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**COMPUTED TOMOGRAPHY  
AND GEOMETRIC  
ARTIFACT CORRECTION**

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VISIT THE INSPECTION  
DIVISION WEBSITE AT  
[ASQ.ORG/INSPECT](http://ASQ.ORG/INSPECT)

## Chair's Message | Jim Spichiger



**Like this newsletter, my message will be brief.**

THANK YOU for reading this abbreviated, special edition newsletter. As we did in 2017, the Inspection Division will publish a quarterly newsletter this year. The first issue is hard copy, followed by three electronic issues. Though the expense to communicate via hard copy is immense, our 2018 business plan has identified communication as the highest-priority activity and since a small percentage of our members have

opted out from receiving electronic communication, this will be one of the two printed media that will reach them this year.

This is the Inspection Division's 49<sup>th</sup> year and I am expecting it will be our best year ever. The Division Management Committee is working hard to deliver extraordinary member value. Though membership dues have not increased, the amount of membership offerings will. In addition to our already expansive list of member benefits, here are some of our expanded offerings in 2018:

- Free webinars will be conducted each month
- An increase in technical articles in our newsletter
- Greater social media presence
- Educational courses besides certification preparation will be offered
- An increase in the number of sessions and exhibitors at our conference
- The Inspection Division web page will be radically redesigned and offer greater information

I know you have a choice in which ASQ divisions you belong to, so I and the rest of the Division Management Committee want to provide you with the information and benefits that will satisfy your needs in order to remain a loyal member. If you are less than satisfied with your membership experience or if you simply have any suggestions on what more we can do, please do not hesitate to contact me at [jim.spichiger@hotmail.com](mailto:jim.spichiger@hotmail.com) or, better yet, call me at 740-349-3708.

Enjoy reading this issue.

Thank you for your membership.

*Jim*

## 2018 Priorities: Communication, Education, and Recognition

The Inspection Division Management Committee has developed an extensive list of activities for its 2018 business plan; however, activities related to communicating to our members, education, and recognition will be top priority. These activities will be executed in the following ways:

- **Communication:** this newsletter and three electronic versions, development of an enhanced website, increased use of social media, and monthly email messages
- **Education:** the annual conference, additional course offerings, and monthly webinars
- **Recognition:** member leaders will receive ample recognition for their contributions.

Follow us on LinkedIn ([www.linkedin.com/groups/4657260](http://www.linkedin.com/groups/4657260)), Twitter (@asqinspecdiv), Facebook (@asqinspecdiv), and the Inspection Division web page [asq.org/inspect/](http://asq.org/inspect/).

### New in 2018: Monthly webinars!

Dates and topics for our monthly webinars will be posted on the Inspection Division website and broadcast via Twitter, Facebook, and email. See our calendar on p. 8.

## 2017 Inspection Division Business Plan – Results

2017 was a great year for accomplishments within the Inspection Division. Twenty-seven of the 30 activities in our 2017 business plan successfully met or exceeded their goal! Two other activities were completed but only partially met their goal, and the remaining activity was started but won't be completed until sometime in 2018.

This truly outstanding work was completed by our volunteer member leaders so a hearty and sincere THANK YOU for your contributions.

### 2018 Inspection Division Business Plan

Inspection Division Activities	Goal
1. Contact all four ASQ international offices to promote division membership and offerings	4 connections
2. Recruit member leaders (domestic/international)	2 new volunteers
3. Offer International Inspector of the Year Award	Bestow award
4. Host networking receptions at WCQI and at division conference	2 receptions
5. Monthly email communication to all division members	12 messages
6. Send monthly new member welcome	12 welcomes
7. Send monthly reminder to renewal	12 reminders
8. Conduct VoC survey	Complete on time
9. Publish Inspection Division electronic newsletters	3 newsletter
10. Publish special edition of newsletter	1 edition
11. Publish articles in Quality Magazine (quarterly)	4 articles
12. Actively maintain LinkedIn group, Facebook page, and Twitter accounts	Maintain
13. Secure advertisers for newsletter	3 ads per newsletter
14. Secure exhibitors/sponsors for division conference	15 exhibitors/sponsors
15. TAG TC 176 meeting	Attend a meeting
16. Offer a CQI exam refresher course	Offer 2 courses
17. Offer a CQT exam refresher course	Offer 2 courses
18. Host webinars	12 webinars
19. Host annual division conference	Host conference
20. Enhance member leader skills and knowledge via e-learning	2 courses each, min.
21. Officer training sessions and TCC meetings	Attend all sessions
22. Mentor officers and chairs; two 1:1 meetings each	Complete on time
23. Bestow Cooper Award	Issue award
24. Certificate of Appreciation for each member leader	Issue certificates
25. Offer H. James Harrington scholarship	Issue scholarship
26. Seek out and nominate candidates for Fellow	1 nomination
27. Section/Student branch collaboration	12 interactions
28. Booth at WCQI	Complete on time

## 2018 Chuck Carter International Inspector of the Year Award

Applications are now available for the 2018 Chuck Carter International Inspector of the Year Award! For more than 40 years, the Inspection Division has offered this award to provide recognition to “The Inspector.” Any qualified individual who spends more than 50 percent of his or her time in inspection, test, audit, calibration, etc., functions to ensure conformance to engineering, manufacturing, quality, and customer standards or requirements is eligible as a candidate to receive the award.

There is no fee for this valuable membership benefit.

Applications can be downloaded from the ASQ Inspection Division website: [asq.org/divisions-forums/inspect/about/INSPECT\\_INSPECTOR\\_OF\\_THE\\_YEAR](http://asq.org/divisions-forums/inspect/about/INSPECT_INSPECTOR_OF_THE_YEAR).

Applications can also be obtained by contacting Jim Spichiger at [jim.spichiger@hotmail.com](mailto:jim.spichiger@hotmail.com) or at 740-349-3708.

**Applications must be postmarked no later than February 15, 2018.**

## Help Yourself by Helping Others!

Volunteering your time to help others is a noble cause, but volunteering for ASQ pays dividends both ways! ASQ member leaders receive the following benefits:

- Exclusive access to over 40 online development courses
- Build an almost inexhaustible network with other quality professionals
- Develop business and leadership skills in a safe environment
- Earn recertification units
- Make a difference!

There are three ways that you can support the division as volunteer:

1. **Committee chair**—currently several committee chair positions need to be filled
2. **Committee member**—support the committee chair
3. **Contributor**—help as needed by teaching courses, writing newsletter articles, etc.

If you have any interest in contributing your time and talents to help serve the members of the Inspection Division, please contact Jim Spichiger at [jim.spichiger@hotmail.com](mailto:jim.spichiger@hotmail.com) or via phone at 740-349-3708.

## Exclusive Inspection Division Member Benefits:

- Webinars (monthly)
- Newsletters (quarterly)
- Monthly email communication
- LinkedIn group
- Facebook
- Twitter
- Inspector of the Year Award (must be a member to nominate someone; self-nomination permitted)
- Scholarship (must be a member to nominate someone; self-nomination permitted)
- New member welcome message
- Membership renewal reminder
- Membership gift at World Conference on Quality and Improvement (WCQI)
- Division representation on U.S. standards Technical Advisory Groups (TAG TC 176, etc.)
- Discounts to division training courses
- Members-only access to portions of the Inspection Division web page

## Other benefits of membership:

- Virtual and in-person networking opportunities
- Networking receptions at:
  - WCQI
  - Inspection Division Conference
- Inspection Division Conference discount
- Training courses and hands-on workshops
- Membership advancement (Fellow nominations)
- Leadership development
- Presentations at section conferences and meetings
- Advertising and exhibiting opportunities

## CQI and CQT Certification Preparation Courses

The best way to prepare for the Certified Quality Inspector (CQI) and the Certified Quality Technician (CQT) exams is by attending an intensive, instructor-led refresher course that covers the complete body of knowledge. ASQ is pleased to provide these two offerings in spring 2018. Attendees will receive the certification handbook, a student manual, and over 250 sample questions.

**CQT: March 26 – 28, 2018 | Austin, TX**

[asq.org/training/certified-quality-technician-certification-preparation-cqtcpsaq](http://asq.org/training/certified-quality-technician-certification-preparation-cqtcpsaq)

**CQI: May 16 – 17, 2018 | Raleigh, NC**

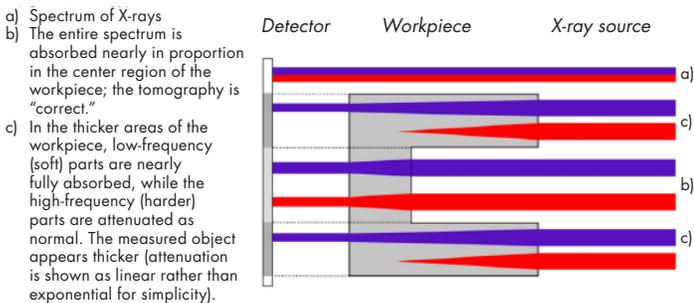
[asq.org/training/certified-quality-inspector-certification-preparation-cqicpsaq](http://asq.org/training/certified-quality-inspector-certification-preparation-cqicpsaq)



# Computed Tomography and Geometric Artifact Correction

The process for measuring a workpiece using a TomoScope® is rather straightforward. The measured object is located on the rotary table. During the tomography process, many 2-D radiographic images are taken. The part rotates once through 360 degrees. The 3-D voxel (volume pixels) image is available as an intermediate result, which can be used for 2-D slice evaluation or exported into an STL image.

To be able to measure the shape and position of a scanned object with sufficient precision, it is necessary to correct systematic errors in tomography. Several process-related effects lead to these systematic deviations. Common to all of them is the dependence on various parameters, such as cathode voltage of the X-ray tubes, the radiation spectrum that depends on it, as well as material and geometry of the measured object itself.



An example of this is beam hardening. This effect can be traced to the fact that the radiation spectrum of an X-ray tube is made up of various frequencies. Due to their higher energy, high-frequency radiation components are absorbed by the irradiated material at

a lower proportion than the low-frequency ones. As shown in Figure 1, this has the effect that for a large material thickness, low-energy sections of the X-ray spectrum can even be completely absorbed, and thus only high-energy radiation impinges on the detector. Since the mathematical algorithm for 3-D reconstruction is based on the thickness-dependent absorption of the entire X-ray spectrum, material areas with large radiographic length will systematically be measured as too large. This effect is known as a beam hardening artifact.

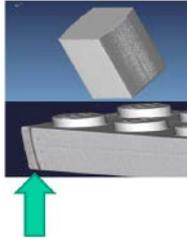
Other geometric artifacts arise from scattered radiation and the influence of cone beam geometry. This also applies to the part geometry, the material density, and the exact X-ray spectrum. Scattered radiation occurs due to the attenuation and deflection of X-ray photons from the original direction when

## About the author

*Robert Kozlowski is vice president of sales and marketing at Werth Inc.*

Systematic measuring errors depend on:

- CT parameters (voltage, etc.)
- Geometry of the object
- Material of the object
- Traceability of technical components cannot be provided by measuring standards with typical geometries (spheres, gage blocks, etc.)



colliding with electrons of the workpiece material. For multiple workpieces, the scattered radiation becomes noticeable as a background radiation and also influences the measurement result. To be able to measure quickly, modern machines use flat panel detectors. The utilization of a conical X-ray beam allows measurement outside of the ideal center plane of the X-rays (the plane through the focal spot of the X-ray tube, perpendicular to the axis of rotation). This means that reconstruction is only approximately possible, and measurement deviations (cone beam artifacts) occur that increase as the distance from the center plane (cone angle) increases.

The term autocorrection was coined by the Werth Messtechnik Company with the introduction of the first coordinate measuring machines with computed tomography (CT) in 2005. Thanks to the greatly improved precision of CT, the original multisensor method is now used only for submicron precision measurements, such as for automotive fuel injection systems. Workpieces made of metal are sometimes difficult to capture tomographically since artifacts from beam hardening, cone beam effects, or scattered radiation often have a great influence on the measurement uncertainty.

Empirical artifact correction (EAC) is the consistency of the relationship between penetrated length and attenuation of the X-ray energy (gray-scale value of the radiographic image). A material-dependent correction curve is created for this purpose

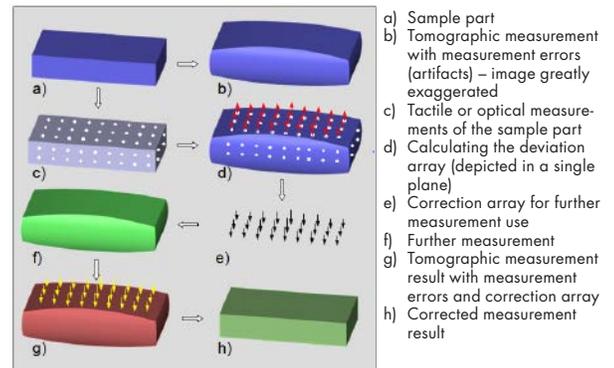
from an empirical reference measurement and is used for correcting the radiographic images, including subsequent measurements of identical workpieces. The advantage of this process is rapid correction of several artifacts using a single characteristic curve. The correction essentially applies to beam hardening and scattered radiation effects. The simplified approach of this correction, precision obtained in complex workpieces, is not always sufficient.

Virtual autocorrection (VAC) is based on the virtual simulation of the CT method, starting with measurement data (e.g., master part measurement) or nominal data (e.g., CAD data) of the workpiece itself (autocorrection). The simulation is done for each workpiece type, once with and once without applying the artifact correction. The simulation includes workpiece geometries and material (absorption behavior), the machine properties (e.g., X-ray spectrum and machine geometry), and the physical models for artifact occurrence (frequency-dependent attenuation, statistical simulation of scattering, etc.). The comparison ("subtraction") of the two simulation results in the correction data that can be applied to a series of part measurements. The subtraction method eliminates most deviations. This method can be used to address the influence of different artifacts individually. This method is remarkably flexible, its focus and precision can be adjusted to the task at hand. VAC can be applied to a wide spectrum of measurement tasks (plastic components, fuel injectors, and much more). The time required for this simulation depends on the artifacts included ranging from minutes to an hour if scattered radiation is considered.

The multisensor autocorrection is a precise correction method.

With the introduction of X-ray tomography into CMM technology, high-precision traceable measurements of the workpiece without multisensor autocorrection would not be feasible. Today, however, measuring with X-ray alone can produce precisions in the order of a few microns. For high-precision measurement tasks with permissible measurement deviations of less than one micron, then use of multisensor autocorrection is still often the only viable solution today. The drawback to this autocorrection method is additional time required to measure the part and expense of additional metrology equipment.

Figure 3 illustrates the principle of the described correction method. The geometric artifact arises because, when rotating the rectangular measured object, shorter radiographic lengths occur at the corners rather than in the middle. This leads to an apparent spherical shape during measurement. Using, for example, tactile measurement of calibration points, these deviations are captured precisely. Building on these reference points, the tomographic point cloud is corrected geometrically as an entire entity. Due to the constant nature of the error curve, relatively few calibration points are sufficient. Using the autocorrection feature, traceable measurement results with specified measurement uncertainties are obtainable when using computed tomography.





## H. James Harrington Scholarship Application Available Now

Applications are now available for the Inspection Division's 2018 H. J. Harrington Scholarship. This \$3,000 scholarship fund was created to help members, their family, or friends defray the costs associated with college expenses. Scholarship funds will be dispersed to one or more deserving students in spring 2018.

Applications can be downloaded from the ASQ Inspection Division website: [asq.org/inspect/about/INSPECT\\_SCHOLARSHIPS](http://asq.org/inspect/about/INSPECT_SCHOLARSHIPS). Or, contact Jim Spichiger at [jim.spichiger@hotmail.com](mailto:jim.spichiger@hotmail.com) or at 740-349-3708.

Applications must be postmarked no later than **March 1**.

## On-Site CQI and CQT Refresher Courses

The Inspection Division is pleased to announce that it is now conducting Certified Quality Inspector (CQI) and Certified Quality Technician (CQT) refresher courses. We would be more than happy to come to your

site and lead a two-day CQI refresher or a three-day CQT refresher. These courses are designed and taught to help experienced inspectors and technicians become better prepared for their respective exam.

An on-site course saves you travel time and travel costs. All of our instructors are highly qualified and seasoned quality professionals, plus we offer competitive rates.

For additional information or a quote, please contact Jim Spichiger at [jim.spichiger@hotmail.com](mailto:jim.spichiger@hotmail.com) or at 740-349-3708.

## Advanced Memberships

Senior and Fellow memberships provide additional benefits for no additional cost. Senior membership is not age dependent but rather is based on one's professional experience and credentials. Information on this membership type is available at: [asq.org/membership/individuals/senior](http://asq.org/membership/individuals/senior). Fellows elected by ASQ's board of directors are recognized as having achieved professional distinction and pre-eminence in the technology, theory, education, application, or management of quality control. Information on Fellow nominations is available at: [asq.org/members/account/fellow.html](http://asq.org/members/account/fellow.html).

## Searching for Presenters, Instructors, and Students

The Inspection Division is searching for knowledgeable instructors interested in teaching inspection-related courses. All instructors earn RUs; instructors will also receive financial compensation.

Though most quality-related topics would be acceptable, we are primarily searching for presentations and educational courses that support the Certified Quality Inspector and Certified Quality Technician bodies of knowledge (e.g., GD&T course, NDT course, etc.).

If there's an inspection-related course that you or your organization are in need of, please contact Jim Spichiger at [jim.spichiger@hotmail.com](mailto:jim.spichiger@hotmail.com) or via phone 740-349-3708.

## KUDOS!

THANK YOU to all of the Inspection Division member leaders for their time and talents; we would not be so successful without you! Your efforts are appreciated. Special recognition goes to the following:

**Carol Turner** – for sending monthly email communications

**Marie Lawton** – for sending monthly new member welcome messages and renewal reminders

**Navin Dedhia** – for publishing outstanding newsletters

**Ben Tomic** – for maintaining the Inspection Division website and three social media communication channels

**Carl Drechsel** – for distributing accurate meeting minutes quickly

**Shirl Furger** – for incredible and immeasurable support from ASQ HQ. Thank you, thank you, thank you!

## Newsletter Advertising Rates

The Inspection Division is offering a limited number of advertisements in its upcoming newsletters. Seize an opportunity to promote your products and services to over 2,500 members!

Rates for:	Three issues	Single issue
Half page (4.75"h x 7.5"w)	\$300	\$125
Quarter page (4.75"h x 3.25"w)	\$200	\$75

Contact **George Cutler** at [cutlergeorge@gmail.com](mailto:cutlergeorge@gmail.com) for additional information. Advertisements for the newsletter must be sized as specified in a MS Word, PDF, or digital image format. Payment can be made online at <https://www.picatic.com/event14794924711005>.

## 2018 Inspection Division Management Committee

### Officers



**Chair/Awards and Scholarship/Inspector of the Year/Conference**  
**Jim Spichiger**  
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**Secretary**  
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**Past Chair (Nominating)**  
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### Committees

**Ads and Exhibits (Open)**

**Arrangements Chair**  
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carp76four@aol.com



**Audit/Newsletter Editor**  
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901-921-0296



**Conference**  
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**Education Chair (Open)**



**Examining (Fellow Nominations)**  
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**Internet Liaison and Social Media**  
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**Webinar Coordinator (Open)**

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**Liaison to Certification Board (CQT)**  
**Ed Maresh**

**ASQ Community Development Administrator and Partner**  
**Shirl Furger**  
sfurger@asq.org  
800-248-1946 x 2147  
414-272-8575 x 2147

#### Division Management Committee Monthly Telecom

**Day:** Third Wednesday of each month  
**Time:** 4:30 p.m. (Eastern Standard Time)  
1:30 p.m. (Pacific Standard Time)

Contact any division officer for dial-in information.

Visit the Inspection Division website at

[asq.org/inspect](http://asq.org/inspect)

## CALL FOR PAPERS

### 2018 Inspection Division Conference | Memphis, TN

The Inspection Division is pleased to announce that its 2018 conference will be held on October 18 – 19 at the Fogelman Executive Conference Center at the University of Memphis in Memphis, TN.

The division is searching for dynamic and informative presentations on a variety of quality-related topics in order to facilitate a valuable and meaningful exchange of information. Though inspection-related presentations are preferred, all topics related to performance excellence, continuous improvement, quality methodologies, etc., will be given equal consideration.

Submit your abstract, 250 words max, to Jim Spichiger at [jim.spichiger@hotmail.com](mailto:jim.spichiger@hotmail.com) by **February 1, 2018**.

All speakers will receive a complimentary, full registration to this two-day conference.

## Website Enhancements Coming Soon!

ASQ's IT department and the Inspection Division will be working together to provide significant enhancements to our website. Further information will be provided via email, newsletters, and social media. Visit the Inspection Division website at [asq.org/inspect](http://asq.org/inspect).

## Please Opt In

Inspection Division leadership asks all members to please opt in to receive emails from the division. Electronic communication is our primary method of communicating events and information; blocking our emails will significantly limit the ability to take advantage of your membership benefits.

We are all inundated with too much email, so your leadership understands not everyone will opt in to receive electronic communication from the division; however, if you decide to opt out, please visit the Inspection Division website periodically to see our announcements, view our electronic newsletter, and check our calendar of events. Also, please join a LinkedIn group, Facebook, or Twitter.



## 2018 INSPECTION DIVISION CALENDAR

Date	Time	Event
January 19	1:00 p.m. (EST)	Webinar: Linking Business Strategic Plans with Quality and Lean Systems
February 13	7:00 p.m. (EST)	Webinar: Measurement Systems Analysis
March 13	2:00 p.m. (EST)	Webinar: Vision Technology for Big Data and the Industrial Internet of Things
March 26 – 28	8:00 a.m.	CQT certification preparation class, Austin, TX
April 29	8:00 a.m.	Division Management Committee business meeting, Seattle, WA
April 30	6:00 p.m.	Annual Inspection Division member meeting, Seattle, WA
April 30	6:30 p.m.	Networking reception, Seattle, WA
May 16 – 17	8:00 a.m.	CQI certification preparation class, Raleigh, NC
October 18 –19	8:30 a.m.	Annual Inspection Division Conference, Memphis, TN
Third Wednesday of each month	4:30 p.m. (EST)	Division Management Committee conference call
Last Tuesday of each month	5:00 p.m. (EST)	New member welcome and orientation, 855-797-9485, access code: 641 694 224

All division meetings and conference calls are open to all Inspection Division members. To join a conference call, contact any officer for dial-in instructions.