Workshop on Interface Standards for Portable Metrology Systems

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CMSC

July 19, 2006 ◊ Orlando

MEL
innovation & productivity

- Compared to fixed CMMs, portables are
  - The new kid on the block
  - A faster growing market
- Emergence of
  - Multiple portable metrology equipment vendors
  - Multiple portable software vendors
  - …and “interoperability” issues

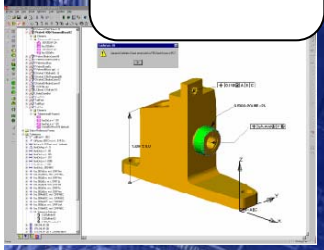
What is interoperability?

- . . .the ability to plug-and-play with components from multiple vendors worldwide with a minimum of cost (programming, time, quality, reduced competition, data translation)

What are Components?

Design | **Planning** | **Execution** | **Analysis**

CAD + PMI



Part geometry, features, tolerances, manufac-turing information

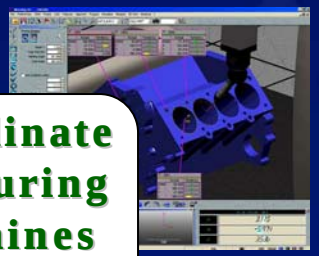
Inspection process planning

Inspection process plans

Inspection execution

CMM control commands and responses

Coordinate measuring machines (CMMs)



Measurement results

Reporting & analysis

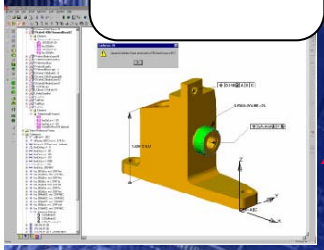
Quality measurement information

Quality device integration

What are Interface Standards?

Design | **Planning** | **Execution** | **Analysis**

CAD + PMI



Part geometry, features, and tolerances

STEP AP203e2, AP224, AP219, DML

Inspection process planning

Inspection process plans

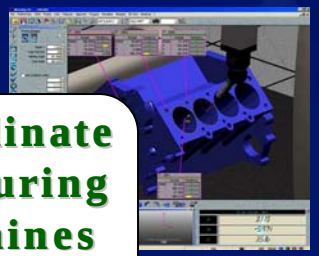
DMIS

Inspection execution

CMM control commands and responses

I++ DME

Coordinate measuring machines (CMMs)



Measurement results

DML, STEP AP219

Reporting & analysis

Quality measurement information

QMD

Quality device integration

Standards provide…

- …the ability to plug-and-play with components from multiple vendors worldwide with a minimum of cost (programming, time, quality, reduced competition, data translation)

IF…

We employ a successful standards development process

- The interoperability solution requires concurrent development of
  - Interfaces: Identify appropriate interfaces, identify existing interface standards, and identify gaps and overlaps
  - Interface languages: Timely, unambiguous, sufficiently functional, and consensus-based
  - Implementations: Timely, compliant, fully functional, interoperable, and performed by a critical mass of vendors worldwide
  - Tests: Product must pass conformance and interoperability tests for purchase

Different perspectives on interoperability

Metrology systems users' perspective on interoperability

- Users want truly common interface standards that really allow interoperability, without limiting functionality
- Interoperability allows most-appropriate-in-class choices, efficiency, and low cost due to increase competition

Metrology systems vendors' perspective on interoperability

- Vendors will seek to satisfy users' desire for interoperability
- Vendors needed to help define the interface specification
- Vendor interest is on functionality
- Vendors fear standards will limit proprietary advantages
- Ultimately even vendor will benefit from common specs:
  - if impartially defined, should level the playing field,
  - reduces cost of support for multiple proprietary standards

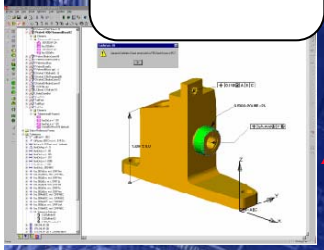
What is the goal of this workshop?

- Where are we?
- Identify interoperability pain/gain
- Where do we want go?
- What can we do to get there?

Which interface standards for portable systems?

Design | **Planning** | **Execution** | **Analysis**

CAD + PMI



Part geometry, features, and tolerances

STEP AP203e2, AP224, AP219, DML??

Inspection process planning

Inspection process plans

DMIS??

Inspection execution

CMM control commands and responses

I++ DME??

Portable measuring machines (CMMs)

Measurement results

DML, STEP AP219??

Reporting & analysis

Two major impediments to a successful interface standards that save time and money

- Lack of OEM and tier supplier involvement
- Failure to use a successful standards development process

Metrology community opinion from International Metrology Interoperability Summit 2006 at NIST

IMIS results summary

- IP issues important
  - Submarine patents and copyrights
  - Change control authority
- CAD + PMI to Measurement process planning of highest priority
- OEM and tier supplier involvement is weak in NA

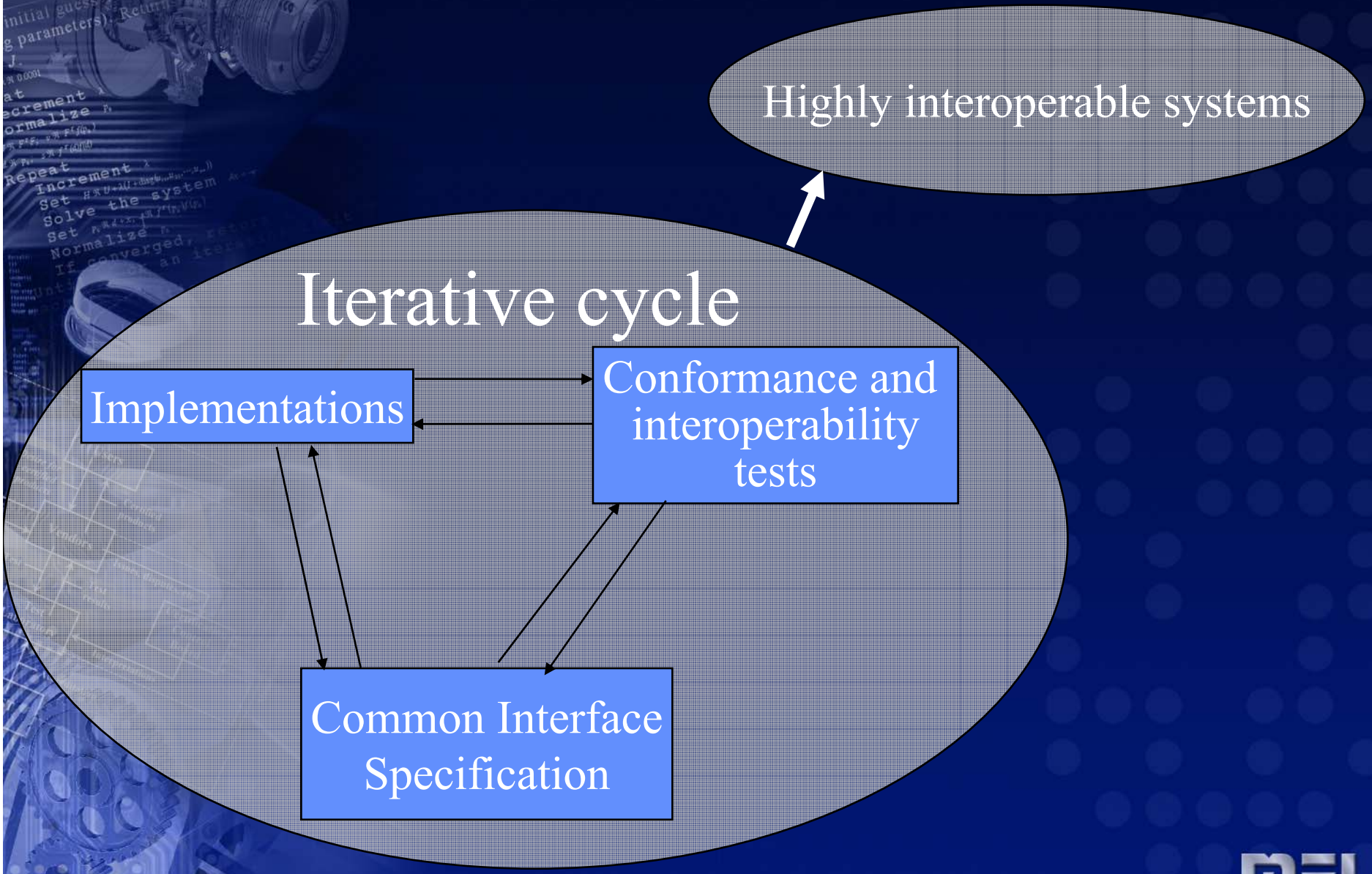
Issue: Solution	User	Vendor	Other	Com-bined
Issue: Showstopper — must be resolved: Lack of comprehensive non-shape product definitions — CAD Tolerance Data, material properties, optical properties, etc. **• Evaluate GD&T in AP203 2nd Edition — consider material properties, surface finish** **• Put GD&T definition in a derivative environment other than CAD and verify schema** **• Push CAD vendors to supply associative GD&T** **• Educate users to prevent incomplete, inaccurate, wrong, ambiguous GD&T**	**25**	**34**	**12**	**71**
Issue: A formal I++ DME framework is needed: Resolve IP, legal issues; Ensure long-term survivability of the group's activities; Preserve participants' investments; Foster the promotion and education process; Support, coordinate and expand testing activities, e.g., NIST testbed, test suite.	**8**	**23.5**	**4**	**35.5**
Issue: There is no shared vision between vendors and users for interoperability (including consensus on open-non-Proprietary only?) To develop a shared vision, gather parties - what are vendor (CAD, metrology, Product Lifecycle Management (PLM - e.g. PTC, UG, Autodesk, Dassault) business objectives, what are user (eg. AIAG, suppliers, etc.) business objectives, what are government and standards organizations objectives, find alignment between them. Solution must be win-win for all.	**6**	**22**	**6**	**34**
Issue: Lack of uniform data model for the single part report.: Provide unified data models for single part inspection measurement results	**1**	**16.5**	**15**	**32.5**
Issue: I++ DME needs to be extended to handle more equipment, sensors, environment: Extend I++ DME	**5**	**21**	**4**	**30**

Issue: Solution	User	Vendor	Other	Combined
Issue: Lack of standard mechanism to capture and exchange knowledge including methods, practices, rules: Define extensible interface standard for measurement, knowledge, rules, best practices	**5**	**16**		**21**
Issue: GD&T data is not associated with individual features of the part (the CAD model) which makes it impossible to automate inspection process programming. BTW If data is expressed as annotations in CAD files, or as notes on drawings it is not available to automated computer processes that can use it: CAD community puts associated GD&T in their data formats. This requires consensus. This is related to the meta-issue of lack of business case consensus.	**8**	**13**		**20.5**
Issue: Lack of uniform data model for quality study summary reports with traceability: Develop unified data model	**4**	**11**	**5**	**20**
Issue: CAD data (including GD&T) does not flow seamlessly to downstream processes when components are not from same vendor. Requires: buy new CAD, or buy new Inspection Planner, or translate the data. A standard data format, STEP.	**4**	**10**	**4**	**18**
Issue: Overlap between I++ DME and DMIS Part 2: dueling standards: Resolve I++ DME v. DMIS Part 2 issue: Assess activities of I++ DME and DMIS Part 2; IMIS will work with DMSC to resolve overlap between I++ DME and DMIS Part 2, so that we have a single solution	**4**	**12**		**16**

Testing defined

- What are we testing?
  - Implementations of interface specifications
  - Specifications are not tested, but benefit from feedback
- What types of tests?
  - Compliance: single implementations
  - Interoperability: pairs of implementations
- Interface specifications are not formal (more like natural language), so building compliance tests cannot be automatic…have to do the hard work of designing and building tests and test procedures by hand

Interface Standards for Portable Metrology Systems



Successful Demonstrations of Metrology System Component Interoperability at the

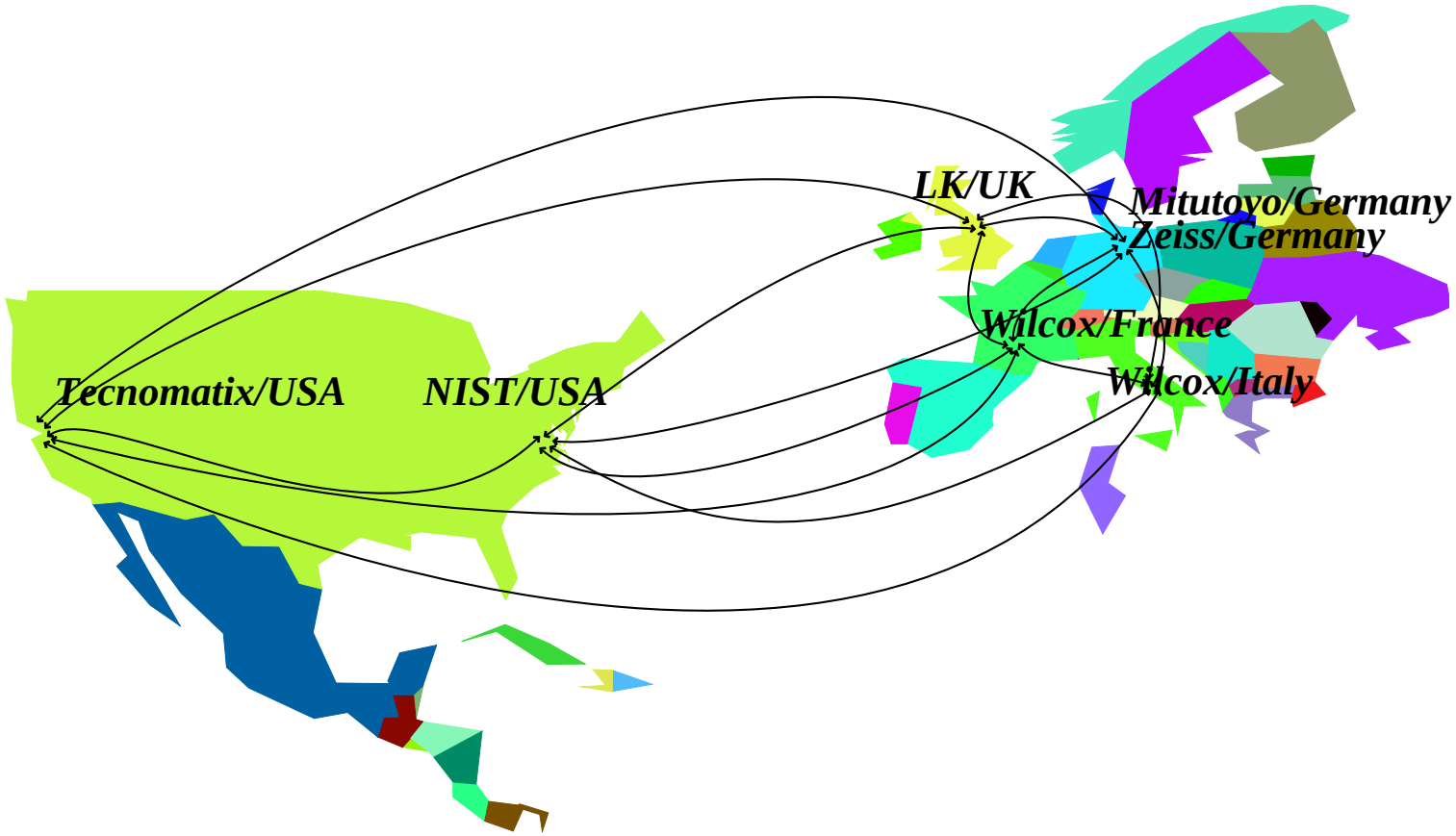
International Manufacturing and Technology Show (IMTS) Chicago, September 2004

Quality Expo 2005 Chicago, USA

Control 2005 and 2006 Sinsheim, Germany

Quality Expo Detroit 2006 Quality Data specification

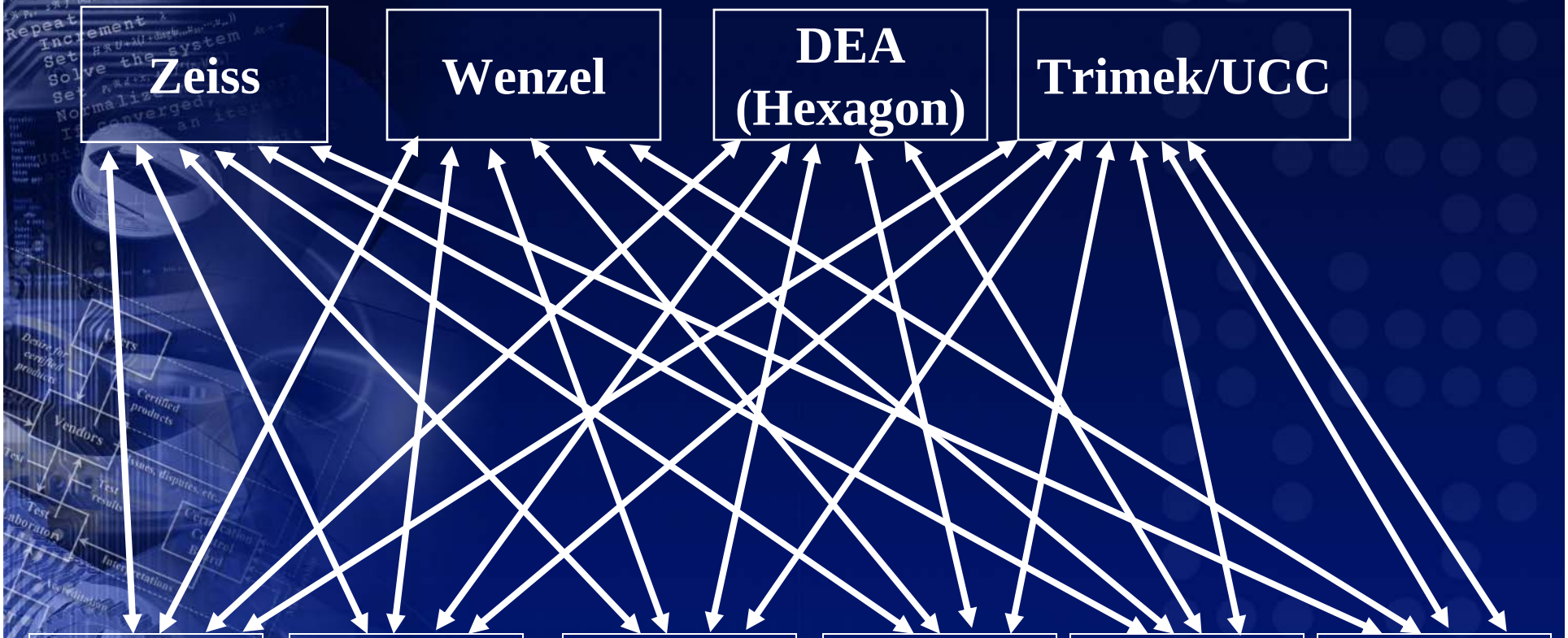
Distributed Interoperability Testing




Three CMMs
Six software clients
NATIONAL INSTITUTE OF STANDARDS
(NIST)
SPECTRUM
discovery II

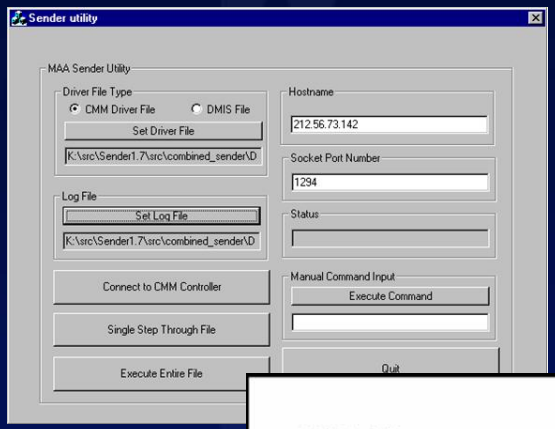
Interface Standards for Portable Metrology Systems

Interoperability Demo at Control (April, 2005) for the DME Interface using I++ DME



I++ DME Implementation/testing team

Lockheed-Martin, Zettmess, General Electric Aircraft Engine, Williams International, Dana, Metrologic, Werth Messtechnik, Delmia, Capps-Edges, John Deere, Maerklen, Mitutoyo, Gemodek, Mahr, Tecnomatix, Faro, Metromec, MessTechnik Wetzlar, Silma, Zeiss, Ford, Brown & Sharpe, Cummins, LK Metrology, Delphi Auto, Daimler-Chrysler, Caterpillar, Pratt-Whitney, Boeing, NIST, Wenzel-CMM, Wilcox & Associates

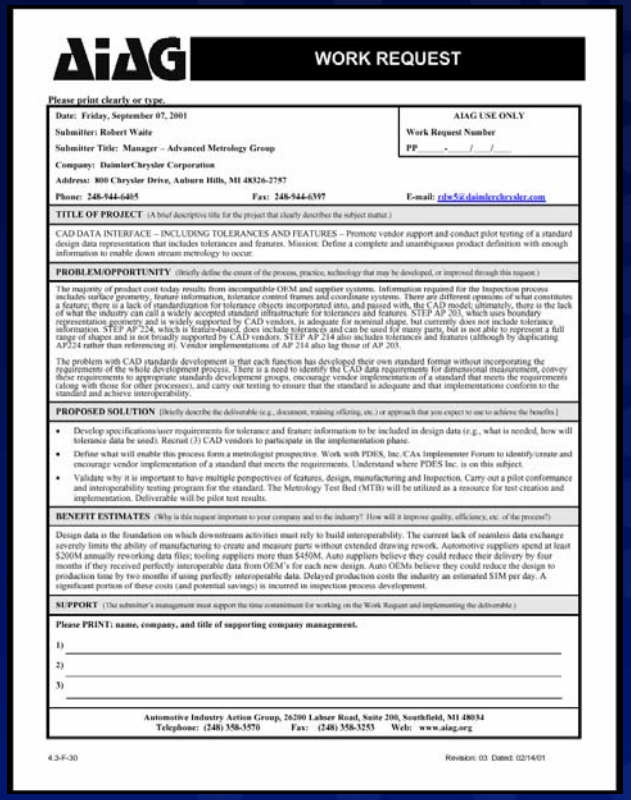


Keys to successful testing

- Broad participation: users, vendors, 3rd party
- Fair and open specification writing/modification procedure
- Increasingly unambiguous specification
- Compliance tests that provide sufficient coverage (+errors)
- No claims of conformance without actual conformance
- Interoperability tests that demonstrate success
- Hard work! Your participation!

Lessons Learned

- Collective user support, involvement, and purchase requirements essential
- Hard to get user support
  - Current economic environment
  - U.S. management wants proof of the nature of the problem
  - View of metrology as temporary evil…thinking that one day it will be unnecessary
- Vendors support the users
- Untimely and sub-functional standards are hard to avoid
- Testing is essential and must be hands-on
- Testing after release can be more costly
- NIST support depends on volunteer effort



AIAG WORK REQUEST

Please print clearly or type.

Date: Friday, September 07, 2001
Submitter: Robert Waite
Submitter Title: Manager – Advanced Metrology Group
Company: DaimlerChrysler Corporation
Address: 800 Chrysler Drive, Auburn Hills, MI 48326-2757
Phone: 248-944-6405 Fax: 248-944-6397 E-mail: rdw5@daimlerchrysler.com

AIAG USE ONLY
Work Request Number
PP ____-____/____/____

TITLE OF PROJECT (A brief descriptive title for the project that clearly describes the subject matter.)

CAD DATA INTERFACE – INCLUDING TOLERANCES AND FEATURES – Promote vendor support and conduct pilot testing of a standard design data representation that includes tolerances and features. Mission: Define a complete and unambiguous product definition with enough information to enable down stream metrology to occur.

PROBLEM/OPPORTUNITY (Briefly define the extent of the process, practice, technology that may be developed, or improved through this request.)

The majority of product cost today results from incompatible OEM and supplier systems. Information required for the Inspection process includes surface geometry, feature information, tolerance control frames and coordinate systems. There are different opinions of what constitutes a feature; there is a lack of standardization for tolerance objects incorporated into, and passed with, the CAD model; ultimately, there is the lack of what the industry can call a widely accepted standard infrastructure for tolerances and features. STEP AP 203, which uses boundary representation geometry and is widely supported by CAD vendors, is adequate for nominal shape, but currently does not include tolerance information. STEP AP 224, which is feature-based, does include tolerances and can be used for many parts, but is not able to represent a full range of shapes and is not broadly supported by CAD vendors. STEP AP 214 also includes tolerances and features (although by duplicating AP224 rather than referencing it). Vendor implementations of AP 214 also lag those of AP 203.

The problem with CAD standards development is that each function has developed their own standard format without incorporating the requirements of the whole development process. There is a need to identify the CAD data requirements for dimensional measurement, convey these requirements to appropriate standards development groups, encourage vendor implementation of a standard that meets the requirements (along with those for other processes), and carry out testing to ensure that the standard is adequate and that implementations conform to the standard and achieve interoperability.

PROPOSED SOLUTION (Briefly describe the deliverable (e.g., document, training offering, etc.) or approach that you expect to use to achieve the benefits.)

- Develop specifications/user requirements for tolerance and feature information to be included in design data (e.g., what is needed, how will tolerance data be used). Recruit (3) CAD vendors to participate in the implementation phase.
- Define what will enable this process form a metrologist prospective. Work with PDES, Inc./CAx Implementer Forum to identify/create and encourage vendor implementation of a standard that meets the requirements. Understand where PDES Inc. is on this subject.
- Validate why it is important to have multiple perspectives of features, design, manufacturing and Inspection. Carry out a pilot conformance and interoperability testing program for the standard. The Metrology Test Bed (MTB) will be utilized as a resource for test creation and implementation. Deliverable will be pilot test results.

BENEFIT ESTIMATES (Why is this request important to your company and to the industry? How will it improve quality, efficiency, etc. of the process?)

Design data is the foundation on which downstream activities must rely to build interoperability. The current lack of seamless data exchange severely limits the ability of manufacturing to create and measure parts without extended drawing rework. Automotive suppliers spend at least $200M annually reworking data files; tooling suppliers more than $450M. Auto suppliers believe they could reduce their delivery by four months if they received perfectly interoperable data from OEM's for each new design. Auto OEMs believe they could reduce the design to production time by two months if using perfectly interoperable data. Delayed production costs the industry an estimated $1M per day. A significant portion of these costs (and potential savings) is incurred in inspection process development.

SUPPORT (The submitter's management must support the time commitment for working on the Work Request and implementing the deliverable.)

Please PRINT: name, company, and title of supporting company management.

1) _____
2) _____
3) _____

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