

# GLOBAL Gas Turbine News

ATLANTA, GEORGIA USA • ASME INTERNATIONAL GAS TURBINE INSTITUTE

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## What Do You Plan To Do With That Gas Turbine?

# GTUS 2005 Offers Practical Advice for Gas Turbine Users

**Workshops: December 4-5, 2005**  
**Symposium: December 6-8, 2005**  
**Sands Expo Convention Center**  
**Las Vegas, Nevada, USA**



The ASME Gas Turbine Users Symposium (GTUS) is back and headed for Las Vegas for a second year of co-location with Power-Gen International. The 2004 GTUS in Orlando was a great success, well received by over 200 members of the gas turbine end-user community. This year's program promises to deliver another robust assortment of practical solutions for the everyday challenges of gas turbine ownership and operation.

GTUS targets the needs and interests of gas turbine buyers, managers, operators, and technicians, and of those who provide products and services to gas turbine users. Leaders across the spectrum of gas turbine applications and field expertise have teamed up to organize sessions on the crucial issues of today for those who specify, select, purchase, operate, maintain, and repair gas turbine equipment.

Gas turbine users at all levels can benefit from the Gas Turbine Users Symposium. The three-day program of panel sessions and tutorials offers best practices and practical problem-solving for owners and managers as well as hands-on operators.

Under the leadership of GTUS Chair John P. Platt, Jr. (Senior Advisor, Machinery, for BP Exploration & Production Technology Group), the 2005 program has been organized under four track headings, each designed to help attendees answer the question, "What do you plan to do with that gas turbine?"

## GTUS 2005 Program Tracks:

### Build It / Buy It:

Focused on the finer points of specification and selection, this track encompasses a range of content. Session topics under development include:

- API Specification Review for Gas Turbine Driven Turbocompressors
- Combustion Turbines – Introductions and Uprates
- Basic Rotordynamics
- Advanced Gas Turbine Reliability, Success, Problems and Solutions
- Advanced Thermal Barrier Coating
- Gas Turbine Materials for the Non-Metallurgist
- Combustion Turbine Package Protection & Safety Systems

...continued on Page 2

# GTUS 2005... continued from page 1

## (Ab)Use It:

Attend sessions in this track to get the knowledge you need to achieve efficient and effective operations while avoiding overtime for your maintenance staff. Sessions are currently planned to address the following topics:

- Combustion Turbines for Oil & Gas Applications
- Power Augmentation
- Fuel, Air, and Water for Combustion Turbines
- Field Performance Testing

## Fix It:

Protect your investment with leading-edge and cost-effective maintenance and repair techniques. Attend sessions on topics such as:

- Combustion Turbine Compressor Washing
- Root Cause Failure Analysis and Problem Mitigation
- Maintenance Agreements
- Advanced Thermal Barrier Coating
- Gas Turbine Materials for the Non-Metallurgist
- Hot Section Repairs

## Don't Make A Mess With It:

Understand the environmental issues surrounding gas turbine operations by attending a tutorial session titled:

- Environmental Regulatory Update

## Pre-Symposium Workshops:

Three pre-symposium workshops are available to supplement the content of the GTUS program. For a separate registration fee, attendees can select one of the following topics for in-depth exploration:

- **Combined Cycle Power Plants** (2-day workshop: Sunday-Monday, December 4-5)

Meherwan P. Boyce of The Boyce Consultancy provides an introduction to practical operation and design considerations of a combined cycle power plant.

- **Combustion Humming in Gas Turbine Based Power Plants** (1-day workshop: Monday, December 5)

Tim Lieuwen, professor of aerospace engineering at Georgia Tech, introduces students to combustion instabilities, often referred to as "humming."

- **Heat Rate Awareness for Combined Cycles** (2-day workshop: Sunday-Monday, December 4-5)

Bruce Kelly and Kristina Brandt of Performance Consulting Services lead a detailed examination of the heat rate effects of operating practices, unit optimization, and environmental compliance.

See page 5 for detailed descriptions of each pre-symposium workshop.

Register online for GTUS 2005 and the pre-symposium workshops at [www.asme.org/igti](http://www.asme.org/igti). Advance registration discounts apply to registrations received by October 21. The GTUS 2005 website also furnishes session descriptions and continuously updated event information.

Registration for the ASME Gas Turbine Users Symposium entitles the attendee to visit the POWER-GEN International exhibition hall, and includes free lunch on Tuesday, December 6 and Wednesday, December 7.

Whatever your interest, involvement, or experience with gas turbines, as a GTUS 2005 registrant you will benefit from the comprehensive line-up of user-focused content. In addition, GTUS attendance offers a prime opportunity to make contacts and network with peers, including customers, suppliers, competitors, and people from other industries. \*

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# Meet the Newest Members of the Turbo Expo 2006 Leadership Team

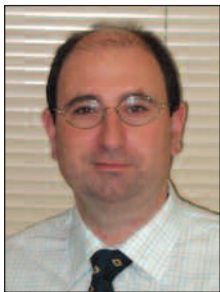
## Jóse Antonio Malumbres Executive Conference Chair

**D**r. Jóse Antonio Malumbres, Director of Engineering and Technology at Industria de Turbo Propulsores (ITP), has accepted IGTI's invitation to serve as Executive Conference Chair for ASME Turbo Expo 2006.

A native of Navarra, Spain, Dr. Malumbres received his degree in Mechanical Engineering from the Centro Politécnico Superior of the University of Zaragoza in 1992. He worked in the composites materials area at the University Technology Centre, and at Groupe Massal in France, before moving to Bilbao (Spain) to join ITP in the gas turbine field in 1994. Dr. Malumbres worked as a Project Engineer in several programs before becoming Chief Engineer for Low Pressure and Power Turbines. In 2000 he took the position of Director of Product Engineering, and later was promoted to his present position.



## Jóse Ignacio Ulizar Local Liaison Committee Chair



**D**r. José Ignacio "Iñaki" Ulizar, Director of Technology at Industria de Turbo Propulsores (ITP) in Madrid, has been appointed Chair of the Local Liaison Committee for ASME Turbo Expo 2006. He received master's degrees in Aeronautical Engineering (Universidad Politécnica de Madrid) and Mechanical Engineering (Cranfield Institute of Technology), both in 1992, and

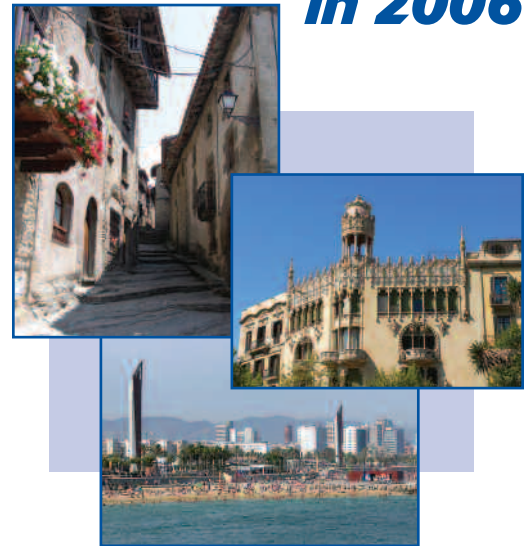
took his Ph.D. in Mechanical Engineering from Cranfield University in 1998 in the field of advanced cycles. Having worked as a research assistant at Cranfield, he joined ITP in 1994 as a performance engineer. Since then, he has held the positions of Aerodynamics Team Leader (1996-99), Head of the Aerothermal Department (1999-2002), and Project Manager for Research and Technology Projects (2002-05). Dr. Ulizar has authored numerous papers in the areas of variable cycle engines for aerospace, advanced cycles for industrial applications, and turbine aerodynamics. An active member and former chair (1999-2001) of the IGTI Cycle Innovations Committee, he is also currently the Spanish representative within the European Turbomachinery Committee and the deputy Spanish representative in the International Society for Air Breathing Engines (ISABE). \*

## Hans von Ohain Terminal Opens to Fanfare at Rostock-Laage Airport

**D**ilip Ballal, Past Chair of the IGTI Board of Directors, appeared in September as a guest speaker at the opening ceremonies for the new Hans von Ohain Terminal at Rostock-Laage Airport in Germany. He presented the airport with a plaque on behalf of ASME International Gas Turbine Institute. Dr. Ballal holds the title of Hans von Ohain Distinguished Professor at the University of Dayton (Ohio, USA).

The new terminal is named for the late Dr. Hans J. P. von Ohain, who patented the world's first aircraft gas turbine engine in 1935. The facility meets international standards and is rated for a capacity of 300,000 passengers per year. \*

## BARCELONA in 2006



*Sandy beaches, persistent sunshine and breezes off the Mediterranean combine with 2,000 years of history and an architectural legacy both gothic and modern to make Barcelona a unique destination with something for everyone.*

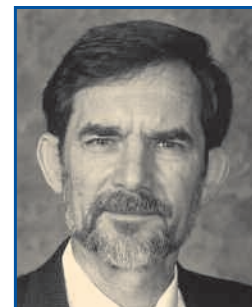
*Mark your calendar for a week (or more) in beautiful Barcelona next May, as Turbo Expo locates in southern Europe for the first time!*

**ASME TURBO EXPO**  
Power for Land, Sea & Air  
Barcelona, Spain • May 8-11, 2006



## VIEW FROM THE CHAIR

Harold Simmons, Chair, IGTI Board of Directors



**Harold Simmons**  
Chair  
IGTI Board of Directors

# Challenges for the Next 50 Years

**A**re a pair of brothers on the verge of demonstrating a revolutionary form of transportation? Are young minds seeking to discover new forms of power production or propulsion? We certainly hope so. Just as Watt, Otto, and Brayton responded to the burgeoning industrial revolution, and world conflict motivated von Ohain and Whittle, our next technical revolutionaries will be responsive to economic and political pressures.

The present economic issue is obvious when we gas-up; fuel costs are soaring! Competition for scarce petroleum resources has doubled U.S. gasoline prices. Fuel costs dominate power production; many new combined cycle plants stand idle because fuel prices have tripled since they were built. Paul Barham, Past Chair of the San Antonio Section of ASME, and Maintenance Manager at City Public Service, confirms that my city favors dispatch of pulverized coal over combined cycle units on the basis of costs.

Environmental issues are continuing challenges in the new industrial era. The environmental impact of conventional gas turbines is well known; conventional coal combustion is worse, introducing SO<sub>2</sub> and mercury. Oscar Backus of Austin Energy, past IGTI board member and former GTUS Chair, evaluates alternative energy sources for controlling emissions. Austin Energy's goal is 20 percent alternate energy by 2020; they are discussing a joint venture for clean integrated gasification combined cycle (IGCC) with other Texas utilities. GE, Conoco/Philips, and Shell offer competing coal gasification processes, which provide negotiation power. Coal gasification is especially attractive as a fuel source for underutilized combined cycle plants; repowering costs are lower than new pulverized coal.

More is needed! Emissions of CO<sub>2</sub> are a great concern as the global demand for power increases, and temperatures rise. According to Craig Canine in *On Earth* (Fall 2005), the atmosphere had 275 ppm CO<sub>2</sub> before the industrial revolution and now contains 380 ppm. Levels are projected to be 10 times higher by the time our 300-year reserves are consumed.

Undoubtedly, the challenge is before us. Mature technology advances in small steps; these modest advances accumulate like interest to create technology fortunes. To fully grow these investments this technology must be vetted and shared. Over

the years, Turbo Expo has been the forum for the introduction of turbofans, combined cycles, coatings, and many other advances. More recently, IGTI members contributed over 60 papers on NO<sub>x</sub> control at Turbo Expo 2005 alone.

Truly exciting for future power generation are another 50 papers from Turbo Expo 2005 on coal, biomass, and innovative cycles. Innovations explored included small nuclear heat sources, turbo-fuel cells, IGCC, and technologies for biomass. The Graz cycle power plant by Sanz and Jericha (Graz University) uses pure oxygen with any fuel to capture all CO<sub>2</sub>, has 60 percent efficiency, and is an ideal partner for enhanced petroleum recovery where nitrogen and CO<sub>2</sub> can be used in vast quantities.

Air propulsion faces the same challenges, and manufacturers are striving to reduce fuel costs and emissions. The technology needed when this industry is required to curtail CO<sub>2</sub> emissions is yet to be discovered.

These challenges are fertile ground for innovation. When will the next Whittle or von Ohain emerge? There will be many; they will need introduction to the latest thinking, peers for review and debate, and a stage to attract collaborators. The open forum of Turbo Expo will provide that environment. \*

## CALENDAR OF EVENTS

### OCTOBER 7, 2005

#### Gas Turbine Repair & Metallurgy Techniques

Fairmont Banff Springs  
Banff, Alberta, Canada

An IGTI short course for operations & maintenance personnel, held in conjunction with CTOTF Fall Forum  
<http://www.asme.org/igti/>

### OCTOBER 18-20, 2005

#### Peer Review Workshop

University Turbine Systems Research  
Clemson, SC, USA

Presentations of ongoing UTSR research projects in the areas of gas turbine combustion, aero/heat transfer, materials, and instrumentation, sensors, and life.  
<http://www.clemson.edu/scies/utsr/>

### NOVEMBER 5-11, 2005

#### 2005 ASME International Mechanical Engineering Congress & Exposition

Orlando, Florida, USA

<http://www.asmeconferences.org/Congress05/>

### DECEMBER 4-5, 2005

#### Pre-Symposium Workshops

Sands Expo/Venetian  
Las Vegas, Nevada, USA

Three short courses held prior to GTUS 2005. "Combined Cycle Power Plants," "Heat Rate Awareness for Combined Cycles," and "Combustion Humming in Gas Turbine Based Power Plants."  
<http://www.asme.org/igti/events/gtus05>

### DECEMBER 6-8, 2005

#### ASME Gas Turbine Users Symposium 2005

co-located with Power-Gen International  
Sands Expo/Venetian  
Las Vegas, Nevada, USA

Ideas and practical solutions for gas turbine operating challenges.  
<http://www.asme.org/igti/events/gtus05>

### FEBRUARY 26-MARCH 2, 2006

#### ISROMAC-II

#### The Eleventh International Symposium on Transport Phenomena and Dynamics of Rotating Machinery

Honolulu, Hawaii, USA

Innovating technologies and idea exchange among world leaders in rotating machinery.  
<http://www.isromac.org/>

### MAY 2-4, 2006

#### 2006 ASME Power Conference

Georgia World Congress Center  
Atlanta, Georgia, USA  
<http://www.asmeconferences.org/Power06/index.cfm>

### MAY 8-11, 2006

#### ASME TURBO EXPO 2006

Barcelona, Spain

The best in gas turbine knowledge in an incomparable Mediterranean setting.  
<http://www.turboexpo.org/>



# Pre-Symposium Gas Turbine Workshops

## DECEMBER 4-5, 2005

Offered in conjunction with the  
**2005 ASME Gas Turbine Users Symposium**  
Sands Expo Convention Center  
Las Vegas, Nevada, USA

### Combined Cycle Power Plants

Sun., December 4 – Mon., December 5, 2005  
8:00 a.m. – 5:00 p.m. \$990 (separate fee)

#### Instructor

Meherwan P. Boyce, The Boyce Consultancy

#### Who Should Attend

This course is aimed at engineers and operational personnel who need a broad-based introduction to practical operation and design considerations of a major combined cycle power plant. Discussion of problems experienced is encouraged.

#### Course Overview & Objectives

This course deals with the design and general operation and maintenance characteristics of a combined cycle power plant with emphasis on the major components, such as the gas turbine, the heat recovery steam generator (HRSG) and the steam turbine. Overall design and operation concepts along with basic operation and maintenance problems for the various pieces of turbomachinery will be discussed. Practical information is emphasized, with minimal theory.

#### Course Highlights

- Design of Combined Cycle Plants
- Power Augmentation
- Major Components
- Maintenance Problems

**Note:** Attendees will receive a copy of *Handbook for Cogeneration and Combined Cycle Power Plants* (ASME Press), by Meherwan P. Boyce, as the course materials.

### Heat Rate Awareness for Combined Cycles

Sun., December 4 – Mon., December 5, 2005  
8:00 a.m. – 5:00 p.m. \$850 (separate fee)

#### Instructors

Bruce Kelly & Kristina Brandt,  
Performance Consulting Services

#### Who Should Attend

This course is designed for operating personnel and those with a direct impact on operating practices and procedures. A review of power plant thermodynamics is included, but participants should have a working knowledge of the power cycle.

#### Course Overview & Objectives

This intensive 2-day workshop will provide the participant with details of heat rate concepts, controllable and non-controllable losses, and the effects of component performance on operating costs in combined cycle plants.

#### Course Highlights

- Power Plant Thermodynamics Review
- Calculating the Cost of Heat Rate Deviations
- Controllable Losses
- Cycle Isolation
- Drains, vents, and bypass
- Non-controllable Losses
- Instrumentation Effects on Heat Rate
- Optimizing Unit Efficiency
- Optimization Tools
- How Does My Job Relate to Heat Rate?

### Combustion Humming in Gas Turbine Based Power Plants

Mon., December 5, 2005  
8:00 a.m. – 5:00 p.m. \$500 (separate fee)

#### Instructor

Tim Lieuwen, Georgia Institute of Technology

#### Who Should Attend

Gas turbine operators and engineers who want a better understanding of humming problems and how to respond to them will benefit from attending.

#### Course Overview & Objectives

This one-day course introduces students to combustion instabilities, often referred to as "humming." It begins with an overview of development and field experience with combustion instabilities, and will describe case studies from several development efforts. Background is provided on the mechanisms responsible for combustion-driven oscillations, and strategies for treating dynamics problems by combustor tuning are discussed. Also presented are dynamics monitoring approaches, and various issues associated with instrumentation, data analysis and data reduction.

#### Course Highlights

- Why humming occurs
- What are the key "knobs" that effect humming's occurrence
- Strategies for taking care of a humming problem
- Instrumentation options and tradeoffs for monitoring dynamics
- Implementation and interpretation of dynamic data analysis procedures

#### Course Credit

If desired, this course can be accredited by Georgia Institute of Technology. Course participants will receive 0.8 Continuing Education Units upon completion of the training. These CEUs are applicable toward Professional Engineer certification requirements in states requiring continuing education for PE registration. \*

## Workshop Instructor in the Spotlight

### TIM LIEUWEN

Associate Professor

School of Aerospace Engineering,  
Georgia Institute of Technology



**TIM LIEUWEN**, an Associate Professor in the School of Aerospace Engineering at the Georgia Institute of Technology, is a leading expert in the area of combustion dynamics in gas turbines. He received his B.S. (1995) from Calvin College (Grand Rapids, Mich.) and his M.S. (1997) and Ph.D. (1999) from Georgia Institute of Technology. Dr. Lieuwen is actively involved in teaching and research at Georgia Tech, where he joined the faculty in 1999. He supervises a variety of projects, many of which relate to various aspects of combustion dynamics problems. He regularly consults with industry on dynamics problems, and has put together a book on the topic (*Combustion Dynamics: Operational Experience, Fundamental Mechanisms, and Modeling*, 2005, available through AIAA Press).

A member of ASME and of IGTI's Combustion & Fuels Committee, Dr. Lieuwen actively participates in the Turbo Expo program each year—as author, reviewer, session organizer, and point contact. His 2004 paper, "Online Combustor Stability Margin Assessment Using Dynamic Pressure Data," received the Combustion & Fuels Committee Best Paper Award. Dr. Lieuwen has been a workshop instructor for IGTI since 2003. We asked him a few questions about his participation in IGTI's programs generally, and specifically about his role as a workshop instructor.

**Q** What initially led you to become involved with IGTI's gas turbine technical programs?

**A** Turbo Expo is a great meeting in that you can interact with both leading scientists and the guys who are actually making the hardware work. Furthermore, the papers are high quality and have a good mix of technical rigor and practical application.

**Q** You have been an instructor for IGTI's workshops series since 2003. What do you find most rewarding about this role?

**A** I enjoy communicating what we do and do not understand about the problem to an audience with a diverse range of backgrounds – we usually have a mix of academics, research scientists, design engineers, and plant operators all attending and asking great questions.

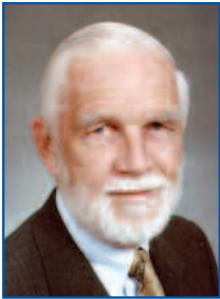
**Q** Can you give potential attendees of the upcoming "Combustion Humming" workshop an idea of what they might expect?

**A** The content is pretty flexible based on who is in the room and the basic questions that they are asking. In any case, we work toward achieving the basic course objective of understanding both the causes of and the solutions to humming problems, while gaining familiarity with monitoring and analysis procedures.

**Q** After the December workshop, what's next for you in terms of research and/or IGTI program involvement?

**A** I look forward to continuing work on the combustion dynamics problem, but also have a growing involvement in the area of fuel flexible combustion issues. I also intend to stay active with the Combustion & Fuels committee. It's a great bunch and I learn a lot from them. \*

# JOURNAL OF ENGINEERING FOR GAS TURBINES AND POWER



## Important News ... from Lee Langston, Editor

The 2005 October issue now put to bed, let me give you the breakdown of papers published in the Journal for this and the past four years:

Year	Paper Total	Total No. of Pages	Average Pages/Paper
2001	125	972	7.78
2002	129	1064	8.25
2003	135	1104	8.18
2004	109	952	8.73
2005	107	928	8.67

## Ron Flack Authors Text on Jet Propulsion Fundamentals

Ronald Flack of the University of Virginia, a member and former chair of the IGTI Education Committee, has published a new book with Cambridge University Press. **Fundamentals of Jet Propulsion with Applications** is an introductory text in air-breathing jet propulsion including ramjets, turbojets, turbofans, and propjets. Aimed at upper-level undergraduate and graduate students, the book provides coverage of the basic operating principles, from cycle analysis through component design and system matching. A basic understanding of fluid mechanics and thermodynamics is assumed, although many principles are thoroughly reviewed. With numerous examples and nearly 300 homework problems based on modern engines, Flack's book can be used as a teaching tool or as a reference for practicing engineers. A CD included with the book contains example files and software to support the text. For more information or to order a copy, visit [www.cambridge.org/0521819830](http://www.cambridge.org/0521819830). \*

As you can see from the values in the table, the general trend is for authors to write longer papers (7.78 pages per paper in 2001 compared to 8.67 in 2005). This upward trend and the continued growth of number of papers submitted to the *Journal* has increased our backlog, which currently is about 1-1/2+ years from paper submission to publication. As I reported to you in the 2005 February issue of *Global Gas Turbine News*, I have asked the ASME Publications Committee for help to reduce the backlog. We have requested an increase of the *Journal's* annual page allotment to 1,100 pages (from the current nominal 950 per fiscal year) and a change in issuance, from four to six issues per year. We continue to petition the committee for these increases.

During this year, IGTI's annual gas turbine conference, TURBO EXPO, celebrated its 50<sup>th</sup> anniversary in Reno, June 6-9, 2005. In recognition, the April 2005 issue of the *Journal* was devoted to papers from recent TURBO EXPO congresses.

About 65-75 percent of *Journal* papers come from TURBO EXPO. Since the first IGTI gas turbine conference in 1956, a remarkable total of 12,453 refereed papers have been published in conference proceedings and presented at this annual meeting. Usually, between 25 and 35 percent of conference papers are judged by reviewers to be archival. Thus, for the last half-century, I estimate that about 4,000 or so have been published in the *Journal*, in our companion publication *Journal of Turbomachinery*, or in the predecessor of both, the *Journal of Engineering for Power*.

The IGTI gas turbine conference has been ASME's leading international technical meeting from its very beginning. The annual meeting is held in North America and in Europe on alternate years. Currently, more than half of the papers presented are from non-North American parts of the gas turbine community, most coming from Europe and Asia.

The *Journal* started 125 years ago as a collection of papers on energy conversion technology in the 1880 first volume of the *Transactions of the ASME*. For the last 50 years, IGTI's annual gas turbine conference has been a major contributor to the *Journal*. We salute the authors, reviewers, and organizers of TURBO EXPO for their fifty years of contributions to the gas turbine industry and to the *Journal of Engineering for Gas Turbines and Power*. \*

Lee S. Langston, Editor

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## In Memoriam Scott Moeller

Mitsubishi employees and colleagues in the gas turbine industry were shocked this June to learn of the sudden death of Scott Moeller and his wife Stephanie. The news of their passing spread quickly, and condolences began coming in from colleagues in Japan, customers, vendors and even competitors.

Scott was widely recognized as a capable and upcoming engineer in the gas turbine industry. He received a Bachelor of Science degree in Aerospace Engineering from the University of Florida in 1991 and a Master of Science degree in Mechanical Engineering from Rensselaer Polytechnic Institute in 1997.

Scott began his career with General Dynamics Electric Boat Division in Groton, Conn. In 1995, he joined Westinghouse as a Gas Turbine Service Engineer. He soon developed a reputation for performing detailed field investigations and root cause analyses and became an expert in the service and repair of combustion system components. Scott was also an inventor; he was granted two U.S. patents and earned the George Westinghouse Innovation Award with one of his designs.



In 2001, Scott joined Mitsubishi Power Systems as Manager, QA & Engineering, later transferring to the Turbine Engineering Services group to become Technical Director – Aftermarket Services. An active industry spokesperson, he participated as a panelist at ASME Turbo Expo for several years running, and served as a reviewer of conference papers. Scott's technical contributions and friendship will be long remembered and missed. \*



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### MISSION STATEMENT

The International Gas Turbine Institute of The American Society of Mechanical Engineers is dedicated to supporting the international exchange and development of information to improve the design, application, manufacture, operation and maintenance, and environmental impact of all types of gas turbines, turbomachinery and related equipment.



## Learn at Your Own Pace: Basic Gas Turbine Course Now Delivered Digitally

Did you know that IGTI's popular self-directed study course on *Basic Gas Turbine Technology* is now available online?

The same classic content that has made the *Basic Gas Turbine* course IGTI's bestselling educational product can now be accessed by computer. Long offered as a printed course for self-paced learning, the *Basic Gas Turbine Technology* unit has been converted to digital text and can be delivered in one of two convenient formats: **CD-ROM** or the **Internet**.

The *Basic Gas Turbine Technology (2nd Edition)* self-directed study course offers a non-mathematical approach to understanding the fundamental nature of gas turbine engines and the processes that affect their performance. The course is ideally suited to techni-

cians and management personnel. It should also prove valuable to engineers starting their careers in the fields of gas turbine engine and auxiliary equipment operation, maintenance or service, specification, sales and manufacture.

### Which format is for you?

Either delivery option provides an economical and convenient way to learn the fundamentals of gas turbine technology: at your computer and at your own pace. Outlined below are some key differences between the two formats to help you decide which is the one for you.

	<b>CD-ROM</b>	<b>Internet</b>
<b>End-of-chapter tests</b>	Print each completed test and mail or fax to IGTI for grading	Submit completed test online for instant grading
<b>End-of-course test</b>	No	Yes
<b>Certificate of Completion</b>	Yes	Yes (requires 75% or better on tests)
<b>CEU earned</b>	No	Yes – 1 CEU upon completion
<b>Access restrictions</b>	No limit for a single user	Course access available for 3 months from registration
<b>System requirements</b>	Microsoft Windows 95 OSR2/98SE/ME/NTSP5/2000/XP. Intel Pentium Processor. 64MB RAM. 24MB available hard-drive space	Internet connection. Microsoft Windows 98/98SE/ME/NT/2000/XP. Pentium processor, 200MHz or higher. 64MB RAM.
<b>Price</b>	US \$230 (US \$190 for ASME member)	US \$185 (US \$150 for ASME member)

### Other gas turbine courses available

IGTI also offers self-directed study courses for the experienced gas turbine engineer: *Gas Turbine Applications & Economics* and *The Design of Gas Turbine Engines -- Thermodynamics & Aerodynamics (2nd Edition)*.

For more information on IGTI's complete line of educational products visit the ASME Products and Services Catalog online at <http://members.asme.org/catalog/> or contact the IGTI office at +1-404-847-0072 or [igti@asme.org](mailto:igti@asme.org). \*

