

# *The IEEE Instrumentation & Measurement Magazine*

## *February 2013 Issue*

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### *Uncertainty*

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#### *From the Editor's Bench*

Mike Gard

#### **Coping with Uncertainty**

We all are familiar with uncertainty in everyday life. Uncertainty is associated with the unpredictable, the unknown, the ill-known, and the vagaries of common experience. Will it rain today? I don't know; I am not certain. We speak of an uncertain future. Weather is uncertain. Will we make more profit if we plant wheat or soybeans? Should I plant my fields with olives or grapes? Who will win the World Cup? We are uncertain.

It is also a matter of common experience that uncertainty can be dangerous or expensive, leading to misinterpretation, misjudgment, and civil, political, and military tactical blunders. Many ancient cultures associated these uncertainties with the machinations of, or conflicts between, one or more deities. For example, Homer's *Iliad* and *Odyssey* often saw mortal humans used as proxies in conflicts between the Olympian gods.

Today's technology-based cultures typically regard uncertainty in a somewhat different way. We think of uncertainty as a manifestation of error or random events which can be studied quantitatively using statistics, probability, and other mathematical tools. It is no coincidence that the early studies of probability and statistics often involved games of chance. Many of the great minds in these early studies were not only brilliant mathematicians, they were also gamblers trying to understand the mathematics of games of chance in an effort to improve their performance at the gaming table. The fundamental developments of probability including combinations, permutations, and distributions arose in part from the many happy hours serious mathematicians spent flipping coins, throwing dice, studying cards, and seeking ways to take home a good night's winnings.

As statistical techniques improved, they were used to study the errors (uncertainties) associated with measurements. In such instances, the uncertainties associated with physical measurements can be described as correlated or uncorrelated processes which are imperfect in some way. Thus, we came to understand that a pressure measurement can contain an error component associated not only with the pressure measurement itself but can also contain many other error components involving the effects of temperature, atmospheric pressure, humidity, mechanical and electrical effects, manufacturing tolerances, and the like. Much of the work in metrology involves identification, compensation, or elimination of this cloud of errors which all contribute to the overall uncertainty of a measurement. This is not as straightforward as it seems, for there is an almost never-ending supply of error sources, sensitivities, and correlated errors that must be identified and eliminated, separately measured, and corrected or compensated. Any physical apparatus will have similar issues arising from small but sometimes highly significant fabrication errors. Unrelenting identification and elimination of these error sources is the focus of much

effort in the science of metrology. Even the preparation of test articles, reference standards, and physical samples all contribute to the uncertainty, or possible error, in a measurement. I do not know who first said, "Inside every large problem are three smaller problems struggling to get out," but it was clearly someone who thoroughly understood the essence of measurement science. The better our instruments become, the more we find that is deserving of additional study. We instrumentation and measurement specialists are among the few people who can ask the apparently contradictory question: "How accurately do we know our uncertainties?"

This "Uncertainty" issue contains two excellent articles addressing new and thought-provoking ways to look at uncertainty and its consequences. In "Forensic Metrology," Alessandro Ferrero and Veronica Scotti explore the pivotal role of a proper understanding of measurement uncertainty in a recent high-profile criminal case. Simona Salicone introduces a distinctly different, yet very useful, way of looking at measurement uncertainty in "Introduction to Theory of Evidence." This issue also contains Edmond Chalom's "Measurement of Image Similarity," Mohammad Hashmi's "Introduction to Load-Pull Systems," informative columns, and reports summarizing a very busy year (2012) for the I&M Society. We hope you enjoy it.

*I&M Magazine* welcomes manuscripts from industrial authors. The scope of instrumentation and measurement activity encompasses almost any field of applied science and engineering, so we welcome submissions from authors working in almost any measurement field. There currently is particular interest in manuscripts dealing with signal processing and energy applications for the publications that will appear in June and December 2013, respectively. However, our readers' interests are as varied as our readers themselves. Please share what you know; we'd really like to hear from you.

*Mike*

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## *President's Perspectives*

Jorge Daher

### **Looking Back and Ahead**

We have started a new year, and at this time we always look back to see what we have done. It is time for evaluations, and I can tell you I am re-ally satisfied with the accomplishments of our Administrative Committee (Ad -Com). It is also time for starting our work with renewed energy. One very important action item we de-cided last year was to start writing the Society's Strategic Plan. During the last two months, we have been discussing the fu-ture of our society. In February each year we hold our strategic meeting where the Officers and Editors-in-Chief discuss is-sues in a kind of brainstorming. A set of ideas come out of that meeting, and then the committee Vice Presidents, together with the members of their committees, will start implementing actions to obtain the desired results. No plan is useful if it is only a document without any metrics and periodical reviews. Our expectation is to make this plan very practical and useful to enhance the development of our members' careers.

At this time, I would like to say good-bye to some members of the AdCom who have finished their term. Daniel Rosenthal, Voicu Groza, and Robert Krchnavek have worked very hard, and I would like to thank them for their continued efforts. I also would like to welcome some new members to the Adcom who were elected by our membership in last year's selections: Alessandra Flammini, Richard Hochberg, and Mark Yeary. I hope they will feel comfortable and contribute

to our society in these positions. Mihaela Albu has been re-elected and will continue working with us as Vice President of Technical Activities and Standards. Since October 2012, Andrew Timm has joined us as our GOLD representative, and since January this year, Erik Timpson is working as our Graduate Student Representative. My hope is that they will help us improve our involvement with our younger members. We need to understand their needs and try to satisfy their expectations. Young members are very important, and we would like to keep them as members in the future as they advance in their careers.

Before I finish writing this column, I would like to congratulate my friend Pasquale Daponte for being elected as President of IMEKO (International Measurement Konfederation) for the years 2012-2015. IMEKO is a non-governmental federation of 38 Member Organizations individually concerned with the advancement of measurement technology ([www.imeko.org](http://www.imeko.org)). Its fundamental objectives are the promotion of international interchange of scientific and technical information in the field of measurement and instrumentation and the enhancement of international cooperation among scientists and engineers from research and industry. Pasquale has always been very active in our committees and in his professional life. I am sure he will be very successful in his new position. See you in our next column and keep in touch.

*Jorge*

*Please contact Jorge at [j.daher@ieee.org](mailto:j.daher@ieee.org). His bio is available at <http://www.ieee-ims.org/contacts/officers>.*

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## *Officers' Reports*

### **President's Summary Jorge Daher**

The IEEE Technical Activities Board (TAB) has a committee that reviews the internal processes of each society every five years. The intent of the Society Review Committee (SRC) is to listen, learn, discuss and comment with a view to helping Societies and Councils exchange practices and better serve the profession. During 2012, our society went through this review.

Most of our Administrative Committee (AdCom) members prepared parts of the report which was sent to IEEE. In the report, we analyzed our processes and performance in such areas as strategy and operations, conferences, publications, education, membership, finance and governance. In June we had a meeting with the SRC to discuss the report. It was a very fruitful meeting where we could explain to IEEE how we work and also receive some interesting comments from them. Later, the SRC sent us a new version of the document which contained a very interesting analysis of our successes and best practices, recommendations to our society, recommendations to TAB, and additional comments.

#### Successes

- We expanded the education program by creating a VP for Education and an Education Committee. We also created a Graduate Fellowship Award, the Faculty Course Development Award, funded Student Best Paper Awards, and expanded our Distinguished Lecturer Program.
- We increased participation from industry in our activities by creating the Industry Liaison position, recruiting active involvement from industry at conferences through dedicated activities, and expanding tutorial offerings, including Continuing Education Units.

- We improved our administrative processes, with regular internet meetings, membership surveys, and improved communication among VPs.
- We improved our editorial practices for publications and significantly reduced the time from acceptance of paper to publication.

#### Best practices

- Monthly AdCom and Committees meetings via Skype or GoToMeeting.
- The appointment of an Industry Liaison to facilitate integration of industry into Instrumentation and Measurement Society (IMS) activities.
- The introduction of “industrial tracks” and tutorials into conferences.
- The use of an Evaluation Committee for Distinguished Lecturers.
- The introduction of a Faculty Course Development Award to develop courses with specific focus on Instrumentation and/or Measurement.
- The IMS governance includes GOLD, graduate, and undergraduate student representatives with a vote on the AdCom.
- Chapter visits to Regions 9 and 10 by AdCom members, followed by scheduling workshops and conferences in the region.
- The practice of informing authors of statistics concerning submission to publication time on the IMS web site, updated monthly.
- The practice of having the Vice President of Finance and the Treasurer review each monthly financial statement and understand any variances. This is followed up as appropriate with a formal outreach to the cognizant AdCom members to determine if actions are necessary to adjust spending or activities.

#### Recommendations

In addition to these good comments from the SRC, we also received some recommendations to improve certain areas of our society. Our society has a large number of technical committees (TCs). Their chairs do not have term limits and we are not using any metrics to evaluate their activities. Our VP of Technical Committees & Standards is already working hard within the committees and also with the help of other AdCom members to improve the performance of our TCs. At this time I want to invite you to join us in this effort by contacting us and expressing your desire to work in any of our TCs.

During our annual meeting each February we perform strategic and tactical thinking to decide the future of our society, but we do not have a written strategic plan. One action item for our society is to start developing a strategic plan as a living document with clear and specific ideas and plans for the following years. This document will be reviewed periodically, and we will develop metrics to help us make the necessary changes in our actions in the short and long term. Of course, we will continue improving all our internal processes, even those which have had a great improvement. All of our actions point to the goal of helping develop our members’ professional careers.

### **VP of Publications Report Shreekanth Mandayam**

The two flagship publications of the Society, the *IEEE Transactions on Instrumentation & Measurement*, and the *Instrumentation & Measurement Magazine*, were reviewed by IEEE’s TAB Periodicals Review and Advisory Committee in 2012. This five-year review was intended to examine all aspects of the Society’s publications, including quality, timeliness and financial health. The Committee provides recommendations for improvement and determines best

practices to be shared with other IEEE Societies. Preceding the review, the Editors-in-Chief and Officers in the IMS worked tirelessly for months to produce a comprehensive self-study document of our publications portfolio and responded to all questions and clarifications requested by the Committee.

We are delighted to report that the Committee's review of our two publications was exceedingly complimentary. Among the many positive comments we received for our *Transactions*, the Committee noted the "clean process of handling papers and performing the reviews, the remarkable minimum time delay that accepted Transactions papers spent in a queue for e-publication and an ambitious, collective society effort behind these improvements." We were commended for developing a number of best editorial practices that could be shared with other IEEE Societies. The Committee acknowledged that our *Instrumentation and Measurement Magazine* was in good shape and supported our goal of increasing the number of authors and articles.

The strong showing of our Society's publications in this recent five-year review is a testament not only to the hard work of our Editors-in-Chief, Associate Editors, reviewers and other publications support staff but also our authors and members who contribute high-quality articles that showcase important advances in the science and practice of instrumentation and measurement.

Finally, I would like to take this opportunity to offer my best wishes to our members, as I relinquish the position of the Vice-President for Publications at the end of this year. Dr. Wendy Van Moer, who many of you know as an Associate Editor of our *Transactions* will take over the position in January 2013. Our members will be well served by her experience and awareness of all issues related to publications.

### **Industrial Liason's Report Max Cortner**

Last year, an industrial liaison was appointed and tasked with creating a strategy to improve society involvement by members employed by industry. Discussions in the conference committee and in the technical committees provided lots of good ideas. The Ad Hoc Committee on Industrial Relations proposed a strategy for achieving improvement. Although the ultimate goal is to increase involvement by members employed by industry, an intermediate step of increasing support from companies themselves is necessary. Members must feel supported by their employer to freely participate. The first strategic goal focuses on creating opportunities for corporate partnerships with the IMS to strengthen industry support of the IMS as measured by:

- Conference financial support,
- Contributions to Conference and publication content, and
- Technical and financial support of employee members as I&M leadership.

The most effective method of partnering with companies in the short term is through industry associations. The committee will identify industries that use instrumentation as a key part of their business and work to partner with existing associations for those industries. Leading companies within those associations are the next level of partnership.

The ultimate goal is enriching our society with broader member participation. The committee endorses efforts by conferences and publications to add more content of industrial interest and to provide forums such as technology transfer panels for engagement between academic and

industrial members. Simply stated, our member-specific goals are to increase society participation by industry employed members in:

- Conference attendance,
- Local chapter event attendance, and
- The Society's total number of members.

As the Ad Hoc Committee tackles these topics, and as we move towards making this a Standing Committee, we will need ideas from across the readership. Please submit your ideas and concerns to [j.m.cortner@ieee.org](mailto:j.m.cortner@ieee.org). If you have a deeper interest and wish to serve on the committee, please make contact using the same address.

### **Vice President of Conferences Report** **Dario Petri**

The Conferences and Technical meetings of the Society were recently reviewed by the IEEE's TAB Society Review Committee (SRC). This five-year review was intended to promote continuous improvement of the Society's Technical events mainly in terms of technical and management quality and value for the attendees. Prior to the Society review, the I&M Officers worked tirelessly to produce a comprehensive self-assessment document of our conference portfolio according to the guidelines provided by the SRC.

We received many positive remarks for the Technical Events organized in the last years. In the future, the SRC recommended that the Society should:

- review full papers instead of extended abstracts for all sponsored Conferences; and
- review periodically the Proceedings of past technically cosponsored conferences published in IEEE Xplore to ensure that the expected quality level is met.

These recommendations were discussed during the last Society AdCom meeting, held in Pisa, Italy on Oct. 10–13, 2012. The AdCom recognized that the Technical Events are among the most important activities of the Society because they provide members with opportunities to share new research results, be in face-to-face contact with their peers, build communities of common interests, and help develop and grow their professional careers. Thus, the high quality level of the Conferences is a major target for the Society. In particular, the AdCom regarded as critically important the identification of development strategies to start new Conferences and redefine the policy for the existing ones.

Different strategies are required for the Symposia or Workshops. These two different kinds of financially-sponsored events are usually focused on well-defined specific topics, whereas Conferences, like I2MTC, cover a wider, more general collection of topics.

Although focused events do not generally attract a large number of attendees, they are attended by people with very similar interests and competences. When they are well managed, they have easily become a forum appreciated for discussing new or hot topics. These events are expected to foster an exchange of competences between I&M and application experts and begin new or continue existing collaboration networks. A good development strategy for these events should identify new topics of interest by seeking cooperation among application experts and other IEEE Societies. Thus, a clear goal should be identified for any financially-sponsored Conference. The Conference General Chair should express clearly and in a measurable way how the event can promote the achievement of the Society goals, e.g. in terms of increasing IMS membership or new collaborations or research networks. In such a way, we will have reliable feedback about the level of success or failure of the organized event.

Conferences covering a wide range of topics can be even more difficult to improve, particularly I2MTC, which is intended to become the most desirable world-wide event in the I&M field. Our goal is for each attendee to leave any conference with the clear feeling that he or she has enriched their competence by discussing their work with the top experts in the field. This result can be achieved if we attract top experts and offer them a qualified and interested audience with which the expert has the chance to interact fruitfully. This outcome has been realized in the most successful Workshops where there has been the most interaction between speakers and attendees. If we can reproduce this interaction in the Conferences with their wider collection of topics, then we will have the key to success. With these goals in mind, we are planning the organization of the Conferences, the selection of papers, the organization of well-balanced sessions, and the selection of Conference Chairs for 2013 and beyond.

### **Vice President of Membership Development Report Georg Brasseur**

The Society Review Committee (SRC) noted that the IMS has a Membership Development (MD) Committee which operates in close cooperation with its Education Committee. One Society success is the use of its Distinguished Lecturer Program to support Chapter revitalization activity. The IMS Chapter Chair Liaison who is part of the MD Committee encourages struggling chapters to participate in the Distinguished Lecturer (DL) program. This has served the Society well both in revitalizing chapters and increasing the activity level and impact of the DL program.

MD will follow the SRC's recommendation to develop a formal program promoting and measuring chapter vitality using Member and Geographic Activities (MGA) report outputs to proactively mitigate chapter problems. This will be a standardized and more consistent process that is less dependent on the time and availability of the Chapter Liaison. Close cooperation with MGA will be helpful, for MGA has long experience supporting and meeting members' needs and implementing IEEE membership, recruitment, and retention strategies.

IEEE local organizational units (Sections, Chapters, Affinity Groups, and Student Branches) provide unique opportunities for members to attend technical presentations, create strong peer-to-peer connections, and participate in leadership opportunities that can make a positive distinction in IEEE members' jobs and careers.

Periodic (annual or biennial) Chapter Chair Summits are scheduled. The Chapter Liaison, along with the Membership Committee, will organize and announce the Summit to be held in conjunction with the I2MTC flagship conference. Holding the Summit in conjunction with I2MTC may allow Chapter Chairs to take advantage of the high quality technical conference, as well as network with other IMS members and professionals while attending the Summit.

Successful Chapter activities will be presented to all Chapter Chairs to promote and develop "Chapter Best Practice" processes and activities. In this way, other Chapters may take advantage of important Lessons-Learned and successful events. The Summit will also provide IMS with a method by which to assess the level of Chapter health and Chapter needs to improve our Chapter support.

The Membership Committee has developed and will work to improve numerous programs, activities, and opportunities for all engineers and some that focus on students. They are:

- The subgroup on LinkedIn for Chapter Chairs and DL's which fosters communication within and between each of these groups. Information on this program is updated by the Education Committee in close cooperation with the MD Committee Chapter Chair

Liaison, and the IMS Media Liaison Officer and can be found online at the IMS LinkedIn page.

- The Chapter Chair Liaison informs all Chapter Chairs that limited IMS funds are available for AdCom member visits to Chapters. If any Chapter would like to request a visit from an IMS AdCom member for a special event or revitalization meeting, a Chapter Chair should submit this request to the Chapter Chair Liaison. The requests will be considered on a first come, first served basis, and will be reviewed for approval by the VP of Membership.
- The Chapter Chair Liaison actively publicizes Chapter activities in the I&M Society *Instrumentation and Measurement Magazine*, in the IMS Newsletter, and on the IMS website to provide timely, condensed information to members. Fostering Chapter events is particularly helpful for students as the attendees of Chapter events are predominantly students.
- IEEE has created a portal website to help and support student branch chapters easily find information about IEEE Societies. The IMS portal site is updated by the Sections Liaison-Officer. Have a look at the webpage: <http://sites.ieee.org/mga-sac/category/societies/instrumentation-and-measurement>.
- IMS Officers recommend, develop, and publicize educational programs available to IMS members like the “Graduate of the Last Decade (GOLD)” program; conduct student design contests; give best paper awards at IMS Conferences and workshops; and maintain close contact with IEEE Student Branches to support the formation of IMS Student Chapters. Additionally, MD Committee sponsors the annual Region 2 Brownbag Hardware Competition for students.
- IMS carries out Graduate Student Panels at IMS conferences to attract and retain members. The MD Committee usually secures four Panelists to speak at the Panel session who represent different career choices, geographic areas, etc. and a local panelist is available as well.
- The Student Liaison has been developing a mentoring program which will soon go live.

A Note from Kristen Donnell: Looking to the future

Beginning in January 2013, I will begin a leadership position as VP of the Membership Development Committee. The MD Committee and I appreciate the opportunity to work with the 2012 MD Committee VP, Professor Georg Brasseur, and I look forward to another exciting and productive year.

### **Vice President of Education Report Ferdinand Poncir**

The Education Committee (EdCom) members had a great opportunity to work together in person during the Fall Ad-Com and Committees meeting series from Oct. 11–13, 2012. These get-togethers always constitute a boost in the activity of the committee and energize the members. Personal contact counts! This is one of the reasons for the EdCom to dedicate particular care to securing support for activities that connect IMS experts and representatives to the Membership. And the Membership really seems to appreciate it! Our Distinguished Lecturer Program (DLP) this year has been overwhelmed with requests. In spite of a very conservative IMS spending approach, as well as extensive support of the hosts, the DLP will have soon consumed its financial resources for the year 2012. We regard this as proof of success of the program and one of the ways our Membership continues to receive a valuable benefit from their membership in the society.

Graduate Fellowship Awards and Faculty Course Development Awards are initiatives supported by the IMS for the purpose of disseminating and strengthening the culture of measurement science. Applications for the 2013 Awards are due Feb. 1, 2013. The guidelines for these award programs are available online at: [www.ieee-ims.org/education/education](http://www.ieee-ims.org/education/education). For details, contact the 2012 Education Awards Chair, Kristen Donnell at: [kristen.donnell@mst.edu](mailto:kristen.donnell@mst.edu).

EdCom members take care of many other items, including some regular business as well as some new initiatives. The development of long-and medium-term strategic plans for the EdCom was the most challenging task. Preparation for the meeting, discussion time during the meeting, and ongoing work conducted by the members will identify sustainable and coordinated ways to serve the Membership in educational matters.

The task is difficult because the IMS covers a very broad spectrum of applications, from power systems, to medicine, to industrial production. Our Membership is varied in occupation from professional engineers, to academic researchers, to students. Some are more engaged in fundamental research while others work in applications of technology. Our Membership is spread in geographic location, spanning ... the whole world. Some look for depth in educational opportunities, some want breadth, and some want informal updates on the most recent developments. And on top of all of this, the educational events really should be a great networking opportunity. The IMS addresses this variety of preferences and situations with Distinguished Lectures, Awards, Tutorials (hoping to replicate in Minneapolis the great success of the I2MTC 2012 tutorials in Graz!), and much more.

One strategic goal of the EdCom is to reorganize and coordinate the entire range of educational initiatives to fit closely to the needs of the Membership. Disciplinary areas must be consistent and well balanced. The different types of educational offerings should be synergetic and refer to one another.

Finally, the EdCom works at strengthening the link between industry and academia and between industry and students. The link between industry and academia is addressed by collection and dissemination of industrial roadmaps and dissemination of cutting edge research results. The link between industry and students is achieved by facilitating internships and co-op opportunities, particularly where there are no well-established academic services for this purpose. The EdCom is working to define this strategic plan in detail, inclusive of practical ways to achieve these goals and metrics of progress.

At this time more than ever, the input of the Membership is precious. Chapter Chairs, on behalf of your groups, and individual members: please, "Let us know what you think." (Ferdi Ponci, [ponci@ieee.org](mailto:ponci@ieee.org)). If you are not fully aware of the IMS educational opportunities, please take a look at: <http://www.ieee-ims.org/education/education>. If this triggers your interest in participating in some of these events or organizing a Distinguished Lecture and you do not know how to do so, tell us. We can help you, and you can help us improve how we inform the Membership of the great IMS educational resources available.

**Editor-in-Chief of the IEEE *Instrumentation and Measurement Magazine* Report  
Mike Gard**

2012 was a year of transition for the IEEE *Instrumentation and Measurement Magazine*, IMS's general-interest publication. Dr. Shlomo Engelberg, Editor in Chief of the *Magazine* for three years, handed off EIC responsibilities to Mike Gard in May of 2012. Shortly thereafter, Max Cortner was named Associate Editor-in-Chief. The *Magazine* staff is Mrs. June Sudduth as

Senior Editor, Kristy Virostek as Administrative Assistant, Gary Garvin as graphic artist for author illustrations and photos, Bob Goldberg handling the New Products Department for each issue, and the Allen Press Staff with Josie Jay as Managing Editor, Onkar Sandal as advertising sales manager, and the rest of the staff at Allen Press doing their usual good job of preparing the physical *Magazine* that our members receive six times a year. Although there were changes to the *Magazine's* Editorial Board, reflecting changes in the IMS AdCom, the mechanics of the process continued to work in a timely way despite the newness of the incoming EIC.

The mission of the *Magazine* remains the same: to publish general interest articles and tutorials of interest to academic and industrial practitioners in the instrumentation and measurement field; to inform the Society's membership of activity within the Society and at the Society's various conferences and meetings; to inform readers about AdCom meetings and activities behind the scenes which are the nuts and bolts of Society operations throughout the year; and to draw attention to new ideas, new products, and new developments which are related to our common interests in the I&M community.

Although the mission remains the same, there is a new emphasis on content. This new emphasis arises directly from reader input in various surveys over several years. Our readers have clearly expressed appreciation for the academic tutorial pieces which appear in the *Magazine* and wish them to be continued. There is also a clear desire for articles and tutorials with a practical, industrial emphasis. The desired industrial emphasis is a little difficult to realize in practice because industry (although there are notable exceptions) generally does not reward employee publication, and because competitive industrial pressures are oftentimes inconsistent with the open sharing of new ideas, new approaches, and new techniques.

Even so, industrial authors are stepping forward to write for the *Magazine* out of a love of their subject and a genuine desire to share their knowledge and experiences with the rest of us in the Society. These industrial authors are to be thanked and congratulated for their contributions, and the *Magazine* will continue to search for the applications-oriented material re-quested by a considerable number of our readers.

Shlomo handed over a *Magazine* with very good editorial practices (confirmed by the 2012 IEEE Publications Review Board findings reported in earlier editions of the *Magazine*), a nice backlog of articles in the publication queue, and a congenial and coordinated staff operation. Current and future efforts will be directed to maintaining this high standard, to continue to place additional emphasis on practical, industrial, applications-oriented material, and to make improvements when possible.

The 2013 production calendar will feature the now-traditional AUTOTESTCON issue in August and a special issue featuring material associated with the oil and gas industry which is planned for December 2013. We are always on the lookout for authors who wish to share their experiences and knowledge with other readers, and we would particularly welcome authors who may be in a position to produce regular columns dealing with developments in their particular inter-ests. The EIC would especially value contributions by writers who have personal and historical perspectives of their field of practice. While 2012 was a year of transition, we hope to make 2013 a year with a bit of evolution and emergence.

We send a heart-felt "Thank you" to Shlomo for all his work. And to readers who have considered doing some technical writing – and we all think about it sometimes – please contact the *Magazine's* EIC at [IandMMagazineEIC@ieee.org](mailto:IandMMagazineEIC@ieee.org). The e-mail address is on the masthead on page two and the last page of every issue. The IEEE *I&M Magazine* exists to share information with one another, and we would love to hear from you.

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## *Article Summaries*

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### *Forensic Metrology: A New Application Field for Measurement Experts across Techniques and Ethics*

(Summary)

Alessandro Ferrero and Veronica Scotti

Since scientific investigation is based on experiments, and measurements play a key role in experiments, this means that measurements have become a relevant and important element in the decisions of courts of justice. The results of measurements and tests are currently considered as objective evidence of a fact or event. As such, courts of law look at them as elements of scientific certitude upon which it can base a judgment. Measurements have become such an important element in the work of the courts of law that a new term, forensic metrology, has been coined to define the measurement activity performed to support judgments.

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### *Theory of Evidence: A New Promising Approach to the Evaluation and Expression of Measurement Uncertainty*

(Summary)

Simona Salicone

This paper discusses the mathematical theory of evidence which represents an interesting generalization of probability and, as such, can be usefully employed to evaluate and express uncertainty in measurement. Being more general than probability, it is expected to provide solutions to certain open problems in uncertainty evaluation, in particular, that of expressing the uncertainty contributions due to uncompensated systematic effects and combining them with all other contributions. This problem is very often met in industrial applications, where the compensation for systematic effects may have a cost that is not justified by the resulting reduction in uncertainty. Its application in the instrumentation and measurement field is even more recent, so many problems remain open, both from the purely theoretical mathematical perspective and that of practical applications.

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### *Measuring Image Similarity: An Overview of Some Useful Applications*

(Summary)

Edmond Chalom, Eran Asa, and Elior Biton

There are abundant computer imaging applications requiring some kind of similarity measurement as part of their processes. Although the applications are quite varied, and the implementation details of each solution are unique, all share the common thread in that features or attributes of the image (in each specific application) are measured and then compared to other features from a database of images or with some reference model to extract some meaningful conclusions or functionality about the image data on hand. This paper describes several methods of measuring image similarity: a pattern recognition approach, comparison of frames in a video sequence, image stabilization using a homographic transformation, and using image feature points to compute similarities and generate an image mosaic.

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## *Introduction to Load-Pull Systems and their Applications: Tutorial 43*

(Summary)

Mohammad Hashmi and Fadhel Ghannouchi

This article presents the load-pull concept and its usefulness in modern wireless power amplifier (PA) design. The most common load-pull techniques are reviewed along with their advantages and limitations. A section on the latest advancements in load-pull setup configurations presents some of the most popular approaches adopted by the users of load-pull systems. The article discusses two of the latest developments in load-pull configurations which have either brought or have the potential to bring a paradigm shift in PA design techniques.

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## *Columns*

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### *Instrumentation Notes*

#### **Selected Problems of Power Sources for Wireless Sensors Networks**

(Summary)

Zbigniew Watral and Andrzej Michalski

For several years, the very suggestive term “energy harvester” was used as a synonym for all activities related to obtaining electrical energy from renewable sources. This concept has become a completely new and very promising field that will solve the problem of supplying wireless networks nodes with energy. Several promising phenomena which can be used to generate

electricity from renewable sources are discussed in this paper, including: fuel cells, photovoltaic cells, piezoelectric energy, thermoelectric cells, and electromagnetic coils. The proposed scheme of the autonomous power supply system presented by the authors is a hybrid structure using photovoltaic panels as the primary energy source, supported by a fuel cell, and with a lead-acid or lithium-ion battery for energy storage.

*Summary written by K. Virostek,*

## *Departments*

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### *New Products*

Robert Goldberg

#### **Dual-Channel Picoammeter/Voltage Source with Ultra-Low Current Resolution**

Keithley Instrument expands on its low level measurement products by introducing a dual-channel picoammeter with dual  $\pm 30\text{V}$  independent, non-floating bias sources and  $1\text{fA}$  measurement resolution. The Model 6482 Picoammeter, the latest addition to Keithley's popular line of sensitive instrumentation, provides two independent picoammeter/source channels in a 2U, half-rack enclosure, allowing simultaneous 6-1/2-digit measurements across both channels. Keithley claims it offers twice the channel density available from other high speed, high accuracy picoammeters for easier control and data aggregation and a lower cost of ownership, as well as higher measurement accuracy ( $\pm 1\%$  on the  $2\text{nA}$  range) and a wider dynamic range ( $1\text{fA}$  to  $20\text{mA}$ ) than competing single-channel picoammeter/source combinations.

The Model 6482's  $2\text{nA}$  current measurement range is ideal for measuring dark currents and other low currents with  $1\text{fA}$  resolution. Once the level of dark current has been determined, the instrument's REL function automatically subtracts the dark current as an offset so the measured values are more accurate for optical power measurements.

The Model 6482 can provide ratio or delta measurements between the two completely isolated channels. These functions can be accessed via the front panel or the GPIB interface. For test setups with multiple detectors, this capability enables targeted control capabilities.

To speed and simplify system integration and control when building multi-instrument test systems that require tightly coupled sourcing and measurement, the Model 6482 provides the Trigger Link feature as well as standard GPIB and RS-232 interfaces. The Trigger Link feature combines six independent software selectable trigger lines on a single connector for simple, direct control over all instruments in a system. This feature is especially useful for reducing total test time if the test involves a sweep.

The Model 6482's current and voltage limits can be programmed to ensure device protection during critical points such as start of test, etc. It also provides Average and Median filters, which can be applied to the data stored in each channel's separate 3000-point buffer memory.

For applications that demand the highest measurement sensitivity, the Model 6482 has rear panel triax inputs for making triaxial cable connections to minimize electrical noise.

For more information on the Model 6482 Dual-Channel Picoammeter/Voltage Source, visit [www.keithley.com/products/dcac/sensitive/lowcurrent/?mn=6482](http://www.keithley.com/products/dcac/sensitive/lowcurrent/?mn=6482).

### **Milliohm Resistance Meter Makes Accurate Measurements Fast**

The TEGAM 1740 Milliohm Resistance Meter offers a powerful combination of accuracy and speed performance. In Fast Mode, the 1740 can make 100 readings per second with an accuracy of 0.05%. The combination of accuracy and high measurement speed allows users to improve throughput with higher yields in resistor, wire, fuse, thermistor, trimmer and contact-resistance testing applications.

The 1740 achieves such high accuracy by using TEGAM's microohm measurement technology. Patented circuitry rejects thermal and line noise, while compensating for thermal and electromagnetic measurement errors caused by contact between device handlers and the device under test. In delayed mode, the 1740 is even more accurate, making up to 27 measurements/second at an accuracy of 0.02%. The 1740 provides users with ten different ranges from 20 milliohm to 20 megohm full scale. On the 20 milliohm range, the resolution is 1 micro-ohm.

In addition to being fast and accurate, the 1740 is very easy to use. On the bench, technicians can quickly configure the instrument via the front panel. Clearly labeled multifunction keys provide front panel control of range selection, reading modes, delays, triggers and measurement HOLD. Clear menu driven options provide easy setup for more sophisticated operation. Front panel calibration makes it easy to maintain the 1740 traceability right on the product floor and in less time than it takes to reload a resistor reel.

For computer-controlled test applications, the 1740/GPIB can be programmed via and data collected from the instrument's GPIB, RS-232, or RS-422 interfaces. To maximize programming efficiency, programs use the same programming command set and front panel indicators, no matter which interface they use.

For more information, please visit [www.tegam.com](http://www.tegam.com).

### **Arbitrary Waveform Capability for Sensor Emulation and System Test**

Geotest announces the introduction the GX1649, a 64 channel, PXI arbitrary waveform generator with 16 - bit amplitude resolution. Geotest claims that the GX1649 offers the highest channel count in the industry for a PXI DC / AC source and features a wide output voltage range of +/- 15 volts.

The GX1649 is a single slot, 3U PXI module and is supplied with a full featured API and user interface for a variety of software development environments including ATEasy, C, Visual BASIC, COM, and LabVIEW.

For more information, please visit [www.geotestinc.com/Product.aspx?model=GX1649](http://www.geotestinc.com/Product.aspx?model=GX1649).

### **Real-Time Emulation for Military Command and Control**

The Logical Company has announced the newest member of its NuVAX hardware emulation family. With double the support for Qbus controllers, the NuVAX 4400 is particularly suited to replace aging high-end VAX systems in C4 programs.

Aging fighters, bombers and weapons systems are mandated by the U.S. Department of Defense to remain operational until 2030 or even 2050. The main preoccupation of program managers is risk reduction in an era of budget constraints. The NuVAX 1000, 2000, 3000 and 4000 series offer the simplest means to reduce risk at the right price point.

Migration to newer hardware has traditionally been difficult in military, industrial, and scientific fields that depend upon specialized controllers. Thousands of Digital Equipment Corporation's legendary VAX systems still use Qbus controllers to interface to expensive process control, test stand, data acquisition and communications equipment. With the NuVAX 4400, up to nine of these controllers can be housed in a rack mount PC, significantly reducing footprint, energy consumption and ongoing maintenance costs.

All NuVAX products provide continued support for multiple Qbus devices and follow all Qbus rules and specifications. Both Qbus PIO and DMA data transfers are supported as well as all four Qbus interrupts. DMA data transfers occur at maximum Qbus speeds with throughput limited only by the Qbus device(s). Special utilities can calibrate timing to match original speed if required.

With NuVAX, software applications and specialized Qbus equipment continue to operate without disruption. An automated process transfers applications in their existing binary form onto NuVAX's self-contained hard drive. Neither application source code nor recompilation is required. No recertification is necessary.

Whether the application is in military or manufacturing, users of DEC VAX systems have found it difficult to migrate to newer technology without sacrificing their years of investment in custom hardware, software, and programming expertise. Now they can continue to build on that investment. The NuVAX family provides a broad range of solutions for the thousands of mission-critical VAXes remaining in operation today.

For more information, please visit [www.logical-co.com](http://www.logical-co.com).

## **Simulation Tool Update**

COMSOL announces the availability of version 4.3a of their Multiphysics simulation tool. This release brings new LiveLink(TM) products, parameter optimization, and cloud computing. All of the application specific modules for mechanical, electrical, fluid, and chemical simulation have received major upgrades.

COMSOL Multiphysics 4.3a Highlights Include:

- LiveLink(TM) for Excel(R) 2010 on Windows
- Fatigue Module
- ECAD Import Module
- LiveLink(TM) for Solid Edge(R)
- Cloud Computing
- Parameter Optimization
- More Efficient CFD Solvers, and

- Accelerated parallel computing for all users.

Find more information and view the release video at [www.comsol.com/4.3a](http://www.comsol.com/4.3a).

### **USB-Configured 2-Wire Transmitters**

Acromag's new TT230 series of isolated transmitters are designed to provide easier installation and setup. These signal conditioners are only 12.5mm wide for high-density mounting on DIN rails and provide a convenient USB connection to a PC for simple, precise configuration using Windows software. A number of models are available to isolate and convert thermocouple, RTD, voltage or current input signals to a 4-20mA output. These two-wire instruments are loop-powered and support both source or sink output wiring connections on the current loop with a 12-32V DC supply. A ruggedized design features -40 to 80 °C operation, electrical noise immunity, and surge protection.

Each model accommodates a variety of signal types. Thermocouple units accept eight different sensor types (J, K, T, R, S, E, B, N), as well as  $\pm 100\text{mV}$  inputs. RTD units accommodate 2-, 3-, and 4-wire 100 ohm Platinum sensors or 0-900 ohm linear resistance inputs. Voltage models convert bipolar signals from  $\pm 10\text{mV}$  to  $\pm 150\text{V DC}$  with multiple selectable ranges. The current units are widely adjustable to support  $\pm 20\text{mA}$ , 0-20mA, and 4-20mA DC input signals.

All models deliver high accuracy, superior noise resistance and fast response times. They also demonstrate excellent linearity and stability with very low temperature drift. Software calibration eliminates zero/span pots, DIP switches, and pushbuttons for easy programming of ranges, over/under scale thresholds, and fail-safe settings.

Many other features add greater flexibility. Programmable over/under range and fault/alarm levels enable identification of a "runaway" process or broken sensor. Selectable up/downscale failsafe modes ensure a safe, predictable shutdown with a NAMUR-compliant fault response.

For more information about Acromag products, visit [www.acromag.com](http://www.acromag.com).

### **WiFi Data Logging Sensor**

Corintech announces the launch of the new EL-WiFi-TP thermistor probe temperature data logging sensor. Like the EL-WiFi-TH, the EL-WiFi-TP is a battery powered sensor which communicates wirelessly using an ordinary WiFi network. The sensor measures temperature through the thermistor probe and then transmits data via WiFi to a PC running our free software program. This allows users to remotely monitor and record data anywhere within a selected WiFi network. View one or multiple sensors on your PC at any one time, re-configure them remotely, and set alarms. This is an easy to use, cost effective monitoring solution suitable for industrial, commercial, and domestic applications.

The sensor features:

- Extended Temperature range -40 to +125 °C (-40 to +257 °F) with thermistor probe
- Monitor & Record Live Data
- High & Low Alarms
- Use your current Router (no additional hardware required)

- WiFi Configuration
- Multiple Sensor Operation within single WiFi network
- Free PC Software, and
- Automatically Log and Save Data.

Also, coming soon is the EL-WiFi-Alert, a dedicated alert unit that picks up alarm messages from any EL-WiFi data logger within WiFi range. The device will warn you when any of your data loggers have gone into an alarm state. Warnings include flashing red LED lights, email, nine audible sounds or one custom sound. AThe EL-WiFi-T, which monitors environmental temperature, will be launched this year.

To see a preview on 'How to Set-Up your EL-WiFi Sensor' software demonstration, please visit [www.corintech.com/support-videos](http://www.corintech.com/support-videos). For more product information, please visit [www.corintech.com](http://www.corintech.com).

### **Wireless Temperature and Humidity Monitoring Kit**

Onset announces the HOBO Wireless Temp/RH Monitoring Kit, an easy-to-use, wireless system that includes everything needed to make environmental monitoring fast, cost-effective, and convenient.

In just three easy steps, users can monitor critical temperature and humidity conditions, log data for trend analysis, and stay notified of alarm conditions via text or email – all without the hassles of wires or manual data offload. The monitoring kit is ideal for use in a broad range of facilities, including food processing plants, office buildings, laboratories, and warehouses.

Key features include:

- Fast, easy set up out of the box
- Centralized monitoring straight from the desktop
- Alarm notifications via text or email
- Automated data delivery to remote locations via email or FTP, and
- Flexible design for easy system expandability.

The system sends users a text message via phone or email when temperature/RH conditions exceed set thresholds and sends an alarm if one of the temperature/RH sensors becomes disconnected from the network. The system also provides visual notification on the PC that an alarm has tripped.

The wireless kit includes HOBOnode Manager software, a component of Onset's HOBOware Pro software. HOBOnode Manager allows users to view near real-time energy and environmental data, set alarm notifications, and get an at-a-glance view of the system with its Network Map feature.

To learn more, please visit [www.onsetcomp.com/wireless](http://www.onsetcomp.com/wireless).

### **High-Intensity Piezoelectric Microphone**

Meggitt Sensing Systems has introduced the Endevco® model 2510 piezoelectric sound pressure level microphone, designed to measure very high-intensity acoustic noise and very low pressure fluctuations over a wide temperature range, supporting extreme acoustic measurement applications such as rocket launch separation studies and high-temperature aircraft engine noise monitoring, among others.

Featuring a rugged design, a wide sound pressure measurement range of 100 to >180 dB SPL and temperature measurement capabilities from -55° to +260 °C (-67° to +500 °F), the hermetically sealed stainless steel housing encloses a special thick pressure diaphragm that is expressly designed to prevent puncturing, particle impact damage, accidental mishandling or high pressure pulses. Special insulation placed between the transducer and mounting surface prevents electromagnetic interference (EMI or ground looping) that can degrade data quality and lead to measurement uncertainty. Units feature integral vibration compensation within the sensing element and insensitivity to altitude changes, making them ideal for in-flight or airborne applications. As a self-generating device, the Endevco® model 2510 also requires no external power source for operation.

As a high-impedance piezoelectric microphone, the Endevco® model 2510 is intended primarily to be used along with charge amplifiers, such as the model 2680 airborne amplifier. Although basic design is directed toward maximizing charge characteristics, the model 2510 also gives excellent results when operated into voltage amplifiers. Long cables may also be used between the transducer and charge converter without affecting charge sensitivity. Also recommended for use with the model 2510 are the Endevco® signal conditioner models 133, 2775A, and 2721B.

For detailed technical specifications, drawings or additional information, please visit [www.meggittsensing.com](http://www.meggittsensing.com).

## **Time-Domain Terahertz Spectroscopy Platform**

TOPTICA introduces the new TeraFlash system, a table-top platform for time-domain terahertz spectroscopy. The all-fiber design is based on mature 1.5 µm telecom technology, combining TOPTICA's established femtosecond fiber lasers and state-of-the-art InGaAs antennas. Using a highly precise delay stage, the TeraFlash achieves a peak dynamic range of more than 70 dB.

Users can choose between a “precise scan” mode and a “fast scan” mode. In “precise scan” mode, a bandwidth of 4 THz and a resolution better than 10 GHz are attained. Alternatively, in “fast scan” mode, a pulse trace is acquired in only 50 ms. The fiber-coupled antenna modules can be conveniently arranged, depending on the needs of the experiment. Integrated in the system is TOPTICA's FemtoFERb 1560, a compact ultrafast laser. The SAM mode-locked fiber oscillator and the usage of polarization-maintaining fibers ensure high robustness and alignment-free, “hands-off” operation.

Key Features Include:

- Versatile time-domain terahertz platform
- Fiber-coupled InGaAs photoconductive switches
- High bandwidth > 4 THz, peak dynamic range > 70 dB
- Selectable resolution: 4 to 40 GHz, and
- Built-in Er:fiber laser with SAM mode-locking technology (100 mW / 100 fs / 100 MHz).

Find more information at [www.toptica.com/](http://www.toptica.com/).

## **New Range Of Deep Memory Mixed-Signal Oscilloscopes**

The new range of mixed-signal oscilloscopes (MSOs) from Pico Technology combines the deep memory and high performance of the PicoScope 3000 Series with a powerful 16 channel logic analyzer. With a built-in function generator and arbitrary waveform generator also included, these oscilloscopes offer a complete test bench in one compact, USB-powered device.

The new MSOs have 2 analog channels with bandwidths from 60 MHz to 200 MHz, a maximum single-channel sampling rate of 500 MS/s, and 100 MHz digital inputs. Buffer memory sizes range from 8 MS to 128 MS.

Serial data in I2C, UART/RS232, SPI, CAN bus, LIN and FlexRay formats can be decoded and displayed in binary, decimal or hexadecimal formats. The 16 logic inputs are organized in two banks, each of which has its own adjustable logic threshold to allow testing of mixed-logic designs.

The PicoScope software supplied with the MSOs includes as standard all of the oscilloscope and spectrum analyzer functions you would expect, as well as mask limit testing, segmented memory, advanced triggers, and the serial decoding mentioned above, features that often cost extra on other manufacturers' scopes. Other built-in features include persistence displays with fast update rates, math channels, automatic measurements with statistics, and programmable alarms. Updates to the software are free of charge.

The advanced trigger types include pulse width, interval, window, window pulse width, level dropout, window dropout, runt pulse, variable hysteresis, and logic. All triggering is digital, ensuring lower jitter, greater accuracy, and higher voltage resolution than the analog triggering found on many competing scopes.

A free Software Development Kit (SDK) allows you to control the new scopes from your own programs. It includes example code in C, C++, Excel and LabVIEW, and can be used with any language that supports C calling conventions. The PicoScope software and SDK are compatible with Microsoft Windows XP, Windows Vista, Windows 7 and Windows 8.

More information on Pico Technology can be found at: [www.picotech.com](http://www.picotech.com).

## **Optical Absorption Sensor**

Endress+Hauser introduces the OUSAF11 sensor for measuring optical absorbance by a process fluid. Using visible and near-infrared wavelengths of light, the OUSAF11 is ideal for product loss detection, interface detection, and suspended solids and turbidity measurements.

The sensor emits light in both the visible and near-infrared regions, and absorption by the process fluid is determined using an optical sensor mounted in the sensor head. The sensor is available in an immersion model for use in open tanks and basins, or in an insertion model with Tri-Clamp or Varivent connections that meet 3A Sanitary Standards.

The body of the rugged OUSAF11 is constructed of 316L stainless steel. The measuring head contains the light source and optical sensor, and it is constructed of FEP fluorocarbon film. The fouling-resistant sensor head contains no glass. The FEP fluorocarbon film is non-reactive, highly transparent, resistant to sunlight, and has a high temperature rating.

The OUSAF11 sensor can be operated continuously up to 194 °F (90 °C) and up to 266 °F for up to two hours.

The OUSAF11 is easy to install and commission. The sensor can be installed in a pipe, with the appropriate fitting, or suspended in an open channel or basin. The integrated cable is easily wired to the transmitter. The menu-guided interface on the CVM40 allows the sensor to be set up quickly. Interface to the transmitter can also be accomplished using a keyboard and the USB port on the transmitter.

The CVM40 has a full-color graphic display, built-in web server, and Profibus, Modbus, Ethernet TCP/IP and RS232C/RS485 communications. It has four optical channels for input from sensors and two universal analog inputs that accept voltage, current, RTDs, thermocouples and other standard inputs. Outputs include up to six relays, a 4-20 mA output, and digital pulse outputs. The instrument can support a range of sensors in addition to the OUSAF11 with its six digital input channels.

For more detailed technical information on the OUSAF11, please go to the product page at: [www.us.endress.com/#product/OUSAF11](http://www.us.endress.com/#product/OUSAF11).

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## *Membership Notes*

Szu-Ying (Carol) Wu

### **IMS Taipei Section Chapter Highlights of the International Scientific Instrument Technology Workshop (ISITW)**

The International Scientific Instrument Technology Workshop (ISITW) is an annual two-week training course that is hosted by the Instrument Technology Research Center (ITRC) of the National Applied Research Laboratories (NARL) in Hsinchu, Taiwan with the desire to build an international collaboration platform. ISITW was previously known as the International Scientific Instrument Technology Program and was supported by the Association for Science Cooperation in Asia and the National Science Council of Taiwan. Beginning in 2009, the IEEE Instrumentation and Measurement Society (IMS) Taipei Section started providing technical support.

Over the years, ISITW has invited more than 497 researchers dedicated to instrument technology to absorb and exchange the latest research progress. It is usually held in October for outstanding S&T government officials and research faculties from the Southeast Asia and the Middle East regions. In 2012, there were 95 applicants to the workshop and that included twenty-seven attendees from nine countries that attended ISITW. This year's topic was "Instrument Technology: Application in Nano, Bio and Green Technology." Invitation letters were sent to Region 10 local chapters, including the New Zealand Section Chapter, the Malaysia Section Chapter, the Japan Section Chapter, the India Section Chapter, the Australia Section Chapter, and so forth. ISITW tries hard to invite as many applicants and speakers as possible to promote the exchange of the latest research and development of instrument technology. During the two-week program, all of the attendees developed close relationships in research and cultural

exchange, as well as actively sought regional cooperation in Asia. ISITW has gradually developed a reputation in serving as a liaison for science and technology collaboration. More information about ISITW is available at: [www.itrc.narl.org.tw/International/ISIT/index-e.php](http://www.itrc.narl.org.tw/International/ISIT/index-e.php).

### **i-ONE International Instrument Technology Innovation Competition**

The 4th “i-ONE International Instrument Technology Innovation Competition” was held at the Instrument Technology Research Center (ITRC) of the National Applied Research Laboratories (NARL), in Hsinchu, Taiwan in November 2012. Beginning in 2009, this competition has been organized by ITRC and has been sponsored by IEEE I&M Society Taipei Section Chapter for the past four years. “i” in “i-ONE” stands for various layers of meaning, including instrument, instrumentation, idea, innovation, integration, implementation, and internationalization. “i-ONE” aims to encourage students in high school through graduate school to attend and to be creative and innovative in the research and development of instrument technology from the beginning of their studies. By participating in this competition, students from Taiwan and the broad Asia region can share their ideas, learn how to integrate, cooperate, and communicate with each other so that they may become leaders in instrument technology research.

This year the i-ONE Award Ceremony was honored to invite Professor Reza Zoughi, the Executive Vice President of IEEE I&M Society, to attend the ceremony and give encouragement to all of the students that “Once you get nominated, you are already the winner!” Three groups in the “high school level” and five groups in the “college and above level” won the prizes. Many of them expressed their appreciation to i-ONE for giving them such a great opportunity to collaborate and connect to the world, and hope they can continue researching in the field. Every year, i-ONE accepts submission from May 1<sup>st</sup> to August 31<sup>st</sup>. For more detailed information, please refer to the official website: <http://i-one.org.tw/index-e.jsp>.

*(The original article includes several photographs from the events)*

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## *Society News*

Dr. Pasquale Daponte has been elected President of IMEKO (the International Measurement Konfederation: [www.imeko.org](http://www.imeko.org)) for the 2012-2015 term. Pasquale has been active in the IEEE Instrumentation and Measurement Society (IMS) for many years and is an elected member of the IEEE IMS AdCom. IMEKO is a non-governmental federation of thirty eight Member Organizations individually concerned with the advancement of measurement technology. Its fundamental objectives are the promotion of international interchange of scientific and technical information in the field of measurement and instrumentation and the enhancement of international cooperation among scientists and engineers from research and industry. Founded in 1958, the Confederation has consultative status with UNESCO and UNIDO and is one of the five Sister Federations within the Five International Associations Coordinating Committee.

The activity of IMEKO is basically carried out through twenty-four Technical Committees, which cover nearly all of the measurement fields and organize symposia, conferences, workshops, and seminars on specific topics at regular intervals. They also publish Proceedings of events, text-books, glossaries, studies, etc. IMEKO organizes an IMEKO World Congress every three years. Word Congress convened in Busan, Korea from September 9–14, 2012. It was at this event that Dr. Daponte assumed the Presidency.

## **Distinguished Lecturer Program – 2013 Call for Applications**

The Instrumentation and Measurement (I&M) Society is currently accepting applications for new Distinguished Lecturers (DL) for the Distinguished Lecturer Program (DLP). The DLP provides experts on topics of interest and importance to the I&M community to Society chapters and for technical events around the world. Our lecturers are among the most qualified experts in their field. More details on the DLP can be found at: <http://www.ieee-ims.org/education/distinguished-lecturers-program>.

DLP Evaluations for 2013 will take place in May at I2MTC in Minneapolis, MN. Details on the Evaluation Meeting will be made available on the IMS website (<http://www.ieeeims.org/>) and the I2MTC website (<http://imtc.ieee-ims.org/>) when available. Suggested topics for DL presentations include (but are not limited to):

- Laser/Optics (including Fiber Optic Sensing),
- Measurement Precision, Sensitivity, and Noise,
- DC Measurements,
- Biomedical Instrumentation and Measurements,
- Robotics/Automated Measurements,
- Nanotechnology in Instrumentation and Measurement, and
- State-of-the-Art of Traditional Measurements and Instrumentation (Digitizers, Voltmeters, Spectrum Analyzers, etc.).
- 

To apply, submit a Word 2003 (or later) file that includes the following:

- Title of Presentation,
- Presenter's name and affiliation,
- Abstract of the presentation topic (between 500 and 1000 words), and
- A biography of the presenter (limited to 150 words).

Applications will be accepted through midnight (CST) on April 29th, 2013. Proposal presentations selected for an evaluation slot must be no longer than twelve minutes. For questions or to submit your application, contact the DLP Chair, Kristen Donnell, at [kristen.donnell@mst.edu](mailto:kristen.donnell@mst.edu).

### **The “Future of Instrumentation” Workshop Report**

Kenneth W. Tobin Ph.D., *IEEE Fellow*, Kim Fowler *Past President of IEEE IMS*,  
Peter Fuhr Ph.D., *Senior Member, IEEE*, and Tim McIntyre

What is the future of instrumentation? It is an absurdly open-ended but interesting question to explore in this age of ubiquitous sensing and wireless devices and the slow but steady realization of the “Internet of Things.” At the U.S. Department of Energy’s (DOE) Oak Ridge National Laboratory (ORNL) in Oak Ridge, Tennessee, we research and develop sensors and instrumentation for a wide variety of energy-related applications impacting energy exploration, energy delivery, and environmental monitoring (Fig. 1). To support research into these challenging measurement problems, the Measurement Science and Systems Engineering Division at ORNL initiated The Future of Instrumentation Workshop in 2010 in collaboration

with the IEEE Instrumentation and Measurement Society (IMS) to reach out to the measurement community and pose this open-ended question.

The first two years of this meeting were in 2010 and 2011 and they were held at ORNL in East Tennessee. They included tours of some of ORNL's national user facilities and unique laboratories, thereby introducing many in the research community to our renewed campus and energy research mission. These workshops brought together industry, academia, U.S. national laboratories, and U.S. federal agencies and provided a unique environment for open and frank discussion on research directions and the merits (e.g., scientific, engineering, or financial) of employing different technologies to achieve practical ends.

While the attendance of around 100 participants for each of the first two years was encouraging, we wanted to create a venue that would reach beyond the impression of this being an "ORNL" event. Consequently, we moved the Future of Instrumentation International Workshop (FIIW 2012) to Gatlinburg, Tennessee in October of 2012 (Fig. 2). The Workshop succeeded in attracting a broader range of participants from outside the U.S. DOE national laboratory community.

FIIW 2012 focused specifically on sensing and instrumentation needs in the energy value chain. Experts in technical areas including sensors, communications, and controls gathered to discuss power generation from both fossil fuels and nuclear energy. Separate technical tracks looked at energy transmission and distribution at large scale and in microgrids. Presentations and discussions focused on end-use energy sensing in manufacturing, commercial buildings, and in demand response systems. In addition, we had a crosscutting area related to advanced instrumentation, including topics such as energy harvesting, wireless sensor networks, and resilient and trustworthy control systems in extreme environments.

Over 40 technical papers were delivered during the two day workshop and two panel sessions dedicated to the role of sensors for building-to-grid integration and the deployment of wireless sensor networks for industrial energy efficiency. To drive the topical discussions in these areas, we had sponsors from several program offices within the U.S. DOE's Office of Energy Efficiency and Renewable Energy, Office of Electricity Delivery and Energy Reliability, and Office of Nuclear Energy. The National Energy Technology Laboratory and large industrial and automation companies Invensys Operations Management, Inc., and Mars, Inc. also provided financial, technical, and organizational support.

The workshop format has provided ample time for audience participation and discussion. In each workshop, we have discussed the value of creating a sensors and instrumentation roadmap that will highlight the key research areas that are necessary to achieve impact in energy efficiency through advances in communications and controls. Fig. 3 is a stylized representation of the general observations that have resulted from these annual discussions. Discrete sensors and instruments have been the mainstay of industry for many years. Their associated communications, albeit automated, were and still are frequently simple observe-and-report methods or sensors wired to control systems.

FIIW 2012 discussions amplified the general consensus that with the advent and integration of robust industrial wireless communications standards and devices, it is now technically feasible, cost effective, and financially advantageous to create sensor systems that can be retrofitted into many types of complex measurement environments. There are two general directions that we are observing today. First, sensors are being employed in harsh environments that require robustness and reliability (e.g., oil exploration, nuclear power industry, environmental monitoring, etc.). These systems are using sensors with onboard computing (e.g. FPGA, DSP, GPU, CPU) coupled

with wireless communications capabilities. Power is still an issue with these systems and often difficult to provide or maintain. Meanwhile embedded computing improvements have proceeded to the point where a million instruction cycles may occur within the instrument for the same amount of power consumption as transmitting a single bit via wireless. (For further information on this topic, please visit <http://trustworthywireless.ornl.gov>.) The net result is that computation takes place on the device resulting in the efficient output of compressed information versus fundamental data.

Second, an alternate path that is emerging includes the development of potentially low-cost, low-power devices that may scavenge power from their environment (e.g., thermal, vibration, wind, solar, etc.). A significant FIIW 2012 discussion topic was the feasibility of using passive wireless sensor tag technologies whereby no batteries are used and the device remains “dormant” until externally interrogated with an RF signal. FIIW 2012 also broke from the “strictly sensors & instrumentation” mold by examining the extremely important instrumentation integration trends associated with industrial- grade additive manufacturing (i.e., 3D printers). As this technology continues to evolve at a very rapid pace, it is anticipated that significant and rapid advances in both structural and functional printing capabilities will result in the creation of instrumented structural systems that contain hydraulics, pneumatics, electronics, communications, and printable sensing elements to measure temperature, pressure, vibration, stress, and a host of other physical properties. These will be truly intelligent structures that are not producible by any other means known today. These are the topics that make FIIW unique.

In 2013, we will transition the workshop into an international conference, representing a significant shift in the reach, audience, and administration of the annual event. Our goal is to expand the availability and influence of FIIW to an international audience and provide greater involvement from the IEEE IMS community. The focus of the conference will be advanced sensors and instrumentation in extreme environments. We plan to expand the participation of major industrial partners, companies, and U.S. government agencies to include a broader worldwide participation that includes international governmental laboratories, agencies, and research programs. We will also expand the opportunities for paper and poster presentations, panel discussions, speakers and distinguished lecturers, and tutorials. Join us in Orlando, Florida, in November 2013 for an unforgettable and thought-provoking conference!

**Call for Papers**  
**Upper-division undergraduate and graduate student papers for the**  
**October 2013 issue of the**  
***IEEE Instrumentation and Measurement Magazine***

This issue is planned as a “Salute to Education.” The Magazine is looking for quality student papers in the field of instrumentation and measurement which would be suitable for publication in this issue. Suitable topics would include material from capstone projects or graduate-level research efforts. Student papers should be a serious piece of writing which will be subject to the same review process as regular Magazine articles. This is an excellent opportunity for publication if your work is suitable for sharing with the academic and industrial instrumentation and measurement community.

Production deadlines require all submissions be received no later than May 18, 2013. Manuscripts submitted after this date cannot be accepted. Please contact the Editor-in-Chief as shown below for author instructions.

Michael F. (Mike) Gard, PhD, PE

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