurement Verifications, four types of Uncertainties will arise in the end.

TENETS AND PRINCIPLES

GPS PHILOSOPHY

ISO/TR 14638

This Technical Report contains the Masterplan of the hierarchy in wich the GPS Standards are organized, wich consist in the Fundamental, Global, General and Complimentary Standards containing the basic principles and the general tenets.

ISO/TS 17450-1

This Technical Specification, wich is part of global GPS documents, contains the model for geometrical Specification , used in the design of assemblies and individual parts, that will deal to compliant measurement procedures.

ISO/TS 17450-2

This Technical Specification is another global GPS document, and contains the basic issues for the development of the overall system wich is based on the four “Tenets”.

ISO/14253-1

As this Standard is probably well known from the Experts, shortly we say that it is very important and it is globally accepted in the Industrial Environment as well at the level of Legal Metrology, as the rules for the Conformity assessment are clearly defined.

ISO/TS 14253-2

This Paper gives a general rule of how find the best Verification Operators compliant to a stated Specification , this is known as the “PUMA” method.

ISO/TR 14638

MASTERPLAN

The Fundamental GPS Standars

The Global GPS Standars

Gps standars or related standars which deal with or influence several or all General GPS chains of standars

General GPS Matrix

General GPS chains of standars

1. The **Size** chain of standars
2. The **Distance** chain of standars
3. The **Radius** chain of standars
4. The **Angle** chain of standars
5. The **Form of a line** (independent of a datum) chain of standars
6. The **Form of a line** (dependent of a datum) chain of standars
7. The **Form of a Surface** (independent of a datum) chain of standars
8. The **Form of a Surface** (dependent of a datum) chain of standars
9. The **Orientation** chain of standars
10. The **Location** chain of standars
11. The **Circular run-out** chain of standars
12. The **Total run-out** chain of standars
13. The **Datum's** chain of standars
14. The **Roughness profile** chain of standars
15. The **Waviness profile** chain of standars
16. The **Primary profile** chain of standars
17. The **Surface defects** chain of standars
18. The **Edges** chain of standars

Complementary GPS Matrix

Complementary GPS chains of standars

A. Process specific tolerance standars

- A1. The **Machining** chain of standars
- A2. The **Casting** chain of standars
- A3. The **Welding** chain of standars
- A4. The **Thermal cutting** chain of standars
- A5. The **Plastic moulding** chain of standars
- A6. The **Metallic and inorganic coating** chain of standars
- A7. The **Painting** chain of standars

B. Machine element geometry standars

- B1. The **Screw thread** chain of standars
- B2. The **Gears** chain of standars
- B3. The **Splines** chain of standars

MDM Mecatronics

ISO/TR 14638

GLOBAL GPS STANDARDS			
1, 370, 10209-3, 10579, VIM, GUM			

GENERAL GPS STANDARDS				
Chain link number			1	2
Geometrical characteristic of feature	Geometric sub-characteristic of feature or parameters		Product documentation indication - Codification	Definition of tolerances - Theoretical definition and values
Size			129 (R), 286-1, 406-1	286-1, 286-2, 1829
Distance	"Step" distance (height)		129 (R), 406	
	Distance between real or derived feature and derived feature		129 (R), 406	
Radius			129 (R)	
Angle (tolerance in degrees)	Angle between real features		129 (R), 1119 (R)	
	Angle between real or derived and derived feature		129 (R)	
Form of line independent of datum	Real feature (line)	Profile any line	1101 (R), 1660 (R)	1101 (R), 1660 (R)
		Straightness	1101 (R)	1101 (R), ¤12780-1
		Roundness	1101 (R)	1101 (R), 6318 (W)
	Derived feature (line)	Profile any line	1101 (R), 1660 (R)	1101 (R), 1660 (R)
		Straightness	1101 (R), 2692 (R)	1101 (R)
		Roundness	1101 (R)	1101 (R)
Form of line dependant of datum	Real feature (profile of any line)		1101 (R), 1660 (R)	1101 (R), 1660 (R)
	Derived feature (profile of any line)		1101 (R), 1660 (R)	1101 (R), 1660 (R)
Form of surface independent of datum	Real feature	Profile any surface	1101 (R), 1660 (R)	1101 (R), 1660 (R)
		Flatness	1101 (R)	1101 (R)
		Cylindricity	1101 (R)	1101 (R)
		Cones	1101 (R), 3040	1101 (R), 3040
	Derived feature	Profile any surface	1101 (R)	1101 (R)
		Flatness	1101 (R), 2692 (R)	1101 (R)
Form of surface dependant of datum	Real feature	any surface	1101 (R), 1660 (R)	1101 (R), 1660 (R)
		Cones	1101 (R), 3040	1101 (R), 3040
	Derived feature		1101 (R)	1101 (R)

¤ = ISO draft standard in progress (WD, CD or DIS) XXXYY = ISO number not yet known (numbered YY)

GLOBAL GPS STANDARDS			
1, 370, 10209-3, 10579, VIM, GUM			
	¤14253-1, ¤-2	¤14253-1, ¤-2	¤14253-1, ¤-2

GENERAL GPS STANDARDS				
3	4		5	6
Definitions for actual feature-characteristic or parameter	Assessment of the deviations of the workpiece - Comparison with tolerance limits		Measurement equipment requirements	Calibration requirements - Calibration standards
286-1, 1938 (R)	Limit gauges	1938 (R)	1938 (R), 3670 (R)	1938 (R), 3670 (R)
8015 (R) ¤14660-1, ¤-2	Indicating measuring instruments	1938 (R)	463 (R), 3599 (R), 3611, ¤9121, 6906 (W) (R), ¤9493, ¤10360-1, 10360-2, ¤-3, ¤-4, ¤-5, ¤-6, ¤13385, ¤XXX01, ¤XXX19	3650 (R)
			463 (R), 3599 (R), 6906 (R), 7863, ¤10360-1, 10360-2, ¤-3, ¤-4, ¤-5, ¤-6, ¤13385	
			7863, ¤10360-1, 10360-2, ¤-3, ¤-4, ¤-5, ¤-6, ¤13385	
			¤10360-1, 10360-2, ¤-3, ¤-4, ¤-5, ¤-6	
8015			¤10360-1, 10360-2, ¤-3, ¤-4, ¤-5, ¤-6	
			¤10360-1, 10360-2, ¤-3, ¤-4, ¤-5, ¤-6	
	5460		¤10360-1, 10360-2, ¤-3, ¤-4, ¤-5, ¤-6	
¤12780-1	5460, ¤12780-2		463 (R), 8512-1, 8512-2, ¤9493, (¤10360-1, 10360-2, ¤-3, ¤-4, ¤-5, ¤-6), ¤12780-3, XXX19	¤12780-4
¤12181-1	5460, ¤12181-2		463 (R), 4291 (W), 4292 (W), ¤10360-1, 10360-2, ¤-3, ¤-4, ¤-5, ¤-6, ¤12181-3	¤12181-4
	5460		¤10360-1, 10360-2, ¤-3, ¤-4, ¤-5, ¤-6	
¤14660-1, ¤-2	5460		¤10360-1, 10360-2, ¤-3, ¤-4, ¤-5, ¤-6	
			¤10360-1, 10360-2, ¤-3, ¤-4, ¤-5, ¤-6	
	5460		¤10360-1, 10360-2, ¤-3, ¤-4, ¤-5, ¤-6	
¤14660-1, ¤-2	5460		¤10360-1, 10360-2, ¤-3, ¤-4, ¤-5, ¤-6	
	5460		¤10360-1, 10360-2, ¤-3, ¤-4, ¤-5, ¤-6	
¤12781-1	5460, ¤12781-2		463 (R), 8512-1, 8512-2, ¤9493, ¤10360-1, 10360-2, ¤-3, ¤-4, ¤-5, ¤-6, ¤12781-3, XXX19	¤12781-4
¤12180-1	5460, ¤12180-2		463 (R), ¤10360-1, 10360-2, ¤-3, ¤-4, ¤-5, ¤-6, ¤12180-3	¤12180-4
			463 (R), 3611, ¤10360-1, 10360-2, ¤-3, ¤-4, ¤-5, ¤-6	
	5460		¤10360-1, 10360-2, ¤-3, ¤-4, ¤-5, ¤-6	
¤14660-1, ¤-2	5460		¤10360-1, 10360-2, ¤-3, ¤-4, ¤-5, ¤-6	
	5460		¤10360-1, 10360-2, ¤-3, ¤-4, ¤-5, ¤-6	
			463 (R), ¤10360-1, 10360-2, ¤-3, ¤-4, ¤-5, ¤-6	
	5460		¤10360-1, 10360-2, ¤-3, ¤-4, ¤-5, ¤-6	

(R) = Revision in progress (W) = To be with drawn

ISO/TS 17450-1

These tools are based on the characteristics of features, on the constraints between features, and on operations used for the creation of different geometrical features.

The machined parts derived from the same drawing are imperfect , with errors relative to size, form, deviation, position; so here we have the problem of how to get a set of parameters for each feature present on the workpiece, wich could be comparable with the Ideal ones on the drawing.

In Coordinate Metrology the problem was solved with the introduction of a new entity wich is the "Sobstitute Geometrical feature".

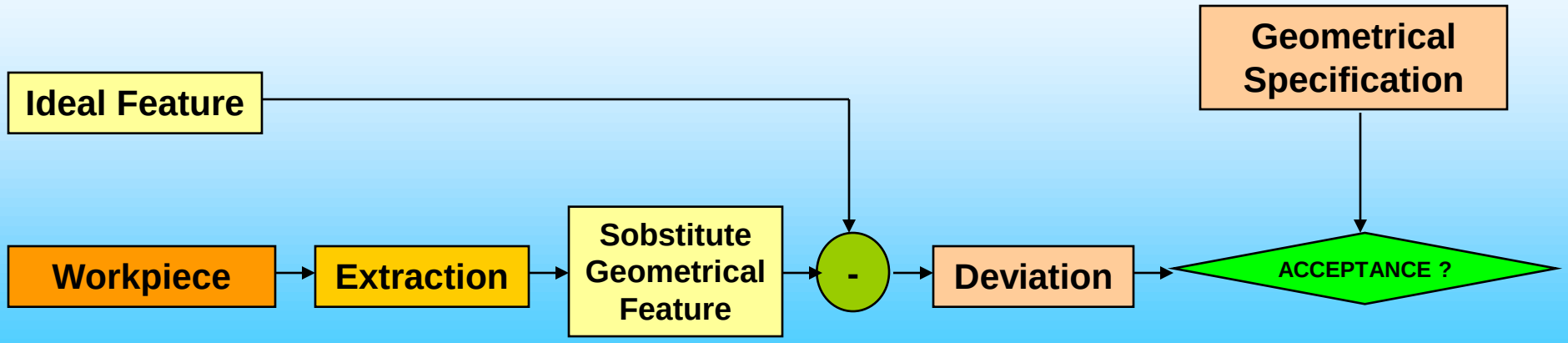
This approach is possible only in the case of, what I call, "Metrology in Predefined Geometry" as the mathematical formalization of the measured part must be known "a priori".

The designer first defines a part of perfect ideal form with shape and dimensions, with tolerance specifications, that best fit the functionality of the final product.

In this document (ISO/TS 17450-1) all the definitions related to geometrical features and their geometrical characteristics, are reported.

In a future evolution wich is being considered from some Researchers, a new Specification and Verification approach, could be the right solution for many problems, this is the VD&T, Vectorial Dimensioning and Tolerancing

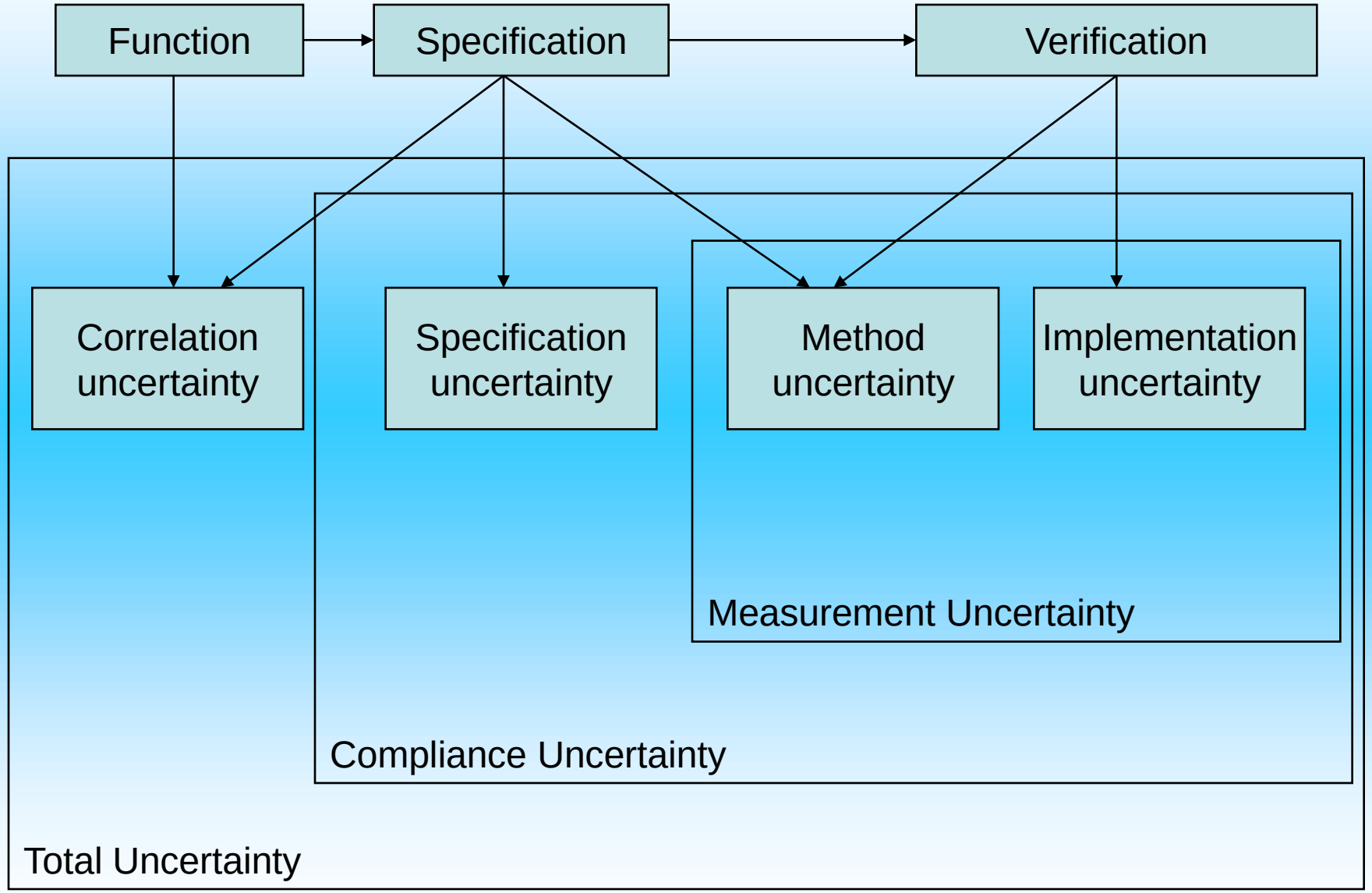
ISO/TS 17450-1



Metrology in PREDIFINED GEOMETRY

The designer first defines a part of perfect ideal form with shape and dimensions, with tolerance specifications, that best fit the functionality of the final product

ISO/TS 17450-2



ISO/TS 17450-2

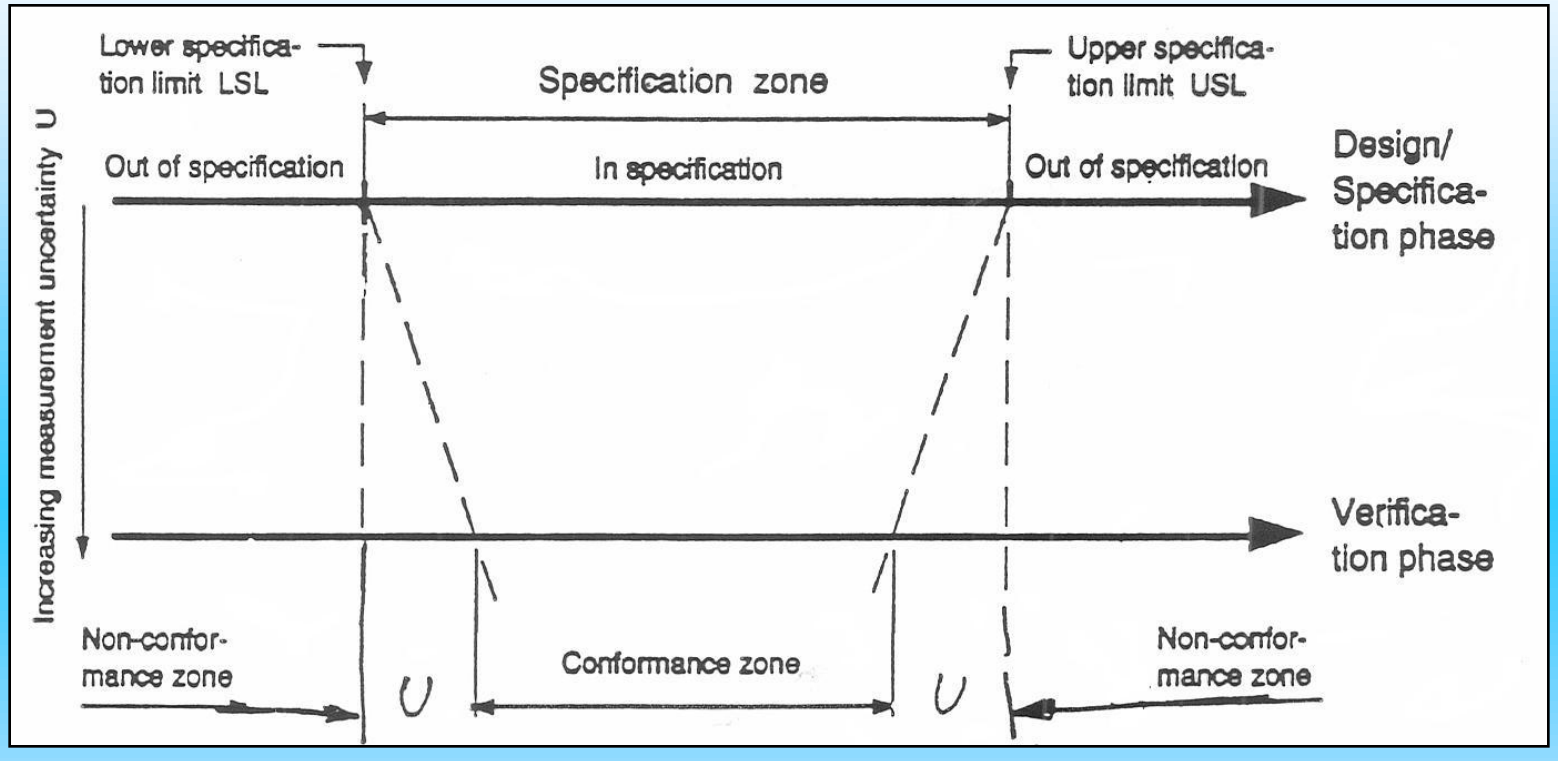
A measurement with low Uncertainty is of little value, when Correlation or Specification Uncertainty is large

The responsability of designers will be strongly accounted in the Production Process

The Specfication Process is the first to take place, and is on the responsability of the Designer

The Verification Process follows the Specification, and is done implementing the actual Specification Operator in an actual Verification Operator

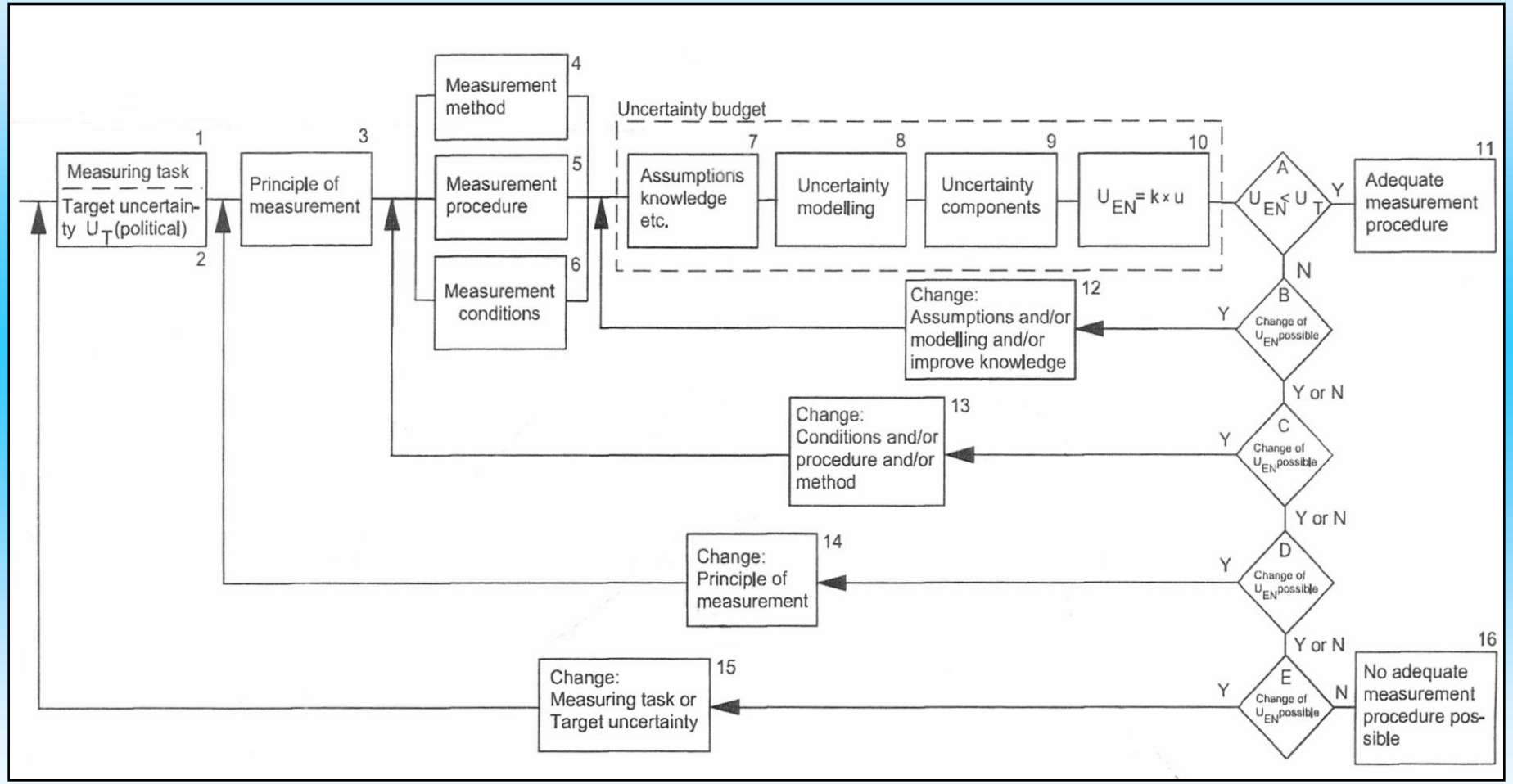
ISO 14253-1



The concept of the Uncertainty as an Economic Factor is evident, and the decision rules for who is going to pay the uncertainty related to measurements are clear

ISO/TS 14253-2

PUMA Method



CONCLUSIONS

Four lelvels of Uncertainty will arise:

- **Correlation Uncertainty**
- **Specification Uncertainty**
- **Compliance Uncertainty**
- **Measurment Uncertainty**

The GPS will be a very useful tool for people involved in the Verification process, in order to better address the responabilities in the production environment and be able to evaluate the amount of risk related to an action of acceptance or rejection.

CONCLUSIONS (2)

An important contribution introduced from the ISO/GPS, is a major involvement of Designers and Specificators, which finally become also partially responsible of the success of the Verification Process

Specification and Verification are two aspects of the same thing, wich is the successful realisation of final product, in a Global Industrial Environment

Specification and Verification Uncertainty is a relevant Economic factor.

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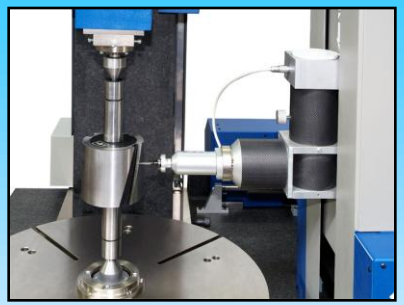
THE END



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