Validation of the Quality Information Framework Specification

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Abstract

Validating the Inspection Results Specification of the Quality Information Framework (QIF)

by Dr. Fiona Zhao, William Rippey, NIST.

- The Quality Information Framework (QIF) is a new standards effort to define standard information interfaces in dimensional inspection. Validating a specification means ensuring that the specification can express all of the data needed by consumers of QIF files. Our talk will cover the goals, scope and benefits of QIF, the purpose and methods of validating the inspection results portion of this technical specification (i.e., Quality Measurement Results (QMR)) , and status of the QIF standards development.
- The most typical producer of QMR files is a CMM, as it outputs results of dimensional part measurement. The typical consumers of QMR are software solutions for part quality analysis, reporting, and statistical process control. Initial validation is being done by comparing the data model of the new QMR specification to the requirements in the ANSI Y14.5 standard for GD&T and feature definitions. Follow up activities for future validation will involve corroboration of the QMR data model with inspection data produced by existing non-QMR compliant programming and execution software. Upcoming exercises may include the use of sample parts and inspection results to test implementations of QMR in prototype and beta software systems.

Capsule

- DMSC is developing a new data standard for the integration of all dimensional metrology systems. It is called Quality Information Framework (QIF)
- The part of QIF nearest completion is Quality Measurement Results (QMR)
- We will convey lessons learned during a walkthrough validation of QMR
- The QIF effort may benefit from your participation

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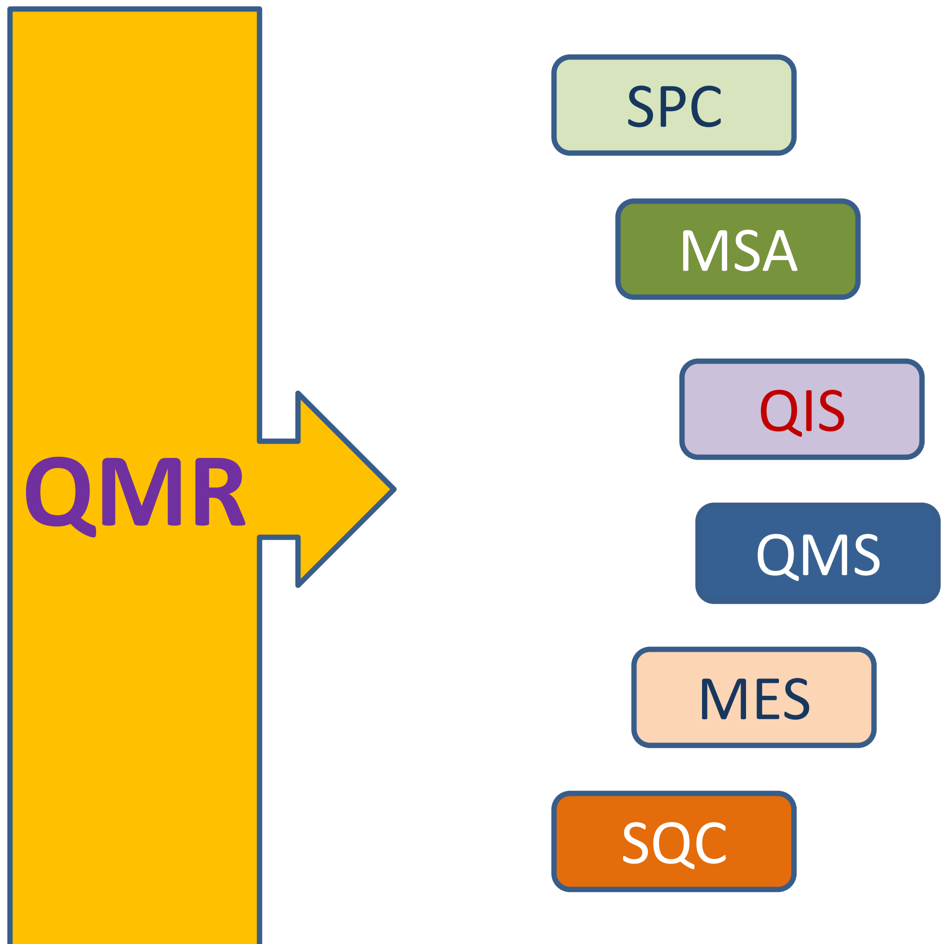
Why a Standard?
One format among many brands, yields *Interoperability*



Identification of commercial equipment is not intended to imply recommendation or endorsement by the National Institute of Standards and Technology.

Quality Information Framework Scope

Inspection Planning

QMPlanning

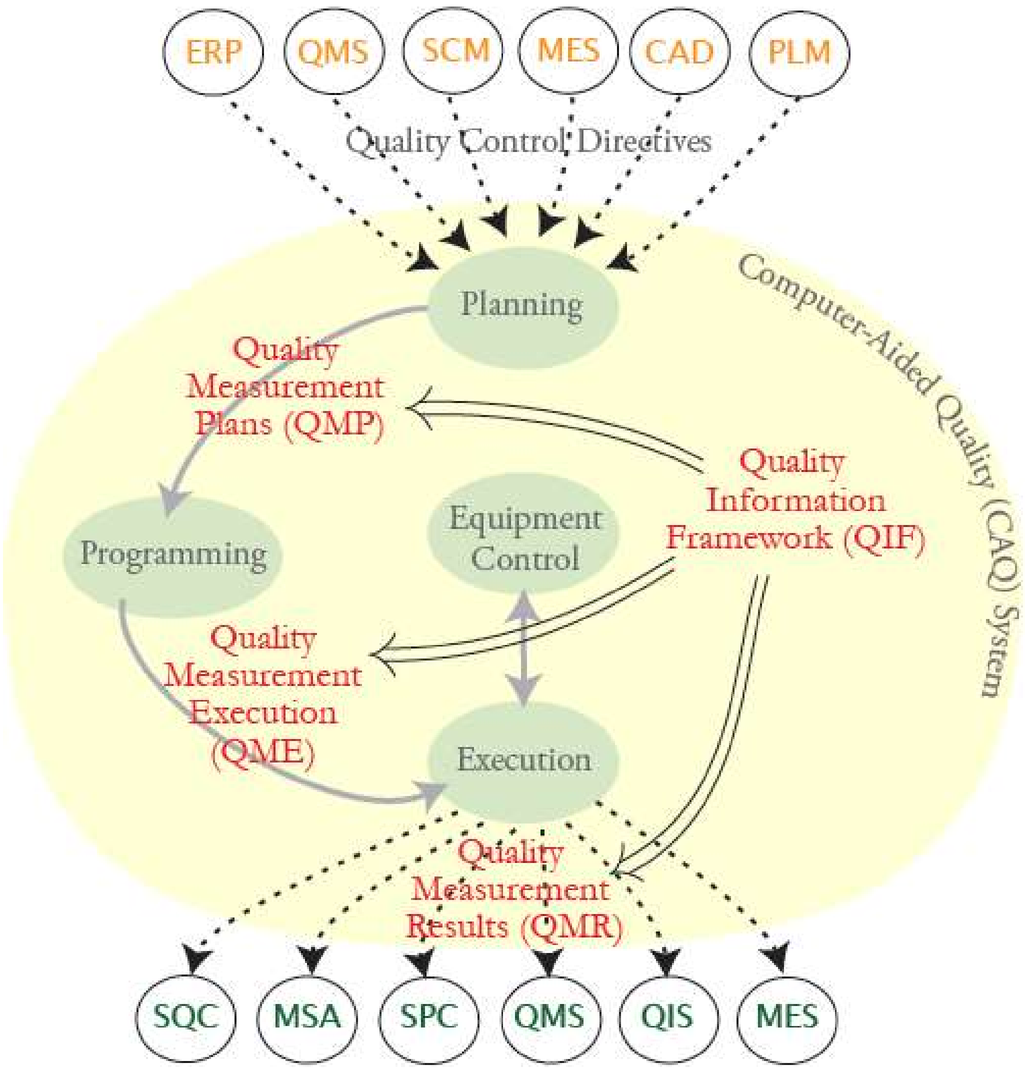
Inspection Programming

QMExecution

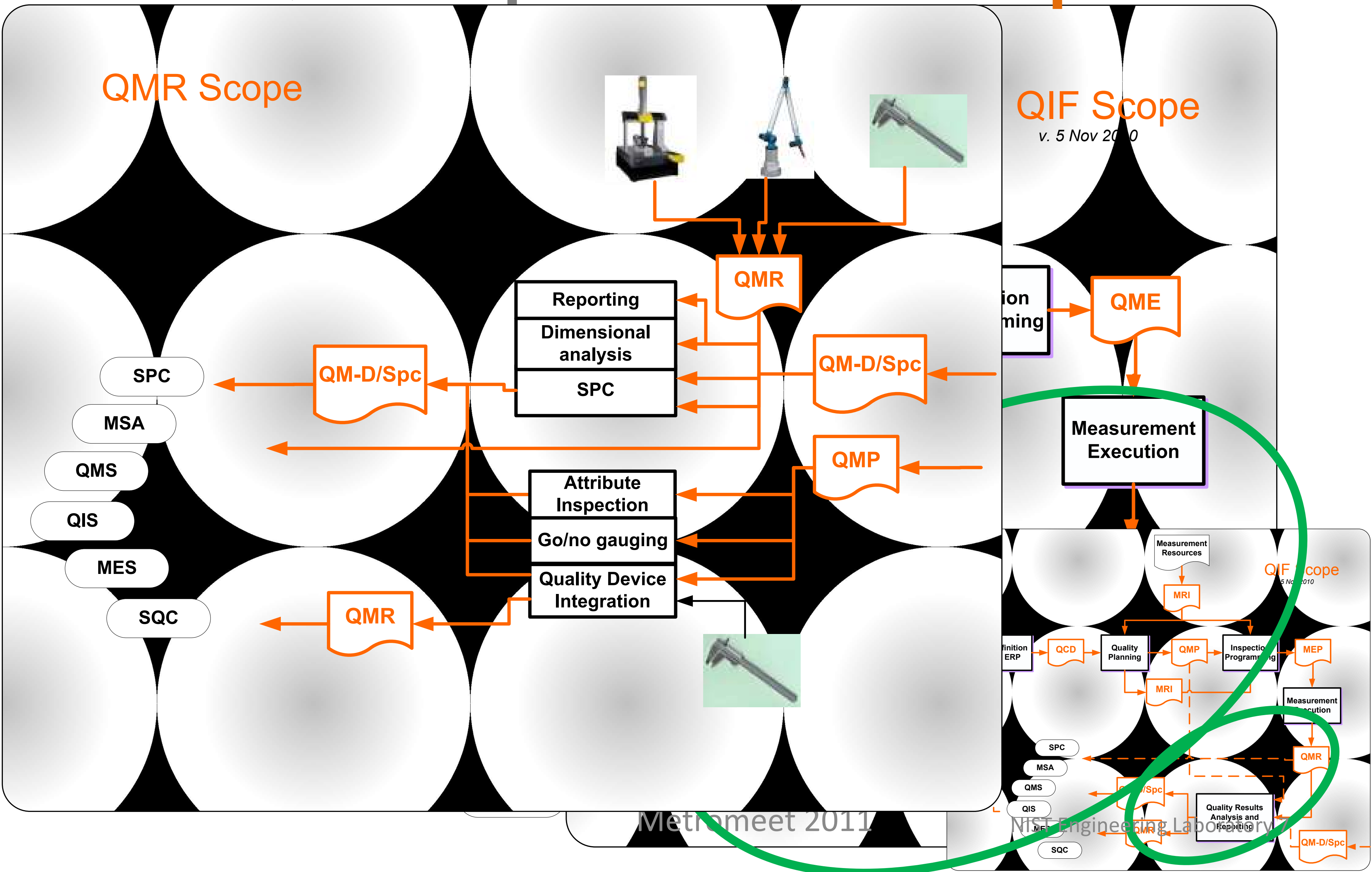
Inspection Execution

QMResults

Measurement results analysis



Quality Information Framework
QIF Scope and QMR Scope



QIF Concept

- Goal is interoperability for data exchange among quality systems
- QIF libraries define ALL base data elements for subsets of QIF (e.g. QMResults, QMPlanning, QMExecution)
- Benefits
  - avoid multiple definitions
  - avoid conflicting definitions
  - no need for point-to-point *harmonization* with other specifications (and mapping).

Validation of an Interface Specification

- We want the specification to be high quality when it is published.
- A correct, complete, and unambiguous specification for information exchange is not enough.
- The goal is having commercial products that can effortlessly exchange data according to the specification's rules. Failure can cause expensive problems in manufacturing.
- Exchange of digital data between automated processes requires agreement between the processes on format, syntax and meaning. Further, lack of agreement on completeness between sender and receiver can prevent the exchange of the rest of the information, or render it unusable.
- Two levels of requirements:
  - Upstream inputs, like planning and links to CAD data
  - Downstream requirements, like inspection analysis and traceability

QIF Validation Methods

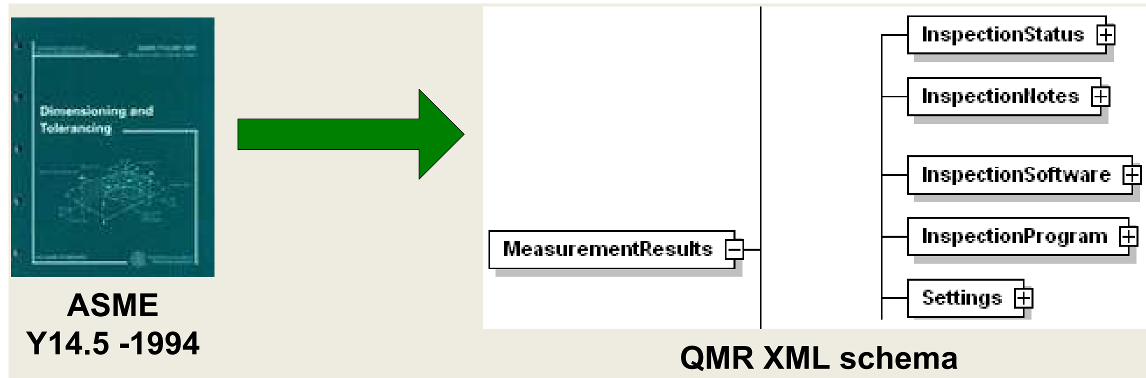
- Validate against ASME Y14.5 (1994)
- We considered: implement reference implementations for validation
- We considered:
  - test or compare to DMIS output specification
  - test or compare to DML specification
  - test against commercially produced results using challenging parts

QIF Validation Methods

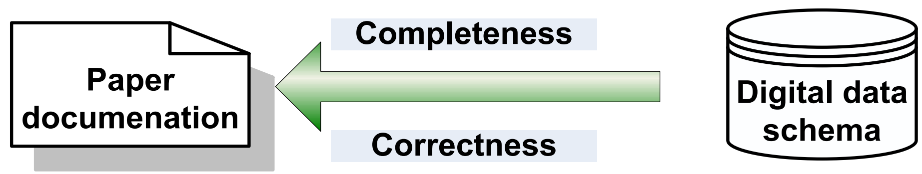
- Opportunity - Mitutoyo had generated a spreadsheet summary of all semantic GD&T in ASME Y14.5
- Approach: Use proposed Mitutoyo document as direct derivation from Y14.5
  - Characteristic (feature control frame) definitions
  - Feature definitions
- Criteria:
  - all Y14.5 data are present in QMR
  - The QMR data model is clear and consistent

Validation results (1)

- Data model development process



- Validation process



•Have all GD&T instances in ASME Y14.5 been defined in QMR? (characteristics, features)

•Does the schema represent correct semantics?

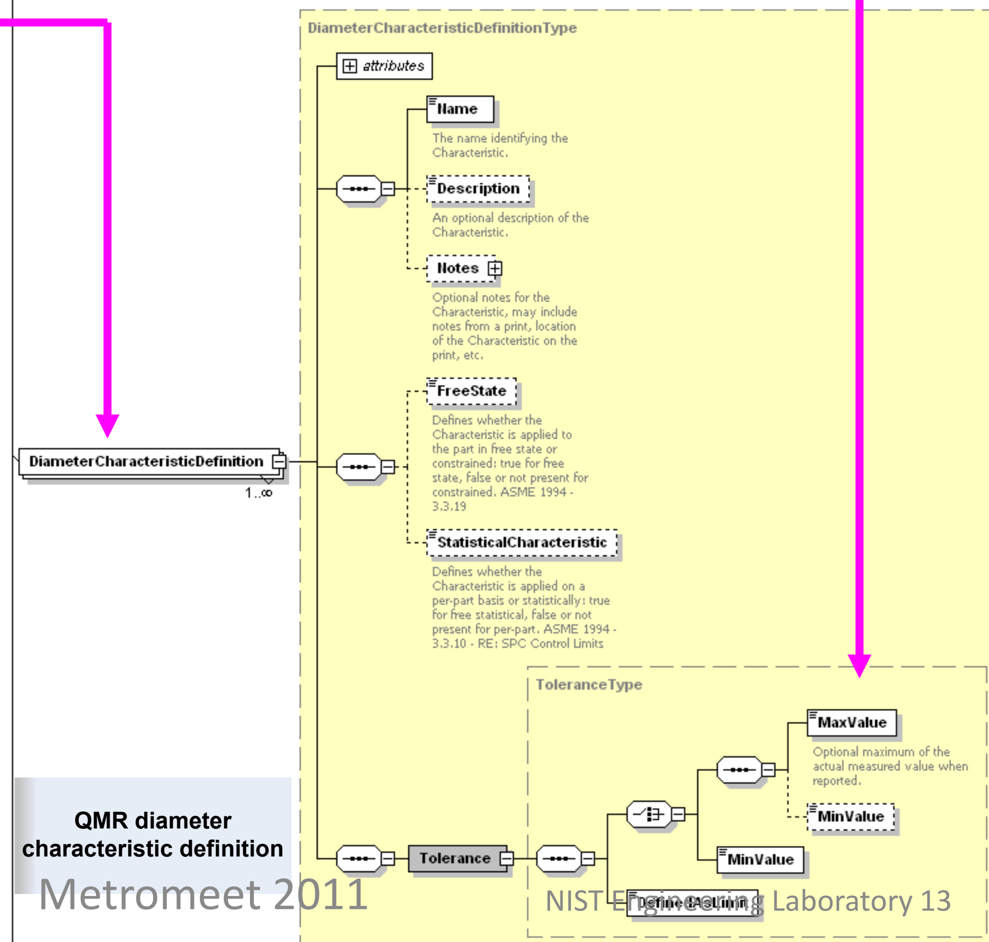
Validation results (2)

ASME Y14.5 -1994

Type	Characteristic	Example	Feature(s)	DatumType	Degree of Freedom	ASME Y14.5-1994	ASME Y14.5.1-1994
S	Spherical Diameter S∅	S∅10±0.01	Sphere	N/A		Sec. 2.7	Sec. 2.3.1
S	Diameter ∅	∅10±0.01	Cylinder	N/A		Sec. 2.7	Sec. 2.3.1
S			Circle	N/A		Sec. 2.7	Sec. 2.3.1

Mitutoyo GD&T semantic 309 form

- Every GD&T from ASME Y14.5 is defined in QMR
- Both syntax and semantics are checked



QMR diameter characteristic definition

Lessons Learned

- All 309 characteristic elements, and related features listed in the Mitutoyo document, are in QMR -> Confidence!
- Validating to the baseline spec, Y14.5, is better at this stage than using a derivative specification
- The exercise generated a document which maps GD&T characteristics to QMR data elements
- The validator was not the primary data architect:
  - this likely provides objectivity
  - validator gained QMR data model experience
  - questions posed generated explanatory material for the specification document including: overall design approach, design approach for specific data areas, and annotations for data elements.

Next Steps in QIF Validation

- Walkthrough validation is not a code-based test. Getting software developers involved is essential.
- Test implementations of solutions that import and export QIF/QMR
  - Start with QMR
  - Reference implementation (in NIST lab)
  - Conformance testing utilities
  - Tests by solution providers
- Continue to gather requirements for QIF data model
- Generate the “brothers”and “sisters” of QMR and validate/test them.
- Validate against ASME Y14.5 (2009)

Acknowledgements

- Dr. Y. F. Zhao is presently a guest researcher at the National Institute of Standards and Technology, USA. She received her BE from the Department of Flight Vehicle Engineering in Beijing Institute of Technology in China in 2003. She received her ME (honors) and PhD from the Department of Mechanical Engineering in the University of Auckland in New Zealand in 2006 and 2009, respectively. Her current research topic is STEP/STEP-NC-enabled integrated process planning system incorporating machining, inspection, and feedback; and interoperable dimensional metrology systems.
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- QIF Committee - John Horst - NIST, Robert Brown - Mitutoyo America, Larry Maggiano - Mitutoyo America

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Acronyms

- ASME: American Society of Mechanical Engineers
- CAD: Computer-Aided Design CAM: Computer-Aided Manufacturing
- CAQ: Computer-Aided Quality
- DMIS: Dimensional Measuring Interface Standard
- DML: Dimensional Measurement Language
- DMSC: Dimensional Measurement Standards Consortium
- ERP: Enterprise Resource Planning
- GD&T: Geometric Dimensioning and Tolerancing
- MES: Manufacturing Execution Systems
- MRI: Measurement Resource Information
- MSA: Measurement Systems Analysis
- NIST: National Institute of Standards and Technology
- PLM: Product Lifecycle Management
- QCD: Quality Control Directives
- QIS: Quality Information Systems
- QMP: Quality Management Planning QMR: Quality Management Results
- QMS: Quality Management Systems
- SCM: Supply Chain Management
- SPC: Statistical Process Control SQC: Statistical Quality Control
- QM-D/Spc: Temporary name for a soon-to-be formally named QIF working group