Summer 2005

The Current Source

Newsletter of the Schenectady Section of the IEEE

Volume XXXII, No. 2

From the Editor...

Welcome to the special Summer issue of the Current Source. A number of readers responded to our call for contributions on new technologies that we ran in the Spring issue. In this newsletter, you will find two articles prepared by our Section members on new technologies being developed right here in our area. The first article deals with ultrasound technology and its applications in the area of medical imaging and non-destructive inspection. The second article describes the application of computational intelligence techniques in the industry. What's interesting about these technologies is that they are being increasingly applied to areas where no one would have imagined they would be applied just a few decades ago. For example, artificial neural networks (just one of many computational intelligence simulation tools) are being applied to solve problems in engineering, medicine and even in the financial industry. We hope you find these articles interesting and informative.

Also, in this issue you will find a report on the 2005 Industrial & Commercial Power Systems Conference prepared by Louie Powell who served as the Conference Chair. We also have an article by Stephen Bush on how IEEE members may be able to help in the Capital District's first ever LEGO Robotics League tournament being held later this year. Although summer is generally a quiet time as far as IEEE related activities are concerned, there's been a lot happening behind the scenes. For one, we now have a new Chapter within the Schenectady Section. The local Chapter of the Computational Intelligence Society was established on June 29. You can read more about the new CIS chapter in this issue of the Current Source.

Your Section and Society Chapter officers have been hard at work during the summer months planning membership meetings and events for the remainder of the year. More information will be sent throughout the fall as more events are scheduled.

Finally, we would like to hear your thoughts about the newsletter and its contents. For example, we have often wondered whether the newsletter is responding to the needs of our membership in providing section news, timely reports of past and upcoming events, as well as articles of broad interest to the Section membership. As always, the Current Source is always open for contributions for future newsletters. Feel free to call me or any of the other Section or Chapter officers with comments and suggestions. We look forward to seeing you at one of the upcoming membership meetings. Remember, the Schenectady Section is what we, the members make of it. Please, get involved! ■

As part of the June Membership Meeting, Schenectady Section Members visited the Mechanicville Hydro Power Plant. The 4.5 megawatt plant began operating in 1898 and is on the National Register of Historic Places. – *Photo Credits: Louie Powell*

2005 Section Officers

Executive Committee
Sameh Salem, Chair
W: 385-0931
s.salem@ieee.org
Shadrack Orero, Vice Chair - Secretary
W: 395-5068
shadrack.orero@ieee.org
Ricardo Galarza, Vice Chair - Treasurer
W: 452-7733
rgalarza@psm-consulting.com

Appointed Positions
Rebecca Nold, Nominating Committee Chair
W: 385-3883 Fax: 385-7752
rebecca.nold@ps.ge.com
Lou Tomaino, Membership Chair, Meeting Coordinator
W: 385-0967
l.tomaino@ieee.org
Ricardo Austria, Awards Chair
ricaustria@pterra.us
Kristin Short, Past Section Chair
W: 395-5117 Fax: 346-2777
k.short@ieee.org
Peter Sutherland, Student Activities Chair
W: 374-4699 ext. 13
peter.sutherland@ieee.org
Zongqi "Sonnie" Sun, PACE Chair
W: 387-6460, Fax: 387-5752
zsun@nycap.rr.com
Chandra Reis, Section Historian
reisc@aol.com
Jose Daconti, Liaison to Prof. Eng. Society
W: 395-5090
jose.daconti@siemens.com
Howard Halstead, Webmaster
W: 356-7664
halstead@ieee.org

Power Engineering Chapter (PES-31)
Jose Daconti, Chair
W: 395-5090
jose.daconti@siemens.com
Saber Azizi, Vice Chair - Secretary
W: 385-3820
saber.azizi@ps.ge.com
Doug Brown, Vice Chair - Programs
douglas.r.brown@siemens.com

Computer Chapter (C-16)
Howard Halstead, Chair
W: 356-7664
halstead@ieee.org

Industrial Application Society
Ed Owen, Chair
Hm: 355-4112
eowen@nycap.rr.com

Computational Intelligence Society Chapter
Neil Eklund, Chair
eklund@research.ge.com
W: 387-5499

Steinmetz Committee
Chandra Reis, Chair
reisc@aol.com

RPI Student Chapter
Prof. Gary Saulnier, Advisor
saulng@ecse.rpi.edu

Union College Student Chapter
Prof. Michael Rudko, Advisor
W: 388-6316
rudkom@union.edu

Newsletter Editor
Srinivas (Sri) Pillutla
W: 783-2088 Fax: 783-4777
srinivas.pillutla@ieee.org

On the web at:
http://www.ieee.org/schenectady

Local Chapter of IEEE Computational Intelligence Society Founded

The Schenectady chapter of the IEEE Computational Intelligence Society (CIS) was founded on 29 June 2005. Computational Intelligence (CI) techniques are used extensively in industry to quickly solve a wide variety of difficult problems. For example, CI is applied at GE Global Research on such disparate problems as gas turbine fault detection and classification, bond portfolio optimization, modeling and multiobjective optimization of coal-fired power plants, and a wide variety of military applications.

Computational Intelligence (also known as soft computing) is inspired by biology, and in particular the brain. CI attempts to mimic the brain's tolerance for imprecision, uncertainty, partial truth, and approximation to quickly generate tractable and robust solutions at low cost. The three principal constituent CI methodologies are reflected by the IEEE CIS publications, Transactions on Neural Networks, Transactions on Fuzzy Systems, and Transactions on Evolutionary Computation.

The first meeting of the local chapter will be held this fall, date and location TBD. For more information, contact Neil Eklund at 518.387.5499 or eklund@research.ge.com

Call for Contributions

The Current Source is always open for contributions for future newsletters. There is certainly much more going on in this area then gets profiled in the newsletter. Do you have an article about a historical moment, a future event, or a notable discovery that might be of interest to the local IEEE community? How about a picture of some momentous occasion? Please contribute! Staff editors can even take your bulleted list and turn it into printable article if writing does not appeal to you. We do however have to reserve the right to refuse any material of a commercial nature.
The Current Source is published twice a year by the Schenectady Section of the IEEE. If you are interested in volunteering for *The Current Source* or wish to submit material for consideration, please contact the editor.

New Frontiers of Ultrasound

Zongqi "Sonnie" Sun, GE Global Research
sunzo@research.ge.com

Ultrasound – thinking about black and white images from a probe touching your abdomen? Today's ultrasound can do much more than that. Those black and white images are 2D cross-sectional views of what is inside the body, while 3D pseudo-color images can be generated on the state-of-the-art ultrasound imaging system. Not only 3D, now it becomes 4D (3D in space + 1D in time): 3D moving pictures of what's happening inside the body. If you are a parent-to-be, don't you want to see your baby moving inside? Here's an example shown in the figure – a series of snapshots of fetus movements. Another important advancement in medical ultrasound is cardiac imaging. Compared to five years ago, a beating heart can be displayed on the screen in real time now.

Not only has it been applied to medical imaging, but also ultrasound can find tiny cracks in materials. As a modality of nondestructive inspection, ultrasound has been applied to aerospace, petrochemical, nuclear, automotive industries etc. Today, more and more manual inspections have been replaced by automatic, remote controlled inspection systems. As an example, thousands of miles of oil and gas pipelines in the United States are automatically inspected with improved defect resolution by ultrasound tools combined with other techniques.

With the development of bio-, nano-, and info-technologies, ultrasound technique will bring more and more benefits into our lives.

4D Ultrasound images (Cited from www.imaging-orlando.com)

Dr. Zongqi "Sonnie" Sun is an ultrasound scientist with the GE Global Research Center in Niskayuna, NY.

2005 I&CPS Conference Held

The Schenectady IEEE Section hosted the 2005 Technical Conference of the Industrial & Commercial Power Systems Department, IEEE Industry Applications Society. This meeting was held at the Prime Hotel in Saratoga Springs in early May.

There were 111 registered attendees, with about 22 companions at this meeting. Participants came from all over the US and Canada, as well as Taiwan, Thailand and Italy. The first two days of the meeting were devoted to working group and committee meetings, focused mainly on the mission of I&CPS in developing the Color Book series of IEEE Standards. The second two days featured parallel technical sessions. A total of 29 papers were presented; these papers were published in a conference proceedings in both CD and hardcopy form, and will be archived in IEEE Xplore for access by researchers throughout the world.

Finally, the conference concluded with a half-day tutorial on arc flash and arc-resistant switchgear applications. 24 participants received continuing education unit credits for completing this tutorial.

Like most IEEE meetings, the I&CPS Conference also included several social activities. The conference kicked off with a reception on Sunday evening at the Prime Hotel. The group gathered for a dinner at Lillian's Restaurant on Broadway in Saratoga Springs on Tuesday evening. Finally, an Awards Luncheon was held at the Prime on Wednesday at which recipients of prize paper awards were recognized. The Department Distinguished Service Award was presented at the luncheon along with a Standards Medallion, a recognition presented by the IEEE Standards Association to individuals who make major contributions to development of standards.

Several members of the section contributed to the success of the conference. The local committee included Louie Powell, Chair; Ed Owen, Vice-chair; Kristin Short, Secretary; Ricardo Austria, Treasurer; Sam Salem, Registrations; Bob Smith, Tours; and Howard Halstead, Webmaster. ■

Louie Powell, Conference Chair, with Prafulla Pillai, Chair, IEEE-IAS Industrial & Commercial Power Systems Department

Hybrid Computationally Intelligent Systems in Industry

Neil H. Eklund, Ph.D.
GE Global Research
Computing and Decision Sciences
eklund@research.ge.com

This article presents a brief overview of the main techniques of computational intelligence, and described some applications of hybrid CI systems used in industry. Computationally Intelligent systems are used extensively in industry to quickly develop accurate, reliable, robust, and low-cost solutions to complex problems. Hybrid CI systems in particular allow engineers to capitalize on the best aspects of multiple approaches, resulting in systems that are overall far better than the sum of individual components.

Computational Intelligence (also known as soft computing) is inspired by biology, and in particular the brain. Computational Intelligence (CI) attempts to mimic the brain's tolerance for imprecision, uncertainty, partial truth, and approximation to quickly generate tractable and robust solutions at low cost. The three principal constituent CI methodologies are Neural Networks (NN), Fuzzy Logic (FL) and Evolutionary Computation (EC), although there are many others. This article will give a very limited overview of NN, FL, and EC and hybrid systems, and briefly describe some applications of hybrid CI systems in industry.

An artificial Neural Network is a computational simulation (in either hardware or software) of a very simplified biological brain. Among other things, NNs can approximate any function to an arbitrary level of precision, which makes them useful for modeling complex, nonlinear systems that are poorly suited to deterministic (e.g., physics-based) models. In addition to systems approximation, NNs are often employed for classification problems.

Fuzzy Logic (FL) is a superset of conventional (Boolean) logic that has been extended to handle the concept of partial truth and so more appropriately model human thought. For example, a man whose height is 6′ is assuredly "tall"; a man whose height is 5′ is assuredly not "tall"; but a man who is 5′ 7″ is to a partial degree (but not fully) "tall". The expression of partial truth makes the extraction of expert user opinion and experience relatively easy ("if the road is steep, increase the throttle slightly"), so FL is frequently used in control applications.

Evolutionary computation is a general term for several optimization techniques based on the evolution of biological life. EC has become the method of choice in the last two decades for optimization problems that are too complex to be solved using deterministic techniques such as linear programming or gradient methods. ECs require little knowledge about the problem being solved (although it is advantageous), and are easy to implement, robust, and inherently parallel. Most real-world problems involve simultaneous optimization of several often conflicting objectives (e.g., a cell phone that is both small and inexpensive). Multiobjective EAs are able to find a set of solutions that are optimal in an overall sense. Moreover, EAs can always be applied to any multiobjective problem; gradient based methods are often impossible to use for multiobjective optimization.

Although many problems can be solved by applying individual CI techniques, most real world problems are best solved by a combination of techniques, selecting as appropriate from both CI and non-CI approaches. The synergy resulting from combining multiple CI techniques is substantial, permitting robust, flexible to solutions complex, real-world problems. Some hybrid industrial applications include:

- bond portfolio optimization using EC and linear programming
- gas turbine fault detection using physics based models and NN
- automated insurance rate classification system monitoring using FL, NN, EC, Random Forests, and Support Vector Machines
- tuning FL controllers using EAs for numerous applications
- using FL to control EAs for multiobjective spectrum optimization

Coal-fired power plant optimization is another example of a complex problem solved by a hybrid computational intelligence. At any time, a control setting must

be determined which meets demand (with a very small margin for error) on the power plant, known as load. While there are many settings that will meet the load criterion, heat rate (HR, an inverse measure of fuel efficiency) should be minimized and NOx (a pollutant) should be also minimized. Unfortunately, HR and NOx are conflicting objectives – minimizing one generally means maximizing the other. For a particular load and HR, the control setting that minimizes NOx production is known as Pareto-optimal; the set of all points (minimum NOx for any HR) is the Pareto-optimal front.

The relationship between inputs (over 30 control variables), time variable uncontrollable variables (e.g., air and cooling water temperature) and the plant outputs of interest - load, NOx (a pollutant), and heat rate (HR, a measure of fuel efficiency) – is too complex to be modeled accurately from first principals. To overcome this problem, the input/output relationships were modeled empirically using neural networks trained on historical data. The resulting models were far faster and more accurate than any of the physics based models previously developed.

Once the problem of modeling the plant was overcome, the problem of developing optimal control settings remained. This is a very challenging optimization problem: there are multiple, conflicting objectives, the problem is nonlinear, and a variety of constraints must be met. Traditional gradient-based methods were unable to solve it satisfactory. However, a hybrid system employing evolutionary algorithms and gradient techniques was successfully applied to determine Pareto-optimal front rapidly enough to be used to control a power plant. ■

Computational Intelligence Courses Offered at Local Universities

There are several excellent courses taught at local universities on Computational Intelligence (CI).

• **The Graduate College of Union University** (www.gcuu.edu) is offering Systems Modeling & Optimization (applications of CI) in the fall trimester, with Machine Learning in the winter trimester and Evolutionary Multiobjective Optimization in the spring to follow, given sufficient student interest.
For more information, contact Robert Kozik at 518.388.8068 or kozikr@union.edu.

• **Rensselaer Polytechnic Institute** (www.rpi.edu) is offering two courses this fall, Applied Intelligent Reasoning Systems and also Fuzzy Logic and Computation Intelligence.
For more information, contact Neil Eklund at 518.387.5499 or eklund@research.ge.com

Dr. Wayne Nelson
Receives Lifetime Achievement Award

Dr. Wayne Nelson of Schenectady, NY received the 2005 Lifetime Achievement Award of the Reliability Society of the Institute of Electrical and Electronic Engineers (IEEE). This most prestigious award of the Reliability Society recognizes his many innovative developments of practical methods for analysis of reliability and accelerated test data, an effective and knowledgeable teaching of thousands of reliability practioners, and skilled consulting which lengthened the life on many hundreds of clients' products, including toasters, heart pacemakers, car and jet engine components, and aluminum siding, among many others.

The IEEE Reliability Society contributes to the development of reliability engineers, who work to improve the longevity and performance of products and the reliability of industrial and military systems. The Reliability Society created the Award in 2004 and presented it then for the first time to Dr. Ralph A. Evans for his 35 years of outstanding service as editor of the *IEEE Transactions on Reliability*, the leading journal on all aspects of reliability. Dr. Nelson is the second to receive the Award.

Dr. Nelson is a graduate of the California Inst. of Technology (Caltech) and the Univ. of Illinois. Formerly a statistical consultant with General Electric Research & Development for 25 years, he now privately consults and gives courses for companies, professional societies, and universities. For his technical contributions, he was elected a Fellow of the Inst. of Electrical and Electronic Engineers, the Amer. Soc. for Quality, and the Amer. Statistical Assoc.. He recently spent four months in Argentina on a Fulbright Award, doing research and lecturing on analysis of product reliability data. The American Society for Quality awarded him the 2004 Shewhart Medal for his technical leadership. ■

For more information, contact Wayne Nelson at WNconsult@aol.com, (518) 346-5138, 739 Huntingdon Dr., Schenectady, NY 12309

Capital District LEGO Robotics Organizations: An Opportunity for IEEE?

IEEE and the First Lego League (FLL) share many important goals. It would make sense that they should consider working together, particularly in the New York Capital District area. The technical activities involved in programming an autonomous robot are clearly within the purview and expertise of the IEEE. The overarching purpose of the FLL is to promote interest in engineering among our next generation of students, including grade school students.

The main purpose of this article is to request help from IEEE members for the Capital District's first ever FIRST Lego League Tournament to be held later this year. We need judges, volunteers, and mentors. If you enjoy working with kids, and want to get them excited about engineering, then you can definitely have an impact by helping with this project. We are firmly committed to instituting an ongoing FLL program and ultimately a FIRST competition in our local area.

Given the shortage and lack of interest in science and engineering in the United States, the results from FLL have been encouraging. The number of FLL teams has grown from 200 teams in the U.S. in 1998 to 5,859 teams in 20 countries in 2004. In a 2004 evaluation of FLL, Brandeis University[1] found: (1) 97% of the participants reported an increased knowledge of the application of school subjects to solving real-world problems (2) 94% of coaches reported an increase in students understanding of how science and technology can be used to solve problems (3) 88% of the participants wanted to learn more about computers, science, and technology (4) 77% of the participants expressed an interest in pursuing a science and technology related job.

You can start a team, ideally through your child's school. Each team is comprised of youngsters, age 9 to 14, with an adult coach. A challenge is announced in September and then tournaments are held throughout the world. More details can be found at www.FirstLegoLeague.org, including other teams and their scores. There were more than 4,000 teams in 2004 and more than 160 teams in NYC in 2004. FIRST has hosted the FIRST LEGO League NO LIMITS World Festival in conjunction with the FIRST Robotics Competition Championship in Atlanta, Georgia at the Georgia Dome and Georgia World Congress Center, April 21-23, 2005.

Team registration began on May 1st, so now is an ideal time to get your team started before the challenge is revealed in September! ■

Author contact info:
Dr. Stephen F. Bush
bushsf@research.ge.com

[1] *Source: FLL Program Study by Center for Youth and Communities, Brandeis University, May 2004*

Prize Paper Awarded

A technical paper titled *"A New Method for Synchronous Generator Core Quality Evalution"* written by the late Gerald Kliman, Life Fellow IEEE, Sang Bin Lee, Member, Manoj Shah, Fellow, Kutty Nair, Life Senior Member and Mark Lusted, Non-member was published in the *IEEE PES Transactions on Energy Conversion* in the Fall 2004 issue. This paper was selected for a first prize, awarded at the IEEE Power Engineering Society General Meeting in San Francisco on June 14, 2005. The same paper, with some changes, is scheduled to be published in the Sept/Oct 2005 issue of *IEEE Transactions on Industry Applications*.

Call for Proposals
IEEE Professional Communication Society

The IEEE Conference on the Convergence of Technology and Professional Communication
23-25 October, 2006

Saratoga Springs, New York USA

We welcome proposals for this conference, which explores dimensions of professional and technical communication in an environment that places increasing emphasis on effective use of technology and on communication as an essential tool for management and innovation.

The conference will be held at the Gideon Putnam Hotel in Saratoga Springs (www.gideonputnam.com), located in New York's Capital Region and emerging "Tech Valley." Sessions will include: paper presentations, panel discussions, workshops, opportunities to "share a table with a member of various professions," and "the winners' circle"—a forum for the free and lively exchange of ideas on a variety of topics.

Proposal topics suggested, but not limited to, are:

- Information Usability
- Web Development
- Managerial Communication
- Innovation in Education
- Communication in High-Tech Environments
- Collaborative Design and Communication
- Innovations in Communication
- Information Evaluation and Testing
- New Communication Media

Send 1-2 page proposals by 10 January 2006 to: Roger Grice. gricer@rpi.edu.

Nominations and a Call for Volunteers

The nominations for officers for the 2006 calendar year are as follows.
Please feel free to direct questions to Sam Salem (Section Chair), or Rebecca Nold (Nominations Chair).
Uncontested positions will be elected via acclimation at the December membership luncheon.

Section Chair - *Sameh Salem*
Vice Chair, Treasurer - *Shadrack Orero*
Vice Chair, Secretary - *Peter Sutherland*
Vice Chair, Membership – *Zongqi (Sonnie) Sun*
PES Chair - *Jose Daconti*
PES Vice Chair, Secretary - *Saber Azizi*
PES Vice Chair, Membership - *Douglas Brown*
PES Vice Chair, Programs - *Antonio Caiafa*
Computer Chapter Chair - *Howard Halstead*
Industrial Applications Chair - *Ed Owen*
Computational Intelligence Chair - *Neil Eklund*

Student Activities Chair: **This is an appointed position that is now open. The Student Activities chair participates and/or coordinates volunteers for various events such as the Professional Engineer's Future Cities competition and the LEGO competition detailed in this newsletter. Also the Student Activities Chair is a liaison to the student chapters at Union and RPI. Given our strong Section membership, this is a position that can leverage to make a big difference for the Section and the students of the Capital District. Please contact Sam Salem or Rebecca Nold if you are interested in volunteering for this position.**

IEEE
Schenectady Section
The Institute of Electrical
and Electronics Engineers, Inc.
P.O. Box 1327
Schenectady, NY 12301

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