Coordinate Metrology Society
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CMS-2017-026

Metrology Certification

AUTHORS
CMS Certification Committee

ORGANIZATION
Coordinate Metrology Society

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Metrology Certification

CMS Certification Committee

July 18, 2017

CMS Certification Committee

The CMS Certification Committee was formed in 2009 to assess the need and feasibility of creating a Certification program for portable metrology professionals. A charter was developed that defined the committee membership, the reporting responsibility and updated the CMS bylaws to make the certification committee a standing committee. The committee researched existing certifications, surveyed the CMS membership (2009 conference) and began developing a preliminary Body of Knowledge (BOK). The committee also determined the role of the Coordinate Metrology Society as an issuing authority.

2009-2017 accomplishments

- Market Study
- Membership surveys
- Committee chartered
- Created Bylaws
- Created a Body of Knowledge
- Accreditation Research
- Selected ASPRS as certification partner
- Development of skills study at CMSC 2010/2011
- CMS contracted National Occupational Competency Testing Institute (NOCTI) to provide oversight of assessment development.
- Developed Level1- (General) and Level2 (Performance) PCMM & Laser Tracker assessments
- Designed and Developed CMS Certification Handbook

Quiz!!!

Certification

CMS CERTIFIED

VS

Certificate



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This cre ssment process



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CERTIFICATE of ACHIEVEMENT
THIS ACKNOWLEDGES THAT
Recipient Name
HAS SUCCESSFULLY COMPLETED THE
Program/Project Name
MONTH, DAY
YEAR
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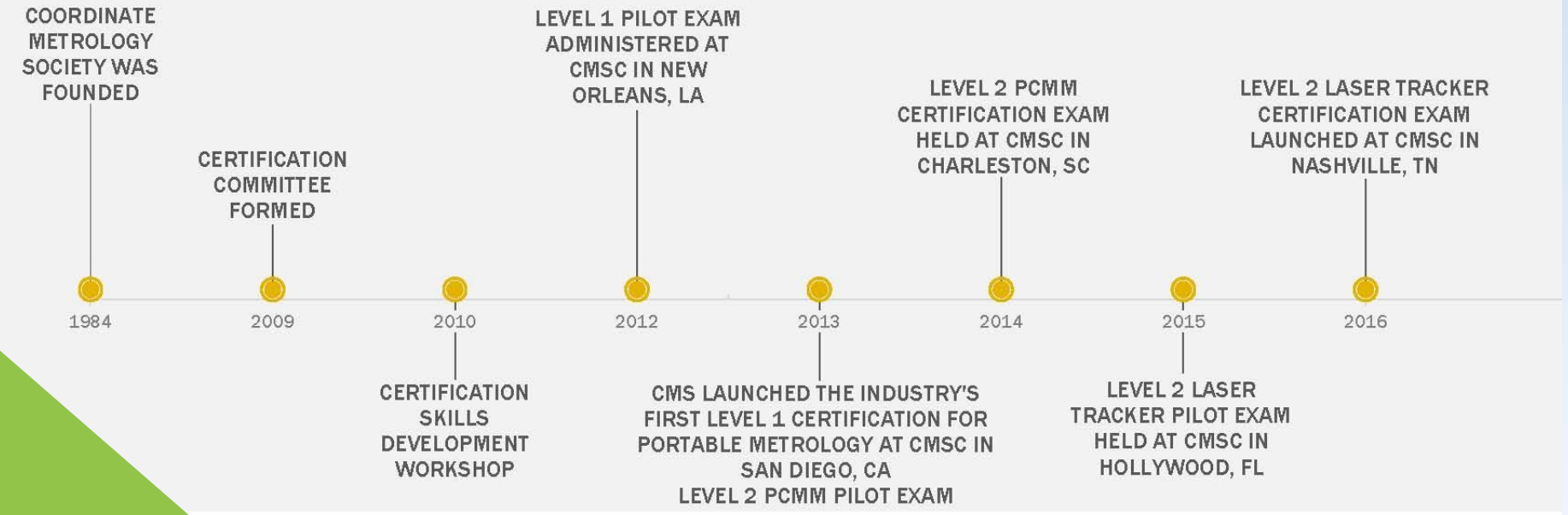
CMS Certification Committee 2017

Members

Randy Gruver	The Boeing Company, Employee Development
Al Metzel	Northrop Grumman Electronic Systems
Bob Elliot	Lockheed Martin Integration/Test Engineering Senior Staff, Alignment Engineer
Matthew Ilardo	Brookhaven National Lab, Alignment Engineer
Gary Confalone	East Coast Metrology, President CEO
Ulysses Green	The Boeing Company /GKN / RT
Chuck Pfeffer	FARO Technologies, Director of Product Management - Metrology
Ben Rennison	The Boeing Company, Boeing Research & Technology

The Certification Journey

Timeline



The Project Plan

ID	Task Name	Duration	Start	Finish
1	Review BOK	1d?	11/29/11	11/29/11
2	Define Job Duties	1d?	11/29/11	11/29/11
3	Define duty tasks	1d?	11/30/11	11/30/11
4	Rank duties & tasks	1d?	11/30/11	11/30/11
5	Draft Non-dosclosure agreement (NDA) reviewed And approved by CMS EC	1d?	11/29/11	11/29/11
6	Define level 1 & 2	1d?	11/30/11	11/30/11
7	Dacum decision	1d?	11/30/11	11/30/11
8	RFP to NOCTI	1d?	12/12/11	12/12/11
9	Quote from NOCTI	9d?	12/13/11	12/23/11
10	CMS EC review and approve Whitener contract	1d?	01/17/12	01/17/12
11	CMS and Whitener sign contract	1d?	01/20/12	01/20/12
12	NOCTI Delphi round 1	16d?	02/10/12	03/02/12
13	Cert committee review ASPRS admin and application process	1d?	03/08/12	03/08/12
14	Final NDA & Ethics approval	1d?	03/08/12	03/08/12
15	NOCTI modifications to Delphi round 1	5d?	03/05/12	03/09/12
16	NOCTI Delphi round 2	10d?	03/19/12	03/30/12
17	NOCTI Delphi study data review	1d?	04/06/12	04/06/12
18	NOCTI DACUM (modified)	2d?	05/01/12	05/02/12
19	NOCTI assessment assembly	11d?	05/04/12	05/18/12
20	CMS cert review of draft assessment	1d?	05/23/12	05/23/12
21	NOCTI assessment approved by EC	6d?	05/25/12	06/01/12
22	**CMSC 2012**	**77d?**	**04/05/12**	**07/20/12**
23	Draft presentation outline c/d with MS	56d?	04/05/12	06/21/12
24	Create feedback questions for test participants	27d?	04/05/12	05/11/12
25	Determine fabulous gift for participants	56d?	04/05/12	06/21/12
26	Create assessment schedule/sign up sheet	13.5d?	04/05/12	04/24/12
27	Create signage	56d?	04/05/12	06/21/12
28	Create proctor guidelines	56d?	04/05/12	06/21/12
29	Print NDA and participant guidelines & insert in grab bags	56d?	04/05/12	06/21/12
30	Presentation approved by EC	1d?	06/21/12	06/21/12
31	Pilot assessment administered	5d?	07/16/12	07/20/12
32	Final assessment approved	1d?	09/03/12	09/03/12
33	Cert committee final draft of ASPRS admin process	1d?	08/09/12	08/09/12
34	Cert committee final draft of ASPRS admin process approved	1d?	08/09/12	08/09/12
35	Cert committee final draft of ASPRS admin process complete	1d?	08/09/12	08/09/12
36	Cert committee final draft of ASPRS admin process approved by EC	1d?	08/31/12	08/31/12

Validate the Need

- Industry Requested Certification
- Potential Growth
  - Nuclear – Increase in production and reset
  - Aerospace – Extended Service Life
  - Automotive – Efficiency requirements
- Contractual Requirements
- Standardized Practices
- Customer Demand of Qualifications
- Membership feedback
- Supports a Quality Management System

Market Research

aseline with CMS membership (survey)

lso contacted UAW International through CMS automotive connected members

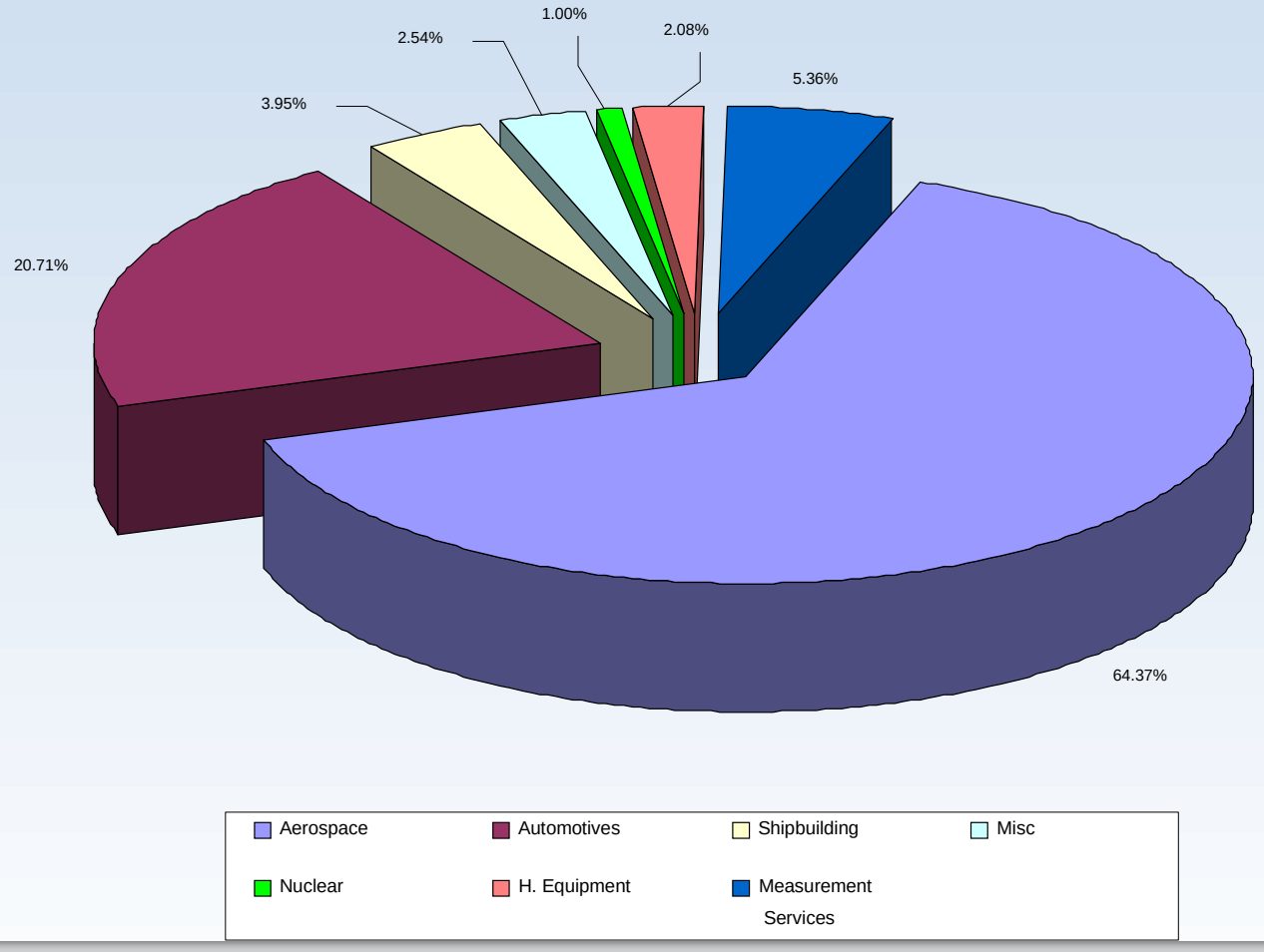
ontacted each represented company by phone

sked to provide how many 3D Metrologists worked at the facility

otal number of users from survey: 2407

Market Research

Portable 3D Metrology users by sector



Accreditation Research

SO 17024 Personnel Certification

NSI accredits to ISO 17024 in US

ttended ANSI workshop on ISO 17024

he Council of Engineering & Scientific Specialty Boards (CESB)

Workshop Feedback

0% of those in attendance learned OJT

2% recommended proficiency testing

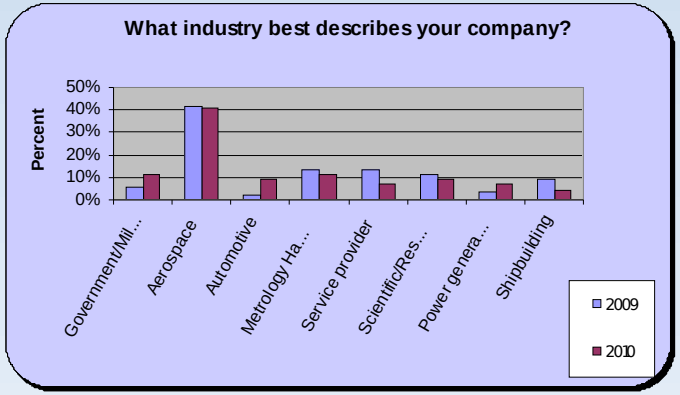
0% recommended graduated levels

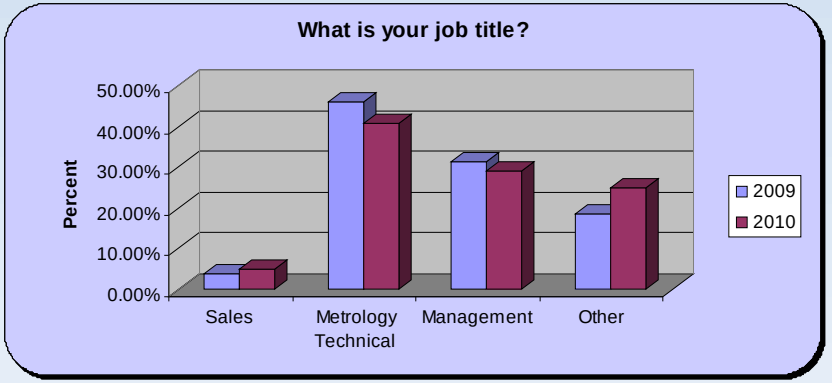
ccreditation was strongly recom

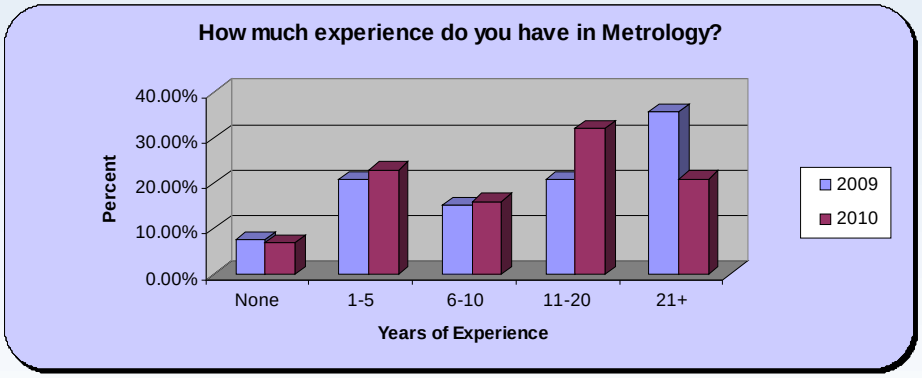


Engage membership

2009/2010 Workshop Attendees - Industry







Perceived Value to Company

- ~91% of respondents felt that certification had at least some value

Category	# Responses	% of Respondents
No value	26	9%
Has some value	115	38%
Valuable	106	35%
Extremely Valuable	53	18%
	300	100%

9%

91%

- Of the 159 indicating valuable/extremely, the highest % were in aerospace (among groups)

Group	# Valuable/ ExtremelyValuable	%
All	159	53%
Aerospace	78	62%
Automotive	11	39%
Metrology Device Mfg	15	48%
Others	55	48%



Value to Customer vs. Company/Individual

- Interest in certification appears largely driven by personal/company benefits, not by customers
  - Only 29% indicated that customers request certification

	% of Respondents
Personal: Valuable/Extremely Valuable	53%
Company: Valuable/Extremely Valuable	53%
Customer: Sometimes/Often Request Certified Operators	29%

Certification Process

- Among the choices, most preferred ‘general certification’ or ‘general with add-on hardware modules’ (~70%)
  - Survey Responses: Certification should be:
    - general and not include hardware specific knowledge.
    - a general certification that is hardware independent along with individual hardware technology group modules that can be added to the general certification.
    - individual certifications for each hardware technology group.
- Similar results across all industry groups (see appendix)

Category	# Responses	% Responses
General Only	46	15%
General plus Hardware Specific	167	56%
Individual by Hardware	72	24%
No Response	15	5%
	300	100%

Certification Requirements

- Of those indicating their company would seek certified employees, majority desire a ***rigorous process***
  - ***With*** both written exam and demonstration of proficiency
    - One potential challenge: some existing certification bodies (such as ASQ) do not perform proficiency evaluations.
  - Majority also wanted documented experience/ annual hours

		N = 271
Category	**# Responses**	**% of Respondents**
Demonstrate Proficiency	216	80%
Written Exam	205	76%
Documented Experience	158	58%
Maintain Annual Hours	150	55%

Jaegar method

$$s_u^2 \equiv \frac{1}{N-1}\sum_{i=1}^{N}(u_i - \overline{u})^2$$

$$s_v^2 \equiv \frac{1}{N-1}\sum_{i=1}^{N}(v_i - \overline{v})^2$$

$$s_{u\,v} \equiv \frac{1}{N-1}\sum_{i=1}^{N}(u_i - \overline{u})\,(v_i - \overline{v})$$

(where $s_{i\,i} \equiv s_i^2$), so

$$s_x^2 = s_u^2\left(\frac{\partial x}{\partial u}\right)^2 + s_v^2\left(\frac{\partial x}{\partial v}\right)^2 + 2\,s_{u\,v}\left(\frac{\partial x}{\partial u}\right)\left(\frac{\partial x}{\partial v}\right) + \ldots.$$

If u and v are uncorrelated, then $s_{u\,v} = 0$ so

$$s_x^2 = s_u^2\left(\frac{\partial x}{\partial u}\right)^2 + s_v^2\left(\frac{\partial x}{\partial v}\right)^2.$$

Lager method



Repeatable but inconsistant

Measurement Study Timeline

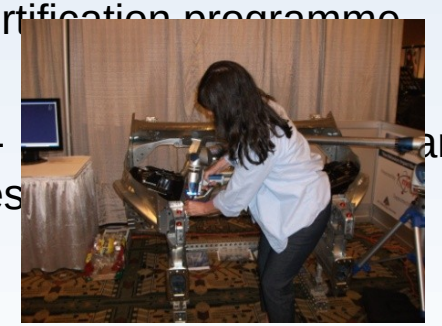
010 - measurement study introduced - First principle measurement study based on a variety of 'hand tools' used in dimensional measurement. The objectives looked at the importance of core measurement principles, instilling the right measurement strategy, questioning and observing behaviours when dealing with measurements.



011 - 3 Portable Co-ordinate Measurement Systems looking at the 'influence of behaviours' on the measurement result.



012 - 6 Portable Co-ordinate Measurement Systems looking at the 'appropriateness' and the 'importance of practical testing' to support the certification programme.



013 - and p pport of th fication proces





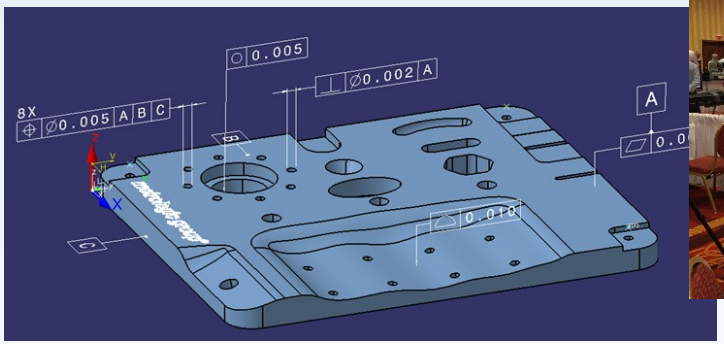
Performed measurement studies

Work area checks: Regarding the part **stability** and **fixturing**, did the participant:



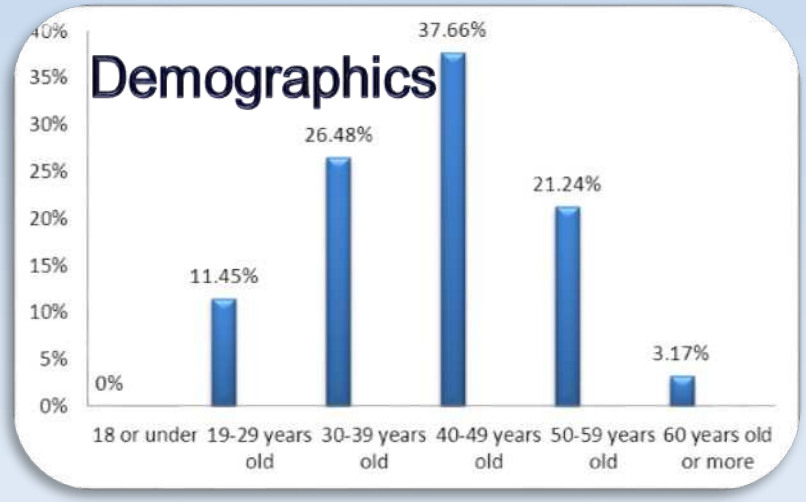






a) Simply ask about it
b) Make sure the part was stable then (re)measured the part
c) Ignore that aspect
d) Correct the stability half way thru the survey without re-measuring features measured prior?

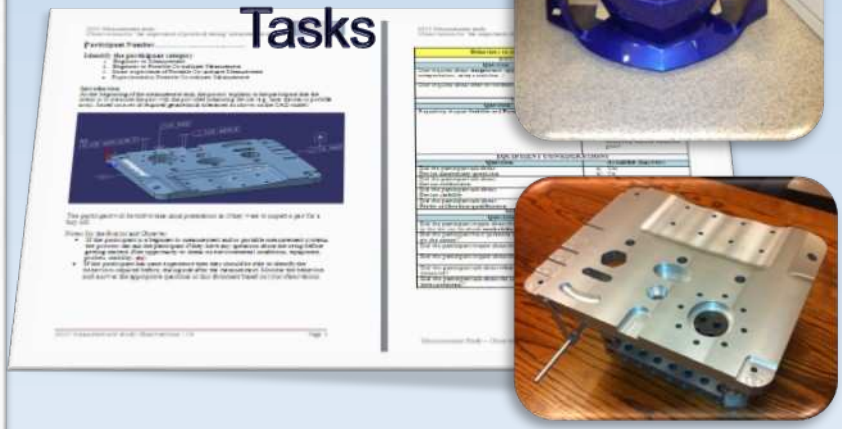
Evaluated results

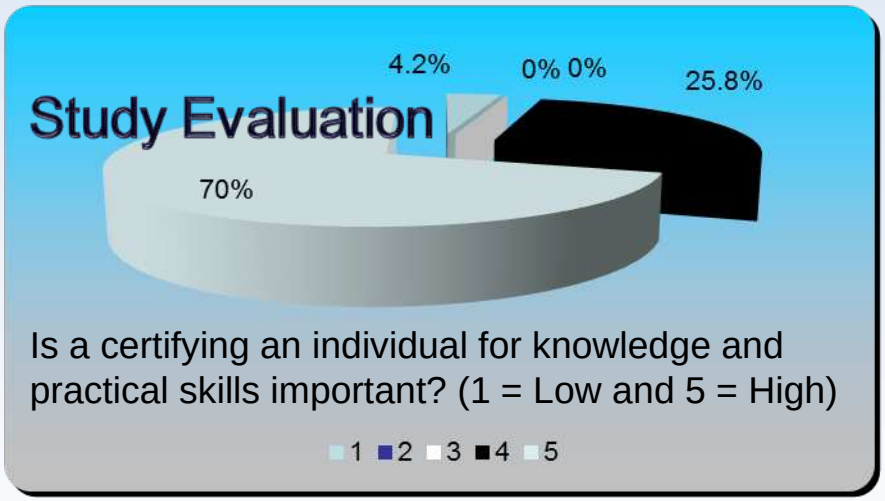


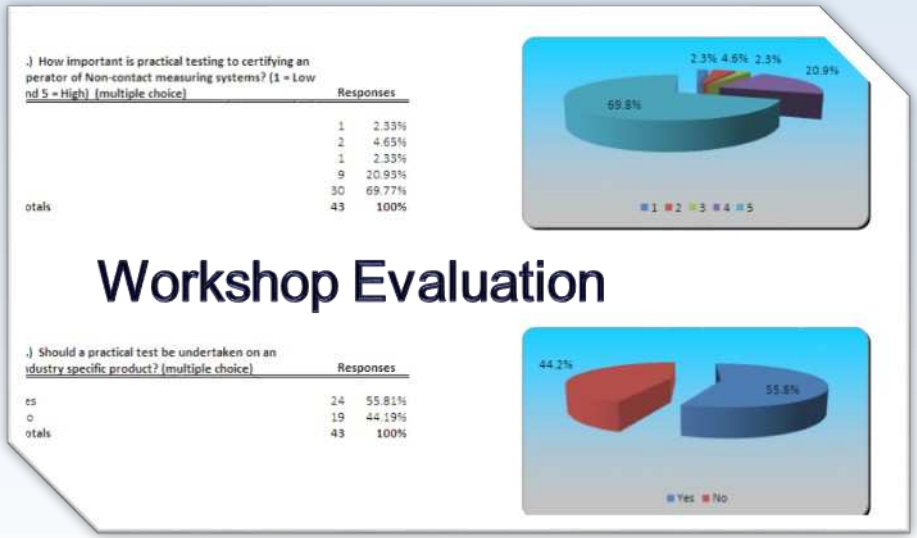
Study Team



Study Tasks







Evaluated results

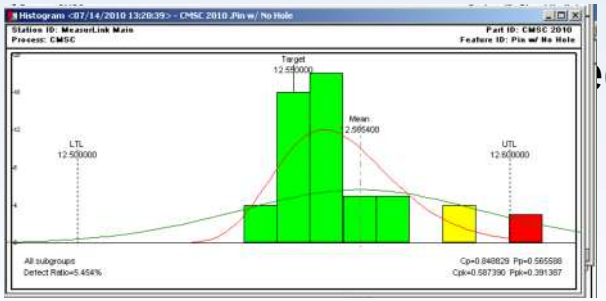
measurement tasks with and without instruction covering diameters,

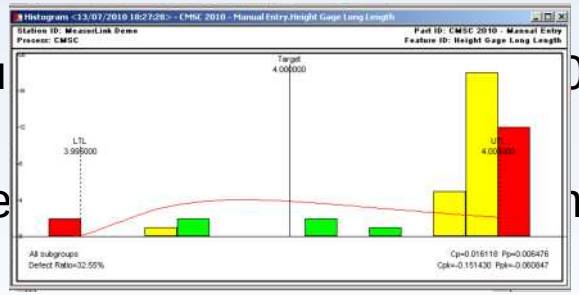
ength, depths and gauge block wringing

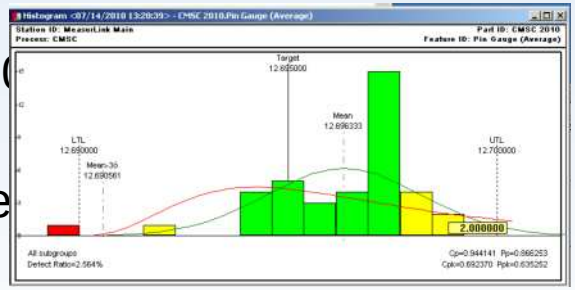
ask 1: Without procedures 55 readings ranged from 0.006 to 0.0075 inches

ask 2: Without procedures 43 readings ranged from 0.0015 to 1.21 inches

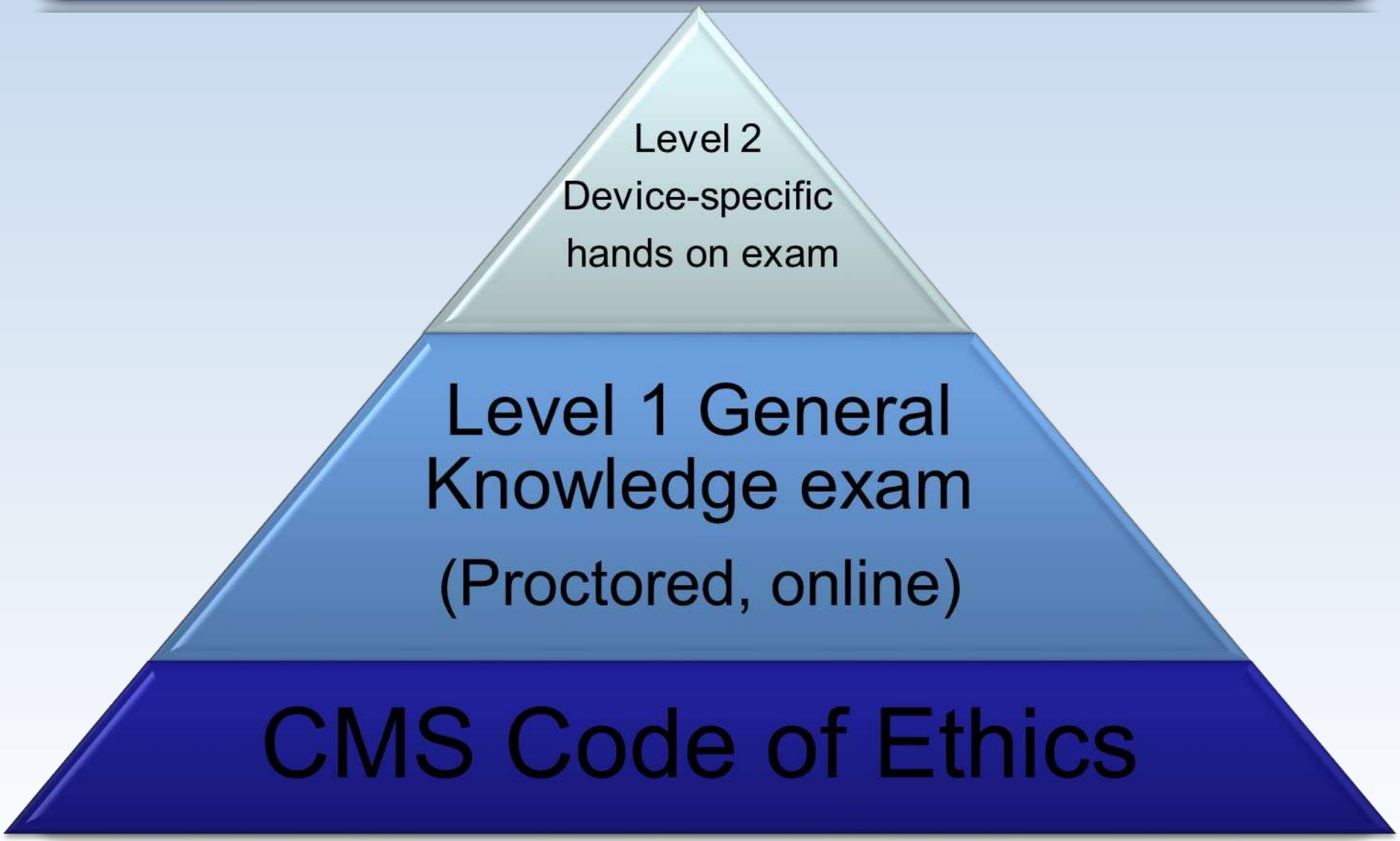
ask 3: With procedures 39 readings ranged from 0.0003 to 0.002 inches







Created Certification Structure



Developed the process



Defined Level 1 Requirements

asic Requirements The basic requirements for a Level-One Certified Portable 3D Metrologist are:

.A professional who uses portable 3D metrology technology to collect measurements and interpret data from a variety of contact and non-contact portable 3D measurement devices. The Portable 3D Metrologist is responsible for all phases of data collection and other requirements such as planning and supervising survey activities requirements and interpretation.

.Two years of experience in portable 3D metrology, one year of which was in a position of responsibility demonstrating professional knowledge and competence.

.References from four people who are holding, or who have held, responsible positions in portable 3D metrology and have first-hand knowledge of the applicant’s professional and personal qualifications.

.Declaration of compliance with the Code of Ethics of the Coordinate Metrology Society.

.Successful completion of the online examination.

Defined Recertification Requirements

Active' Status Requires Re-Certification

- Every 5 Years for Certified Professional

ubmit Completed Application

rovide 3 References

o Written Examination Required

ub-Committee Evaluation

- Document Experience and Activity During the **Previous 5 Years**
- Must Satisfy Minimum Requirements of 75 PDH's
  (Professional Development Hours)

Certification Structure

Level 1 General Principles (Cognitive)

Focus Area	% of questions
Interpret design documents/requirements	**16%**
Measurement device knowledge	**16%**
Pre-measurement planning	**23%**
Performing measurement operations	**25%**
Analyzing data	**19%**
Ethics and professional responsibility	**1%**

Certification Structure

Level 2 PCMM Performance Matrix (PCMM)

Assessment Matrix for Level-Two Certification for 3D Metrology		
Job #	**Performance Assessment**	**% of Exam**
Job 1	Set up, Compensate Probe and Perform Field Checks on an Articulating Arm including Basic Operator Repeatability Test	9%
Job 2	Measure Dimensions and Angle with Print	24%
Job 3	Measure Feature Form (including Flatness, Roundness) with Print	14%
Job 4	Measure Orientation (Parallelism, Perpendicularity) with Print with GD&T	18%
Job 5	Relocation	14%
Job 6	Measure Position Features (6 Hole Pattern) using a Print including Alignment and Analysis in CAD, including Probe Change with Sheet Metal (Thin Section) Trim.	7%
Job 7	Measure Profile (CAD)	14%

Defined Recertification Requirements

Evaluation Activity for Recertification	Criteria	Maximum Number of PDH Allowed Within Last 5 Years	Documentation Requirement
Required Minimum Continuing Experience: Applicant has been active in providing services within their certified discipline, or has been in the academic arena involved directly with those subjects.	3 years of the past 5 years actively providing services	50 PDH Credits	Document Position(s) Description(s) and dates
Applicant has contributed and participated in activities of service to the profession and community (see list below)	See items 1 – 10 listed below for PDH Credits	50 PDH Credits	Document Titles with Referencing
Published Papers and/or professional manuals (see list below)	See items 11-13 listed below for PDH credits	20 PDH Credits	Document time spent, titles with full referencing
Applicant has attended workshops/classes or (webinars) in directly related subjects	1 PDH per hour attended (0.1 CEU = 1 PDH)	50 PDH (5 CEU)	Document Course, Titles, and Date
Applicant has attended technical conferences and other professional meetings sponsored by CMS, ASPRS, ISPRS, SPIE, and other appropriate professional organizations.	1 PDH per hour of technical session attendance	40 PDH	Document Meeting Titles

Defined Recertification Requirements

	Description of Activities that may be used for Recertification	Credits
1)	Active member of an industry committee (5 PDH Credits per year)	20
(2)	Holding office on industry committee (e.g. elected or appointed CMS Executive Committee member appointed CMS subcommittee chair, appointed chair of vice-chair on other industry committees) (5 PDH Credits per year)	25
(3)	CMS Executive Committee Chair or other elected chair or vice chair on other industry committees (10 PDH Credits per year term)	50
(4)	Session Moderator at Technical Conference (1 PDH Credit each)	5
(5)	Author or co-author of a conference technical presentation, poster session, paper or panel session (5 PDH Credits each)	25
(6)	Adjunct teaching a formal class in an academic setting [when not applicant's primary occupation] (2 PDH credits per course)	10
(7)	Workshop Instructor (2 PDH credits per course for a maximum of 4 credits per year)	12
(8)	Examination Committee Contributor (2 PDH credits per instance for a maximum of 5 per year)	10
(9)	CMS/ASPRS Certification exam proctor/panel (2 PDH credits per instance for a maximum of 4 per year)	8
(10)	Community/Career extra curricular, i.e., Pro Bono involvement (3D metrology), e.g., Public Agency (3D metrology) Advisory Board, Citizens Advisory Group, (5 PDH credits per activity)	10
(11)	Author/editor of published 3D metrology-related book (15 PDH Credits per book)	20
(12)	Author (not prime) of one or more chapters of a published 3D metrology-related book (5 PDH Credits)	20
(13)	Author/Co-author of a peer-reviewed, published paper (5 PDH credits per paper)	20

Certification Structure

Level 2 Hands-On (Psychomotor)

aser Tracker

CMM

hotogrammetry

rea Scanner

and Scanner

pherical Scanner

ost Processing

Authorized Level 1 Proctor Sites

API Services - Virginia
Contact: Ron Hicks, President
709 Middle Ground Blvd., Suite B-105, Newport News, VA 23606
T. 877-687-954 | F. 877-946-5776
E. services@apitechnical.com

BuildIT Software & Solutions Ltd - Canada
Contact: John Chan, Application Engineer, Metrology Specialist
4999 Ste-Catherine W., Suite 308, Montreal, QC, H3Z 1T3, Canada
T. 514-369-4055 ext. 245 | Toll-free 888-687-2348 | F. 514-369-2348
E. info@builditsoftware.com

ECM - Global Measurement Solutions (East Coast Metrology) – Massachusetts
Contact: Gary Confalone, President
428-A Boston Street, Topsfield, MA 01983
T: 978-887-5781 x116 | M: 978-621-0846 | F: 978-887-5782
E: gary@eastcoastmetrology.com

FARO Technologies – Florida
Contact: Michelle Edwards, Applications Engineering Manager
250 Technology Park, Lake Mary, FL 32746
T. Toll-free 800-736-0234 x1004 | M. 386-846-9997 | F. 407-562-5246
E. Michelle.Edwards@faro.com

Hexagon Manufacturing Intelligence – California, Texas, Virginia, Washington
Contact: Emily O'Dea, Applications Engineer
7 Orchard Rd #102, Lake Forest, CA 92630
T. 734-233-4147 | Toll-free 800-955-5200 | F. 949-727-0167
E. emily.odea@Hexagon.com

Planet Tool & Engineering – Missouri
Contact: Ron Rode, Manager of CMM Services
315 S. Cool Springs Rd O 'Fallon, MO. 63366
T. 636-379-9800 | F. 636-379-9400
E. rgrode@ktis.net

Level 2 Certified Member

“The CMS Certification gave me tremendous credibility when meeting with customers. They understand that I possess the knowledge required to tackle their metrology challenges.”

John Chan
Application Engineering Manager | Chef Ingénieur d'Applications
T 1-514-369-4055 x245 www.builditsoftware.com

Level 2 Certified Member

Strenuous checks and balances have been set to ensure metrology hardware and software are traceable, accurate and precise. Yet, few standards have been set to ensure the operator is knowledgeable in the science of measurement. The CMS Certification instills reassurance in my customer that I am qualified in metrology best practices.

Matt Chieppa | Account Manager, Faro

Mobile: 434.856.2687 | Fax: 407.333.4181

Level 2 Certified Member

Thank you!

Contributors

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Dr. David MacKinnon	**National Research Council Canada**
Ron Hicks	**API**
Mike Renslow	**ASPRS**
Randy Gruver	**Boeing**
Ulysses Green	**Boeing/GKN Aerospace**
Talion Edwards	**Boeing**
Paul Reed	**Boeing**
Ben Rennison	**Boeing**
Matthew Ilardo	**Brookhaven National Lab**
Mathieu Dube'-Dallaire	**BuildIt Software**
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Thank you!

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Nathalie Anderson	Metrologic
Jeffrey Bourque	Nikon Metrology
Pat Walsh	MVS Group
Dr. Katherine Manning	NOCTI
Al Metzel	Northrop Grumman
Ron Rode	Planet Tool
Mitch Fields	TriMet
Ernie Hustad	Verisurf
Scott Knoche	Verisurf
Michael Mock	3D Systems

Developed Certification Handbook

Download

www.cmsc.org



Questions?

EC candidates Al Metzel, Phil Caudill, Daniel Sawyer, and Bob Elliott are manning the mic’s.

Thank You!

