TEES
TURBOMACHINERY LABORATORY
TEXAS A&M ENGINEERING EXPERIMENT STATION

YEAR IN REVIEW: 2018

NEW LEADERSHIP

Lab veteran welcomed to director seat

Dr. Eric L. Petersen

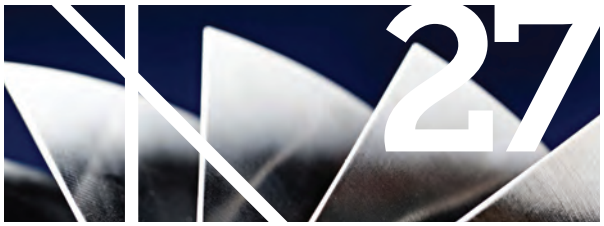
ADVANCING TECHNOLOGY:

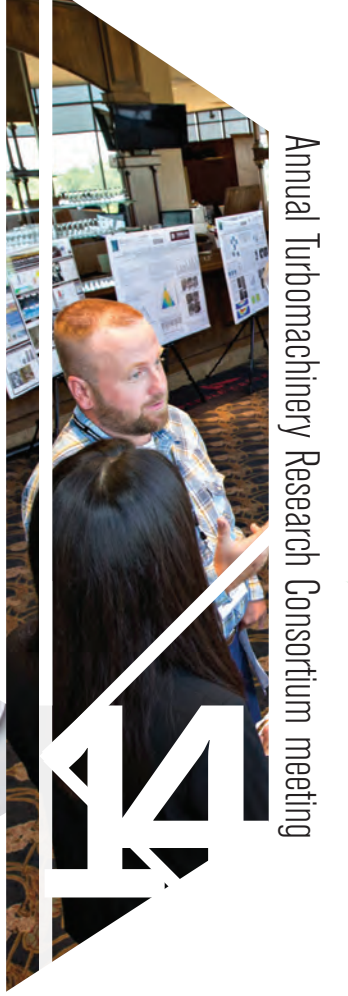
two new patents in progress

TOPPING RECORDS:

Turbomachinery & Pump Symposia sees another successful year

INSIDE THIS ISSUE:





Also in this issue:

THANK YOU FOR MAKING 2018 A WONDERFUL YEAR!

Thank you for being such an important part of the Turbomachinery Laboratory. Your support through our symposia, short courses, the TRC and other education and research initiatives makes it possible for us to carry out our mission of research, education and workforce development. Cheers to 2019!

TURBOMACHINERY LABORATORY
TEXAS A&M UNIVERSITY

SYMPOSIUM OFFICE:
979-845-7417

RESEARCH LAB:
979-845-6669

info@turbo-lab.tamu.edu

turbolab.tamu.edu

TEES TURBOMACHINERY LABORATORY
TEXAS A&M ENGINEERING EXPERIMENT STATION

TEXAS A&M UNIVERSITY

OUR MISSION

The Turbomachinery Laboratory, a center of the Texas A&M Engineering Experiment Station (TEES) and a member of The Texas A&M University System, makes a vital impact on turbomachinery and related industries through three pathways:

RESEARCH

Turbo Lab faculty and students team up with industry partners to conduct research into important problems of reliability and performance of turbomachinery through the Turbomachinery Research Consortium (TRC). The TRC is a unique organization of major turbomachinery developers and users who have joined with the Turbo Lab to find answers to important questions through cutting-edge research. In addition to TRC research, the Lab conducts fundamental and applied research through industry- and government-sponsored projects.

EDUCATION

The Turbo Lab produces engineers ready to work by offering undergraduate and graduate engineering education through Texas A&M's J. Mike Walker '66 Department of Mechanical Engineering. The Turbomachinery Research Consortium blends the Turbo Lab's impact areas of education and research by teaming graduate students with industry to find solutions to real-world problems. Turbo Lab students are highly sought after for industry positions upon graduation. Ph.D-level graduates also find positions in academia and government research laboratories.

WORKFORCE DEVELOPMENT

The Turbo Lab impacts the turbomachinery industry by providing a platform for the continuous exchange of ideas among working professionals. These platforms include the annual Turbomachinery & Pump Symposia (TPS) in Houston, the biennial Asia Turbomachinery & Pump Symposium (ATPS) in Southeast Asia, and various extended short courses held throughout the year.

TURBO LAB'S TURBOMACHINERY & PUMP SYMPOSIA CONTINUES TO SET EVENT RECORDS

Symposia Tops 2016 Exhibitor Record

HOUSTON, Texas | The Turbomachinery Laboratory at Texas A&M University hosted another record-breaking Turbomachinery & Pump Symposia in September.

The 47th Turbomachinery and 34th International Pump User's Symposia (TPS 2018) attracted 53 new companies to the George R. Brown Convention Center, for a total of 365 exhibiting companies, topping TPS 2016's record by five companies. The exhibition featured full-size equipment and emerging technology and industry trends from leading turbomachinery, pump and related organizations. Before the conclusion of TPS 2018, 85 percent of the exhibit floor for TPS 2019 was booked.

4,750 unique delegates representing 45 countries visited the exhibition or attended technical sessions. Engineers and technicians, from novice to experienced, chose from a combination of 18 short courses, 18 lectures, 23 tutorials, 24 discussion groups and 32 case studies. The technical program is selected by the turbomachinery and pump advisory committees and led by engineers and technicians with experience in particular disciplines. Topics included compressors, steam and gas turbines, expanders, pumps and drivers, and auxiliary equipment such as couplings, bearings, gearboxes, dry gas seals and annular seals.

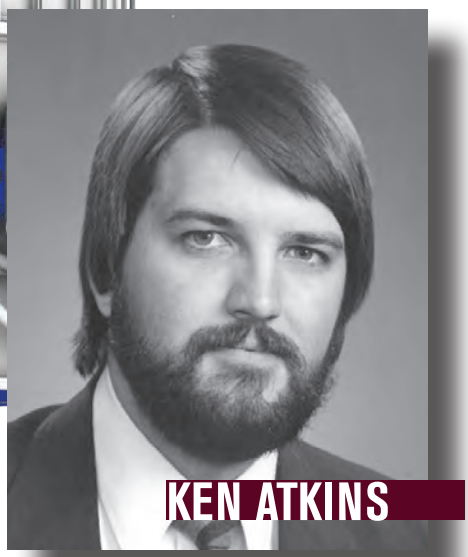
Technical content from TPS 2018 will be available to the public in March 2019. Proceedings from previous symposia are free for perusal and download at turbolab.tamu.edu/proceedings.

"I am grateful to all of our authors, leaders, delegates, exhibitors and advisers who make TPS a staple event for the industry," said Dr. Eric L. Petersen, Turbo Lab director. "I am fortunate to be a part of this unique forum, where the best in the industry come to share their expertise. I look forward to building on this experience for many more successful symposia to come."

TPS 2019 is set for Sept. 10-12 in Houston. Short courses will be held in conjunction with the symposia on Sept. 9.

> "TPS offers everything one would hope to expect with the cost of shows. Networking, current and potential customer contact, technical and learning sessions, trend observation, helpful staff and most importantly, targeted exposure to the industry resulting in quality leads. The Turbomachinery Show continues to be one [of our] most successful and beneficial platforms for industry exposure…TPS is relevant and the best show in the turbomachinery industry."
>
> **~ Maeve McGoff, Sales & Marketing Coordinator, Cincinnati Gearing Systems**

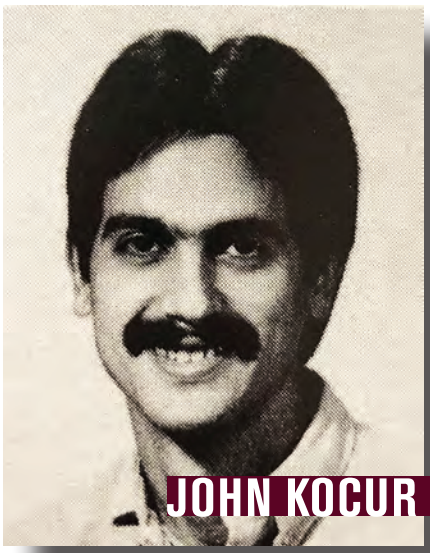
TPS:



KEN ATKINS

What do perfect 1980s hair, carne guisada, carousel slide projectors, and the Masters Tournament have in common? Ken Atkins.

"It's been a lot of fun. I'll tell you a feeling about being part of this. It comes from the Masters tournament. I had the good fortune of attending a tournament few years ago. Their slogan is "a place like no other." When I watch these interviews with guys like Jordan Spieth and Ricky Fowler and they talk about what it means to be in the Masters, that's how I feel when I'm at the Turbomachinery Advisory Committee meetings. I feel like I'm amongst the masters in this very special group. It's very enjoyable to me."



JOHN KOCUR

Don't let the mustache distract you. Dr. John A. Kocur, Jr., machinery engineer with ExxonMobil, has something serious to say about the Turbomachinery & Pump Symposia...

"This is the symposium, the meeting to go to. It's recognized worldwide...It keeps everyone informed, and it keeps our industry functioning well. You have vendors, contractors, purchasers of equipment, management, salespeople, down to field engineers, even professors. You have that entire breadth of people there. You can go to other research conferences, but you won't find many end-users there like you do at TPS."

Then & Now

The Turbomachinery Symposium has been around for more than 45 years, and the Pump Symposium for almost 35 years. Several leaders, authors and advisers of the technical program have been with TPS since its inception, or very close to it. Here are some snippets of our Q&A interviews with some of them, along with their professional headshots featuring the best hairstyles and mustaches the 70s and 80s had to offer.

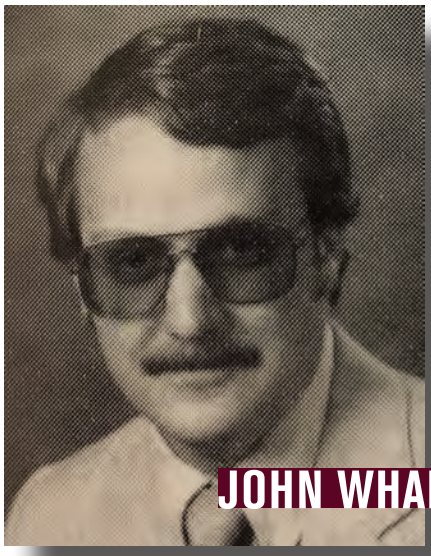
GREAT HAIR, SHARP 'STACHES, & EVEN SHARPER MINDS

MARK KUZDZAL

Need glasses to read this magazine? Mark J. Kuzdzal might let you borrow his.

While his look might be curious, his involvement with the Turbomachinery & Pump Symposia is no nonsense. See what the head of advanced components and methods at Dresser-Rand has to say about TPS:

"It's an opportunity to learn. It doesn't matter how long you've been around or what you've been exposed to, you are always going to learn from interacting with other people. It helps you learn a lot about issues bigger than yourself, or issues that are broader than what your company is experiencing."



JOHN WHALEN

The future was so bright, John K. Whalen had to wear shades.

Just like his lenses, John has seen the turbomachinery industry and the Turbomachinery and Pump Symposia transition over the years, but its mission has remained the same...

"I think that the Symposia is the perfect event for practicing engineers to contribute . . . These are people who are the actual end-users who are solving problems out in the field and writing about them, and helping other people with their problems. They're sharing what they know."

EXCHANGING IDEAS.
IMPACTING THE INDUSTRY.

SAVE THE DATE
2019
SEPTEMBER 10-12

TPS
48TH TURBOMACHINERY &
35TH PUMP SYMPOSIA

TPS.TAMU.EDU

Read the full interviews at tps.tamu.edu/thenandnow.

Dr. Eric L. Petersen led students from the Universidad de Guanajuato on a tour of the Turbo Lab as part of the Mexico Leadership Exchange program.

Texas A&M Engineering Experiment Station names new Turbo Lab director

COLLEGE STATION, TEXAS | The Turbomachinery Laboratory, a center of the Texas A&M Engineering Experiment Station (TEES) and part of The Texas A&M University System, has a new director: Dr. Eric L. Petersen.

Petersen, the Nelson-Jackson Professor in the Department of Mechanical Engineering at Texas A&M University, is a 10-year veteran of the Turbo Lab. His research encompasses gas dynamics, propulsion, combustion, shock waves, chemical kinetics, optical diagnostics and spectroscopy, laminar and turbulent flames, and rocket combustion. He has authored more than 400 journal and conference papers in these areas. He is vice-president of the Institute for Dynamics of Explosions and Reactive Systems (IDERS) and an associate editor of the *Journal of Engineering for Gas Turbines and Power* and the *Journal of Propulsion and Power*. He is a Fellow of the American Society of Mechanical Engineers (ASME) and a member of the American Institute of Aeronautics and Astronautics (AIAA), The Combustion Institute and the American Society for Engineering Education (ASEE).

> "The Turbo Lab means many things to different people. To me, it's been my research home for 10 years. To others, it's technology development, or an education, or world-renowned symposia. I aim to uphold the stellar reputation of the Turbo Lab as a leading institution making a vital impact on the industry through research, education and workforce development."
>
> **~ Dr. Eric L. Petersen**

Petersen holds three degrees in mechanical engineering:

Dr. Eric L. PETERSEN

Director is a 10-year veteran of the Texas A&M Turbo Lab

a bachelor's from the University of Central Florida (1988), a master's from the University of Florida (1990) and a doctorate from Stanford University (1998). Before coming to Texas A&M, Petersen taught at the University of Central Florida. Prior to becoming a professor, he was an analytical engineer in the combustion group at Pratt & Whitney for three years, and a research scientist in the propulsion science group at the Aerospace Corporation for four years.

As director of the Turbo Lab, Petersen will oversee all operations of the Lab and Symposia Office, including industry- and government-sponsored research, education and workforce development initiatives including short courses and symposia.

"I am honored to be named director of the Turbomachinery Laboratory," Petersen said. "The Turbo Lab means many things to different people. To me, it's been my research home for 10 years. To others, it's technology development, or an education, or world-renowned symposia. I aim to uphold the stellar reputation of the Turbo Lab as a leading institution making a vital impact on the industry through research, education and workforce development."

Petersen assumed the post held for more than three decades by Dr. Dara W. Childs, who retired in January 2018.

From left, Dr. Narasimha Reddy, Dr. Dara W. Childs, Dr. Eric L. Petersen, Dr. Dimitris Lagoudas

Texas A&M Turbomachinery Laboratory closes out second symposium in Asia

ATPS offers education, networking opportunities for industry engineers, technicians

SINGAPORE | The reach of the Turbomachinery Laboratory at Texas A&M University has long been global. That impact was demonstrated spring 2018 when the Turbo Lab hosted its second biennial Asia Turbomachinery & Pump Symposium (ATPS) in Singapore.

The 2018 ATPS was held March 13-15, with short courses on March 12. Engineers and technicians, from novice to experienced, chose from a combination of seven short courses, 23

lectures, 16 tutorials, 12 discussion groups, 38 case studies and 11 technical briefs. The technical program is selected by the Asia Turbomachinery and Pump Advisory Committee and led by experts in their disciplines. Topics included compressors, steam and gas turbines, expanders, pumps and drivers, and auxiliary equipment such as couplings, bearings, gearboxes, dry gas seals and annular seals.

The conference is modeled after the Turbomachinery & Pump Symposia (TPS), founded in 1971 and hosted annually in Houston. ATPS debuted in Singapore in 2016 in response to a need for industry education and networking in Southeast Asia.

"ATPS is a very important platform to share our experience, learn from others, and to network," said Minhui He, machinery specialist with BRG Machinery Consulting and advisor and technical session leader for ATPS. "Having this event in Southeast Asia is important because this area has a need for knowledge in turbomachinery. We come here to make new connections, hear what they are doing and what they need. It is an expansion of our network. It's important that we connect with one another and share our knowledge."

New to ATPS this year were two panel sessions, one on career and industry intended for students and young professionals, and one on successful applications of digitalization in oil & gas.

"Everyone is interested in digitalization, but not so many people understand, so we came together to discuss what it is, look at where we are and determine where we should go with it," said Ishigaki Hiroyasu, digitalization panelist and general manager of information and communications technology operations of Mitsubishi Heavy Industries Compressor Corporation, top-tier sponsor of ATPS. "It's very important to combine machinery

knowledge and experience with computer science, including artificial intelligence, and data analysis for a more beneficial result. I think ATPS can play an important role in the digitalization movement."

The technical program was paired with an international exhibition featuring leading companies and organizations from across the globe that showcased full-size equipment and the latest technological trends. Longtime TPS exhibitor Flowserve Corporation that also exhibited at the inaugural ATPS, was pleased with their event experience and praised the quality of delegate interaction at their booth.

"Flowserve is accustomed to participating in TPS each year. That is not the reason for being at ATPS, but it did make the decision easier," said Torsten Bernicke a product manager in the compressor seals and systems/mixer seals division of Flowserve. "With Singapore being a gateway to Southeast Asia, India and China, it's a nice location to present our products. My advice to companies considering ATPS is to give it a try. It helps to grow the visibility of your products, and you have the chance to explain your products better, and secure follow-up leads."

ATPS hosted 670 delegates from 31 countries, and 30 exhibiting companies.

"I am very pleased with the quality of the program and the traffic in the exhibit hall," said Dag Calafell, chair of ATPS. "We have seen some setbacks due to economics in the region, as well as challenges in the oil & gas industry. Still, we achieved success, thanks to the support of Texas A&M, the Advisory Committee, delegates and exhibitors. Our ultimate goal is to provide a platform for the exchange of ideas and practices that impact our industry, and we have certainly achieved that."

Plans are underway for future events in the region, including a stand-alone technical program in summer 2019. The regular ATPS, with technical program and exhibition, is slated for spring 2020.

Former Turbo Lab director still teaching, consulting

Dr. Dara W. Childs and wife Judy Childs

COLLEGE STATION, TEXAS | Can a historical landmark have feelings? Former director of the Turbomachinery Laboratory, Dr. Dara W. Childs, is beginning to think so.

"I felt like Mount Rushmore," he said, laughing, referring to his first post-retirement experience at the Turbomachinery & Pump Symposia (TPS). "Some young person would walk up to me and say, 'Dr. Childs I am so happy to meet you. Would you mind standing here while I take a picture next to you?'"

Childs said this happened at least four times during the three-day continuing education conference in September, which is organized by the Turbo Lab. "I could see it coming—the look, the camera," he said. "It's entertaining. I'm pleased to be remembered."

Childs retired from the director post in January 2018 after more than three decades of leading the Lab and chairing the Turbomachinery & Pump advisory committees who oversee the program for TPS. He remains active by teaching short courses, consulting, and seeing a final graduate student through to commencement in May.

Since retiring almost one year ago, Childs has continued traveling the world with his wife, Judy, helped teach a short course in Mexico, and picked up a few consulting jobs—all activities he plans to continue so long as he is able. In recent years, he has presented Rotordynamics short courses in Brazil, Qatar, and Singapore.

There are very few new rotordynamics and vibration issues in turbomachinery that haven't already been addressed via experience or in the literature, Childs said. His consulting work consists of considering symptoms and diagnosing the cause based on knowledge—not running new analyses. In January 2018, he secured a consulting job in which he diagnosed the absence of full reaction forces, including moment coefficients, as the reason why the prior analyses had failed to explain an instability in a turbo expander.

> "I enjoyed this symposium more than any in my memory," Childs said. "I had a good time. I thought the quality of the content was as good as ever, and I thought the execution was excellent."
>
> **~ Dr. Dara W. Childs**

"I was able to predict what was observed in test results from more than 15 years ago," he said. In addition to consulting, Childs plans to continue teaching short courses on rotordynamics. He was one of four instructors during a three-and-a-half day course in Houston, January 7-11, 2019. More information on the course, organized by the Turbo Lab, is available at turbolab.tamu.edu/short-courses.

"You have to keep changing these courses," Childs said. "Engineers, somewhat surprisingly, don't like equations. They like case studies. They want to talk about someone else's problems." Childs' latest book, Dynamics in Engineering Practice with Case Studies, published in 2015, includes 31 case studies.

While his time spent at the Turbo Lab is much less frequent, Childs still remains involved with an office at the Lab and as a lifetime member of the Turbomachinery & Pump advisory committees.

"I am greatly relieved that Eric is running [the lab and symposia]," Childs said of his successor and former colleague, Dr. Eric L. Petersen. "I'm happy to see that it's as good as ever. The symposia have historically evolved to capture new requirements. If it hadn't changed, it wouldn't still be here."

Dr. Childs can be contacted at dchilds@tamu.edu.

Seal update increases damping effectiveness

A TURBOMACHINERY LABORATORY INVENTION IS GETTING A NEW TWIST

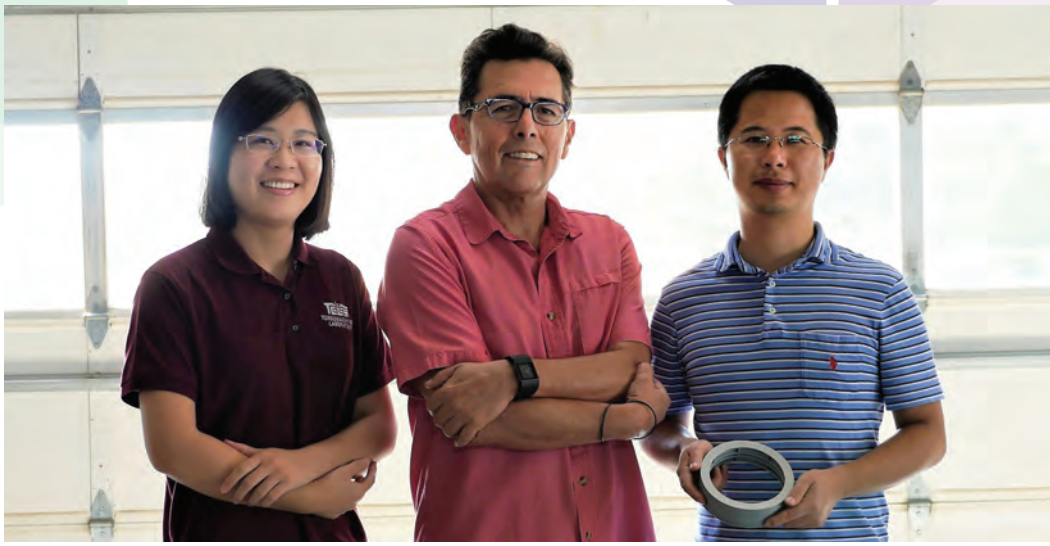
The pocket damper seal was created at the Turbo Lab as an alternative to the labyrinth seal. The Turbomachinery Research Consortium (TRC), an organization of turbomachinery manufacturers and end users supporting research projects at the Turbo Lab, funded the testing of the original pocket damper seal as well as improvements made over time.

Seals are used to reduce leakage from high pressure zones to low pressure zones in compressors and turbines. The labyrinth seal has a number of cavities made by sharp teeth, on the stator or the rotor or both, where a gas loses energy after passing through a tight clearance. Pocket damper seals have added restraints in the cavities of the labyrinth seal, making them more effective to reduce the circumferential swirl velocity development and also offering substantial gains in damping needed to ameliorate rotor vibrations. The new pocket damper seal will include a small change that will further increase its damping effectiveness. Graduate student Xueliang Lu and research associate Dr. Jing Yang, along with Dr. Luis San Andrés, Mast-Childs Chair Professor in the Department of Mechanical Engineering, are responsible for the invention, already tested in the laboratory.

San Andrés said the pocket damper seal has been a success since invented in the early 1990s. The original pocket damper seal was licensed to many companies and is still much in use in industry. He is confident that the improvement to the seal will increase the use and sales of the invention.

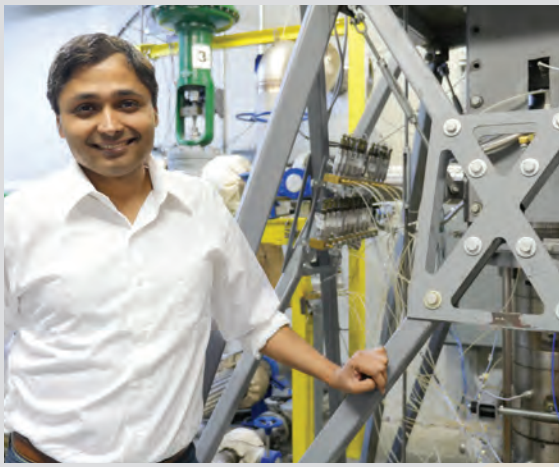
"I am excited to have the opportunity to introduce it. The innovation will be great for our Turbomachinery Research Consortium members," said Dr. San Andrés. "They'll have the first look, and opportunity to use it."

The team is awaiting a provisional patent for the seal.



From left: Dr. Jing Yang, Dr. Luis San Andrés and Xueliang Lu

TURBO LAB ENGINEER DEVELOPS NEW ENERGY CONVERSION DEVICE



Dr. Abhay Patil, research engineer in the Turbo Lab, has received a temporary patent for inventing a new energy conversion device.

The invention, "High Energy Density Turbomachines," has a unique design and provides explicit advantages in terms of performance and reliability. It has a potential to be retrofitted to current multistage electrical submersible pumps (ESPs) deployed for oil and gas production, conventional surface pumps, compressors and turbines. The technology allows turbomachines to operate at elevated speeds while reducing internally generated destructive forces.

Patil completed his Ph.D. in mechanical engineering at Texas A&M University in 2013 under the direction of Dr. Gerald Morrison, Professor Emeritus of Mechanical Engineering. He co-invented the first patent related to thrust reduction in multistage ESPs while working at Baker Hughes. Here at the Turbo Lab, he is leading and working on various projects involving current and new technology initiatives applied to ESPs, turbopumps, multiphase flow meters and process lubricated bearings. His main research thrust is in the field of fluid mechanics, multiphase flow and rotating machinery.

Dr. Patil is working with The TEES Commercialization and Entrepreneurship Office, who has initiated the process to secure a temporary patent based on numerical modeling results. The patent includes more than a year and a half of groundwork. The key to such an accomplishment is to "follow your passion and remain focused," Patil said.

Collaborators on the project include Turbo Lab faculty members Drs. Gerald Morrison, Adolfo Delgado, and Dr. Luis San Andrés.

"The invention is a complete technology, which can bridge some of the critical gaps and create new opportunities for oil and gas business," Patil said.

There is ongoing communication to form a new start-up based on the invention, and a Houston-based artificial lift supplier has expressed interested in funding it. Future plans include manufacturing and testing to improve confidence.

Texas A&M Turbo Lab wraps up 38th annual Turbomachinery Research Consortium meeting

COLLEGE STATION, TEXAS | Since 1981, the Turbomachinery Research Consortium at Texas A&M University has solved problems for major industry leaders through student-led research.

The TRC is a group of 36 companies that contribute annual fees of $25,000 to fund projects that are investigated by 15 to 20 Texas A&M graduate students and faculty in the Turbomachinery Laboratory. Each year, the Turbo Lab, a center of the Texas A&M Engineering Experiment Station (TEES), hosts a meeting for TRC representatives where faculty members and students present research proposals. Forty proposals were presented this year during the meeting held May 15-17 in College Station. The goal of the proposals is to find answers to questions relating to performance and reliability of turbomachinery—rotating equipment that extracts or adds energy to fluids.

TRC representatives provided feedback on the projects, and will select which proposals receive funding. TRC member companies get access to all TRC research dating back to its foundation in 1981, a suite of platinum software, and highly-qualified students for hire.

Manish Thorat was one of those students. Thorat studied labyrinth seals in the Turbo Lab under former director Dr. Dara Childs before earning his master's in mechanical engineering in 2010. Thanks to the TRC, he immediately landed a job with Elliott Group upon graduating. Thorat attended the meeting last week as Elliott Group's representative.

"I would say it is better to be on this side of the podium, rather than presenting on the other side," Thorat said, laughing. "There's less pressure, and I get to ask the questions now."

Aside from cutting-edge research, Thorat said the greatest aspect of TRC is that it connects students with feedback directly from industry.

"When you're developing a tool, you're developing it for industry," Thorat said. "So getting feedback on what specifics are needed is important. Not only is this helpful for students in their research, but it ultimately benefits TRC companies."

> We have gotten results from TRC research that have really helped us."
>
> **~ Rick Pollick, New Way Air Bearings**

Rick Pollick is director of new business development for New Way Air Bearings, a manufacturer of externally pressurized porous media gas bearings and a member of TRC for four years. Pollick said the company continues to support TRC because of the reputation of the Turbo Lab.

"We've gotten results from TRC research that have really helped us," Pollick said. "I know those results are furthering externally pressurized gas bearings in the industry as a new, upcoming technology. The students we work with are extremely knowledgeable and they have the benefit of working with great professors. I think they will go far in the industry, and be recognized as leaders one day. They are some of the best students we've found to work with on projects such as these."

TRC representatives reviewed proposal material through June, and awards were announced in July. Work on selected projects began in September.

For more details on TRC, including membership information, visit turbolab.tamu.edu/trc.

TRC MEMBER COMPANIES

Atlas Copco
BHEL
Chevron
ConocoPhillips
Danfoss
TURBOCOR
ELLIOTT GROUP
EBARA CORPORATION
equinor
ETU i+D
INVESTIGACIÓN Y DESARROLLO EN TURBOMAQUINARIA
ExxonMobil
Research and Engineering
Garrett
ADVANCING MOTION
GE Oil & Gas
Hanwha
Techwin
HITACHI
Ingersoll Rand
Kawasaki
KOCH
INDUSTRIES INC
KOBELCO
MAN Energy Solutions
Future in the making
MITSUBISHI
HEAVY INDUSTRIES
NEWWAY
air bearings
BR
PETROBRAS
Pratt & Whitney
A United Technologies Company
PRAXAIR
SURFACE TECHNOLOGIES
SAFRAN
Schlumberger
SHENYANG BLOWER
WORKS GROUP
Shell Global Solutions
SIEMENS
Ingenuity for life
Solar Turbines
A Caterpillar Company
SULZER
SwRI
TORISHIMA
WAUKESHA
BEARINGS
A DOVER COMPANY

2018-2019 PROJECTS LIST

Tilting pad Thrust Bearings
(Dr. Luis San Andrés)

Experimental Investigation of the Morton Effect
(Dr. Alan Palazzolo)

Tilting Pad Journal Bearing Flow Rate
(Dr. Luis San Andrés)

Morton Effect Prediction and Large Steady State Journal Motion Simulation
(Dr. Alan Palazzolo)

Integral Squeeze Film Dampers and Experimental Verification
(Dr. Luis San Andrés)

CFD-Based Impeller and Seal Rotordynamic Force Coefficients
(Dr. Alan Palazzolo)

Software for Torsional Vibration of Machinery Trains with VFD
(Dr. Alan Palazzolo)

Pressing Needs CFD Labyrinth Seals
(Dr. Luis San Andrés)

Drag Reduced, Textured Surface Bearing and CFD of Tilt Pad Journal Bearings
(Dr. Alan Palazzolo)

Solid Modeler Implemented Rotordynamics
(Dr. Alan Palazzolo)

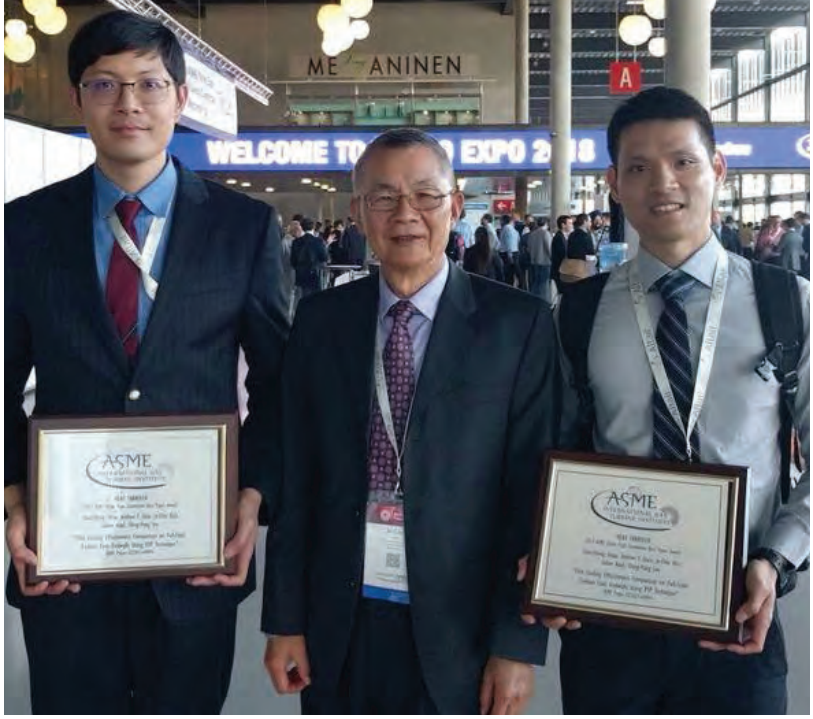
An Experimental and Computational Investigation of the Rotordynamic Coefficients of a Labyrinth Seal
(Dr. Paul Cizmas and Dr. Adolfo Delgado)

Dynamic Characterization of Fully Partitioned Damper Seals
(Dr. Adolfo Delgado)

Measurements of Static Dynamic Load Capacity of Porous Carbon Graphite
(Dr. Luis San Andrés)

Developing a Test Rig to Examine How Vibration Leads to Mechanical Seal Failure
(Dr. Adolfo Delgado)

TURBO LAB FACULTY, STUDENTS LEAVE MARK AT ITN'L ASME CONFERENCE



Chao-Cheng Shiau, Dr. Je-Chin Han and Andrew F. Chen received a best paper award from the American Society of Mechanical Engineers (ASME)-Gas Turbine Heat Transfer Committee.

OLSO, NORWAY | The Turbomachinery Laboratory furthered its global impact this summer during the Turbomachinery Technical Conference & Exposition (Turbo Expo) in Olso, Norway.

The conference, presented by the American Society of Mechanical Engineers (ASME) International Gas Turbine Institute, was June 11-15, 2018. Experts from around the world came together to share the latest academic findings in turbine technology, research, development and application.

Turbo Lab faculty and students presented or hosted more than 50 technical papers and sessions, and Turbo Lab staff represented the Lab in the expo, booth 518.

The majority of Turbo Lab papers submitted to the conference are accepted to journal. Papers undergo a stringent review process in order to be journal-ready. They must be interesting, original, innovative and of significant relevance to the gas turbine industry, according to ASME evaluation guidelines.

"It's a big honor to get accepted to journal," said Dr. Eric L. Petersen, Turbo Lab director. "This is common for the Turbo Lab. It speaks to the high-quality research, and the high-quality students and faculty behind the research."

Two Turbo Lab faculty researchers and three students were honored during the conference for papers presented at the 2017 Turbo Expo in Charlotte, North Carolina. Dr. Luis San Andrés and Xueliang Lu received an ASME Best Paper Award from the Structures and Dynamics Committee for "Leakage, Drag Power and Rotordynamic Force Coefficients of an Air in Oil (Wet) Annular Seal." Dr. Je-Chin Han, Chao-Cheng (Joe) Shiau and Andrew Chen also received an ASME Best Paper Award from the Heat Transfer Committee for their paper, "Film Cooling Effectiveness Comparison on Full-Scale Turbine Vane Endwalls Using PSP Technique."

The Best Paper Award is given to papers that rank in the top one percent of all conference submissions. They are high-quality, original and contribute uniquely to the science of engineering.

> "It's a big honor to get accepted to journal. This is common for the Turbo Lab. It speaks to the high-quality research, and the high-quality students and faculty behind the research.
>
> **– Dr. Eric L. Petersen, Turbo Lab Director**

Top | Turbo Lab student Bonjin Koo presents during the ASME conference in Norway. **Middle** | Dr. Luis San Andrés and Xueliang Lu received an ASME Best Paper Award from the Structures and Dynamics Committee. **Bottom** | Turbo Lab faculty and students gather together for a group photo.

Ph.d. Student Earns Prestigious Scholarship

PASSION KEY TO STUDENT'S SUCCESS

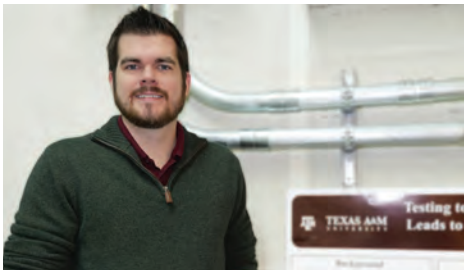
COLLEGE STATION, TEXAS | Clay Norrbin hasn't always been interested in turbomachinery. His undergraduate studies in the Scansorial and Terrestrial Robotics and Integrated Design (STRIDe) Lab at Florida State University focused in the area of robotics. He applied to the Texas A&M University mechanical engineering department in 2013 with a goal of earning a master of science in the robotics program. It wasn't until he responded to a job post from Dr. Dara Childs that his work aligned with his interests.

"It was a privilege working with Dr. Childs on predictions and mechanical face seal vibration," Norrbin said.

Fast forward to the Turbomachinery & Pump Symposia (TPS) 2018 in Houston, Texas where Norrbin received The Ralph James Memorial Scholarship, the Turbo Lab's largest scholarship award of the night. Norrbin was nominated by his advisor, Dr. Adolfo Delgado, who called the doctoral student an excellent researcher.

The fund was chartered in 1979 and named in honor of Ralph James, a founding member of TPS and a Turbomachinery Advisory Committee member. The scholarship is awarded to a senior or graduate student in the Mike Walker '66 Department of Mechanical Engineering at Texas A&M University working in the turbomachinery area of interest.

Norrbin said the funds will be used to continue his graduate studies in mechanical seal dynamics and lateral vibrations.



The key to a successful graduate career in the Turbo Lab is being in love with the work, Norrbin said.

"Make sure you're passionate about the project or some aspect of it." Norrbin also advised participating in TPS and presenting research proposals during the Turbomachinery Research Consortium (TRC). "Both are valuable resources and TRC members have advice to share," Norrbin said.

What's next for Norrbin? He plans to finish his Ph.D. in mechanical engineering in 2020 and continue in a research capacity. He is also looking forward to spending time with his wife and newborn son.

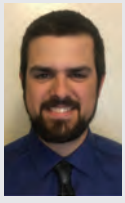
Three Turbo Lab students earn mechanical engineering impact award:

Three Turbo Lab students were celebrated recently with the J. Mike Walker '66 Department of Mechanical Engineering Impact Award.

Sean Cooper, Xueliang Lu, and Nian Wang were honored beside a handful of their mechanical engineering student colleagues at the Fall 2018 Donor Recognition and Scholarship/ Fellowship Banquet on Oct. 18. The award recognizes graduate students' academic excellence in their fields. Recipients celebrated alongside the professors who have guided them through their studies.

NIAN WANG

Hometown: Wuhan, Hubei Province
Advisor: Dr. Je-Chin Han, Distinguished Professor and Marcus Easterling Endowed Chair
Field of Study: Heat transfer and fluid science



SEAN COOPER

Hometown: Tijeras, NM
Advisor: Dr. Eric L. Petersen, Turbomachinery Laboratory Director, Nelson-Jackson Professor
Field of Study: Combustion Science

XUELIANG LU

Hometown: Hunan Province
Advisor: Dr. Luis San Andrés, Mast-Childs Chair Professor
Field of Study: Seals, bearings and rotordynamics

Turbo Lab facilitates National Science Foundation undergraduate program

COLLEGE STATION, TEXAS | Five faculty members in the Turbomachinery Laboratory and eight others throughout the College of Engineering spent their summer investing in the future of energy and propulsion research.

This is the second summer the Turbo Lab has facilitated the Research Experience for Undergraduates (REU) site in Energy and Propulsion and overall the seventh summer of the site under the direction of Dr. Eric L. Petersen, director of the Turbo Lab. Funded primarily by the National Science Foundation (NSF) with contributions from the Turbo Lab, this REU site is a ten-week summer program that immerses undergraduate students from across the U.S. in graduate-level research.

Seventy-five percent of participants from the Energy and Propulsion REU site end up going to grad school, Petersen said. Petersen finalizes the student participant list and assigns each student chosen for the program to their faculty mentor based on research interests. This year the program accepted a total of 17 students, six of whom are sponsored by the Turbo Lab. These six students, from Trinity College (Connecticut), Le Tourneau, Georgia Southern-Armstrong, and Texas A&M universities, were mentored by Turbo Lab professors Petersen, Dr. Luis San Andrés, Dr. Waruna Kulatilaka, Dr. Adolfo Delgado, and Dr. Alan Palazzolo.

> "This is a great opportunity for undergraduates to do high-quality research and to see what it's like to go to grad school. The goal is to encourage participants to pursue an advanced degree in a STEM field.
>
> **– Dr. Eric L. Petersen**

"This is a great opportunity for undergraduates to do high-quality research and to see what it's like to go to grad school," Petersen said. "The goal is to encourage participants to pursue an advanced degree in a STEM field."

Students conducted research with guidance from university professors and graduate students—an experience they might not have otherwise gained at their own university. Their research can have a global impact, as they investigate issues that could ultimately affect global warming, finite fossil fuel resources, pollution and providing energy to an increasing world population. In addition to their daily research activities, students attended lunchtime seminars, participated in REU functions, delivered two oral presentations and presented a final poster.

The program covers room and travel expenses as well as a stipend of $5,000 for student participants.

Two triplet undergrads conduct graduate-level research in the Turbo Lab

COLLEGE STATION, TEXAS | A pair of triplet sisters realized a goal this summer at Texas A&M University.

Kristi and Tarina Naudé, sophomores at LeTourneau University, are two of 15 students who landed a slot in the competitive Research Experience for Undergraduates site in Energy and Propulsion, a ten-week summer program where undergraduate students take part in graduate-level research. The REU site is facilitated by Dr. Eric L. Petersen, director of the Turbomachinery Laboratory. Five Turbo Lab professors, including Petersen, menotred REU students this summer.

Kristi conducted her research under Dr. Waruna Kulatilaka. Her research used Laser-induced breakdown spectroscopy (LIBS) systems to analyze the plasma formed on solid, metalized propellants. Tarina, partnered with Dr. Adolfo Delgado, examined fluid-lubricated thrust bearings for Electric Submersible Pump (ESP) reliability.

The sisters' interest in the REU program was sparked by their dad, Kristo Naudé, a senior engineer with NRG Energy. Kristo serves on the Pump Advisory Committee, a group of experts who oversee the Turbomachinery and Pump Symposia (TPS), organized by the Turbo Lab. The annual Symposia is a training and networking event for engineers and technicians in the turbomachinery, pump and related industries.

Kristi attended TPS with her dad for the last three years and Tarina the last two years. Their dad informed them of the REU program and encouraged them to apply. While the sisters had a connection to the Turbo Lab, they earned their slots in the program on merit alone.

"Their grades and their extracurricular involvement shows that they are serious about becoming researchers in energy and propulsion," said Dr. Petersen. "I think they have a lot to offer this program and that they will leave this summer having grown academically and professionally."

In their free time, the sisters enjoy staying active by taking classes in taekwondo and krav maga. On weekends, they head home to Houston, where their dad teaches them more about machinery and pumps. They also spend time with their triplet sister, Annette. Annette also attends LeTourneau, where she studies nursing.

"I've enjoyed the research so far," Kristi said. "I've never been good at chemistry, but I'm learning more every day with the help of my mentors as well as other students in the program."

Kristi and Tarina delivered their midterm presentation in late June, and showcased their final project posters on Aug. 3.

"I've really enjoyed learning more about fluid dynamics, as well as other topics," Tarina said. "I've had a great experience in this program."

Left: Tarina Naudé, Right: Kristi Naudé

A pair of sisters realized a goal this summer at Texas A&M University

PUMP SYMPOSIUM ADVISOR

Kristo Naudé

Kristo Naudé is a Senior Engineer with NRG Energy, responsible for all pumps in the extensive power plant fleet. He joined NRG Energy in 2008 and is based in the corporate office in Houston, TX. Kristo has more than 24 years pump-related experience in consulting engineering, pumps manufacturers and power utilities in South Africa, Canada, and the USA. All power plant work has centered on pump problems, root cause analysis, pump system reliability and system enhancement. Kristo obtained a B.Sc. (Mechanical Engineering) from the University of Pretoria in 1986, and an MBA through the University of Stellenbosch Business School in 1998.

Turbo Lab wraps up centrifugal compressor operations short course in Houston

When faced with a new challenge at work, Laura Donnelly turned to a familiar resource to sharpen her skills for the project.

Donnelly, a rotating equipment specialist at ConocoPhillips in Houston, is responsible for overseeing the design of a floating production storage and offloading (FPSO) facility that transports natural gas to shore. She reviews documents and drawings to ensure the FPSO's pumps and compressors will perform optimally, and analyzes 3D models to ensure equipment can be accessed for maintenance.

A colleague of Donnelly's told her about the Centrifugal Compressor Operations for 21st Century Users (CCOps) offered by the Turbomachinery Laboratory in March, and it piqued her interest.

"I took a Turbo Lab short course several years ago, and it was a very good course with top instructors," Donnelly said. "As soon as I learned about new course content that fit my current role, I signed up."

CCOps is intended for beginning-and intermediate-level professionals to accelerate their understanding of centrifugal compressors and how they are used in oil & gas applications. The course covers design aspects, aerodynamics, rotordynamics, the practical applications of installation, testing, commissioning and procurement.

The CCOps course taught Donnelly best practices for installing equipment offshore, including the design aspects that must be considered when assembling such equipment.

"My experience in CCOps was really great," Donnelly said. "The attendees come from all different backgrounds—some work for original equipment manufacturers and some are end-users—so you learn a lot about the issues people see in different industries. The instructors are experts in their fields, and they cater to the people attending."

Instructors include Jim Sorokes of Dresser-Rand, A Siemens Business, J. Jeffrey Moore of Southwest Research Institute, Mark Sandberg of Sandberg Turbomachinery Consulting, LLC, and Jigger Jumonville of Jumonville Engineering. The four instructors' combined experience surpasses 100 years.

Moore, a Texas A&M graduate, has taught the course for 10 years. Despite its history, the material stays fresh with additions of latest technological advancements and new case studies.

"What makes Turbo Lab short courses unique is not only discussions around cutting edge-technology, but the caliber of my fellow instructors," Moore said. "It's a good mix. Each of them has many years of experience in the industry, and some are consultants, while others are OEMs."

Rotordynamics short course helps surmount on-the-job challenges

Alberto A. Lopez has a new air of confidence after attending a three-day Rotordynamics short course hosted by the Turbomachinery Laboratory.

Lopez, a 2016 Texas A&M mechanical engineering graduate and engineer for Andeavor, said his team faced vibration issues with a recently-installed complex turbine compressor assembly. During breaks, Lopez conversed with his colleagues about the problem. He said the knowledge gained from the course and the perspectives of his fellow attendees helped him identify solutions before he had even completed the three days of training.

"I didn't know how to troubleshoot or analyze a system like that before I came to Rotordynamics," Lopez said. "Now I can bring some ideas to reduce the vibration of the equipment so it can run reliably and safely, too."

The Turbo Lab's Rotordynamics course, offered each spring in Houston, is for beginning- and intermediate-level engineers in the petroleum, chemical, power and gas industries. It provides a basis for understanding the rotordynamics — the behavior and diagnosis — of turbines, compressors, expanders, motors, pumps and generators and their subcomponents to help select, analyze, troubleshoot and repair them for maximum reliability. The course is packed with case studies and workshops for hands-on evaluation of actual machines.

> "I didn't know how to troubleshoot or analyze a system like that before I came to Rotordynamics."
>
> ~ **Alberto Lopez, Andeavor**

Malcolm Leader, owner of Applied Machinery Dynamics in Durango, Colo., has taught the course for ten years. He is involved in the design, testing, modification, and installation of rotating equipment, and has written several papers on experimental rotordynamics, bearing design, design audits for rotating equipment and practical implementation of rotordynamic programs.

"I hope what people get out of this course is the ability to go back to their jobs and use that knowledge in practically solving problems that crop up every day."

Leader's mission was accomplished for Lopez before he returned to the refinery.

"It's important for mechanical engineers to develop these skills early on in our careers," Lopez said. "This training has helped me develop a strong technical foundation so I can not only understand complex equipment, but so I can troubleshoot and improve reliability of critical components. If equipment goes down, the loss can be high. A course like this is a must-have tool for entry-level engineers."

2019 EXTENDED SHORT COURSES

MARCH 18-21, 2019

(Courses run concurrently)

Houston, TX

CENTRIFUGAL COMPRESSOR OPERATIONS FOR 21st CENTURY USERS (CCOPS)

Intended for beginning- and intermediate-level professionals to accelerate their understanding of centrifugal compressors and how they are used in oil & gas applications.

ROTORDYNAMICS

Provides a basis for understanding the rotordynamics of turbines, compressors, expanders, motors, pumps and generators and their subcomponents to help select, analyze, troubleshoot and repair them for maximum reliability. Intended for beginning- and intermediate-level engineers.

REGISTER NOW AT

TURBOLAB.EDU/SHORT-COURSES

Faculty Features & Honors

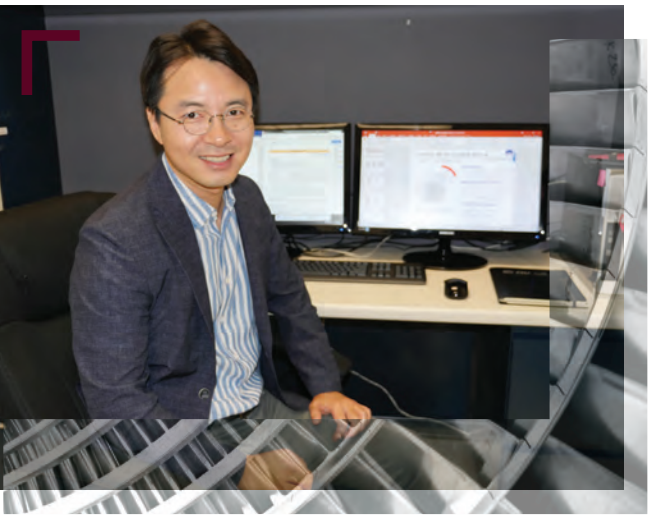
FORMER TURBO LAB STUDENT, LESLEY WRIGHT, JOINS FACULTY

Dr. Lesley Wright joined the Turbo Lab team in August after teaching at Baylor for ten years. She was encouraged by the head of the J. Mike Walker '66 Department of Mechanical Engineering, Dr. Andreas A. Polycarpou, and distinguished professor, Dr. Je-Chin Han, to apply for the opening.

Wright is investigating enhanced convective cooling technology. This includes heat transfer enhancement for gas turbine cooling applications.

SAN ANDRÉS RECEIVES INVITE FOR ADJUNCT PROFESSORSHIP IN CHINA

Dr. Luis San Andrés, Mast-Childs Chair Professor of Mechanical Engineering, was named an adjunct professor at China's Xi'an Jiaotong University, a top 10 global institution for mechanical engineering. He will lecture at the university twice a year, mentor graduate students and collaborate with a team of researchers. He plans to spend the Fall 2019 semester at Xi'an Jiaotong University.



FORMER TURBO LAB STUDENT RETURNS AS VISITING SCHOLAR FROM SEOUL

Dr. Tae Ho Kim, Associate Professor of mechanical engineering at Kookmin University in Seoul, Korea will serve one year as a Visiting Scholar at Texas A&M University in the Turbo Lab. The appointment is a recognition of Dr. Kim's work in the fields of gas foil bearings and microturbomachinery rotordynamics.

Kim received his Ph.D. in mechanical engineering from Texas A&M in 2007. Dr. Luis San Andrés, Mast-Childs Chair professor of Mechanical Engineering will serve as the host professor.

KNOWLEDGE SHARING
TURBO LAB BRINGS IN ACADEMIC EXPERTS FOR LECTURES, SEMINARS

DR. BRANDON ROTAVERA
UNIVERSITY OF GEORGIA

Combustion Chemistry of Advanced Biofuels
April 23, 2018

DR. TIM LIEUWEN
GEORGIA TECH UNIVERSITY

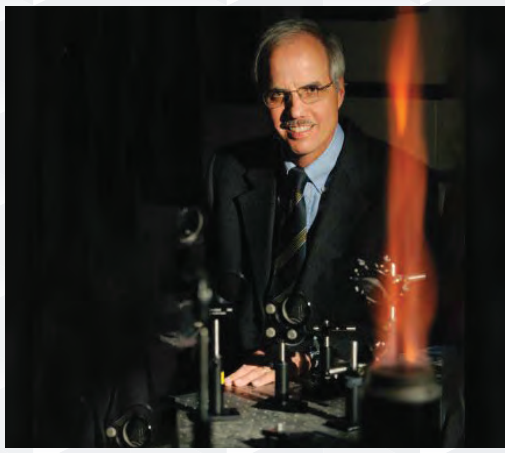
Dynamics of Premixed Flames in Unsteady Flow Fields
2018 Turbomachinery Distinguished Lecturer
November 7, 2018

The Turbomachinery Distinguished Lecture Series was endowed in 2014 by the Turbo Lab on behalf of the Turbomachinery Advisory Committee, a group of dedicated industry experts who volunteer their time to oversee the success of the annual Turbomachinery & Pump Symposia (TPS). Advisors are respected leaders in their companies and fields who select the technical program for TPS each year. The lecture series enables the Department of Mechanical Engineering to invite prominent turbomachinery experts to present lectures of importance and interest to Texas A&M students and faculty.

Dr. Andreas A. Polycarpou (left) and Dr. Eric L. Petersen (right) of Texas A&M present Dr. Tim Lieuwen (center) with a distinguished lecturer certificate.

DR. ROBERT W. PITZ
VANDERBILT UNIVERSITY

Cellular Tubular Flames: A Model of Preferential Diffusion and Extinction in H2 Fueled Laminar and Turbulent Flames
November 16, 2018



TEES
TURBOMACHINERY LABORATORY
TEXAS A&M ENGINEERING EXPERIMENT STATION

FACULTY & STAFF

DR. ERIC PETERSEN

Turbomachinery Laboratory Director
Nelson-Jackson Professor

DR. LUIS SAN ANDRÉS

Mast-Childs Chair Professor

DR. JE-CHIN HAN

Distinguished Professor and Marcus Easterling Endowed Chair

DR. PAUL CIZMAS

Professor

DR. ALAN PALAZZOLO

Professor

DR. OLIVIER MATHIEU

TEES Research Associate Professor

DR. LESLEY WRIGHT

Associate Professor

DR. ADOLFO DELGADO

Associate Professor

DR. WARUNA KULATILAKA

Associate Professor

GREG GAMMON

Director of Operations

ASHTON DROLLINGER

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Exhibitor Services Director

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Business Administrator, Registrar

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Communications Specialist

STEPHANIE HIDALGO

Exhibitor Services Assistant

BROOKE CONRAD

Communications Director

TIM MEEKMA

Business Coordinator

CARL JOHNSON

Laboratory Facilities Manager

DEBBIE MAGGS

Program Specialist

POSTAL (MAILING) ADDRESS

Turbomachinery Laboratory
Texas A&M University
3254 TAMU
College Station, Texas
77843-3254

RESEARCH LAB ADDRESS

Turbomachinery Laboratory
1485 George Bush Drive W
College Station, Texas
77843

SYMPOSIUM OFFICE ADDRESS

Turbomachinery Laboratory
Texas A&M University
202 Spence Street
College Station, Texas
77843-3254

P: (979)-845-7417
F: (979)-845-1835
info@turbo-lab.tamu.edu

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TEXAS A&M ENGINEERING EXPERIMENT STATION

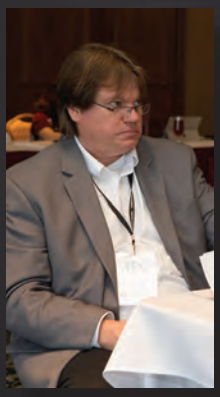
2019 CONTINUING

MAR 2019

MARCH 2019

EXTENDED SHORT COURSES

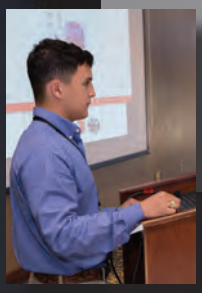
March 18-21, 2019
(Courses run concurrently)
Houston, TX



- Centrifugal Compressor Operations for 21st Century Users (CCOPS)
- Rotordynamics

Society for Machinery Failure Prevention Technology 2019 Conference

May 13-16, 2019
Philadelphia, PA



The Turbo Lab will offer a vibrations solutions short course in conjunction with the Hydraulic Institute and the Vibration Institute.

MAY 2019

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Turbomachinery Research Consortium (TRC) Annual Meeting

May 14-16, 2019
College Station, TX

TRC member company representatives review current project results; review new and continuing project proposals; tour the Turbo Lab facility; and network with students, faculty and colleagues.

EDUCATION OPPORTUNITIES

JULY 2019

ASIA TURBOMACHINERY & PUMP INDUSTRY SUMMIT

July 10-11, 2019
Kuala Lumpur, Malaysia

The Industry Summit is a free, two-day information-sharing, training and networking event for practioners in rotating equipment and related fields.

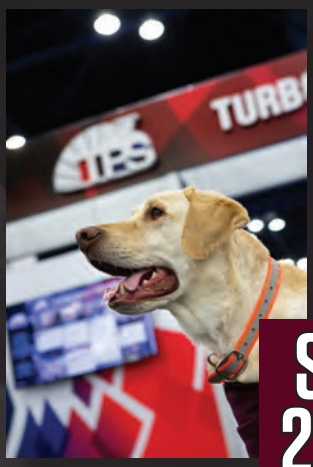
The full Asia Turbomachinery and Pump Symposium will return in Spring 2020.

OCT 2019

Call for Papers for TPS 2019

October 2019
Abstracts Due

Be a part of the TPS 2020 technical program by submitting an abstract for a case study, lecture, tutorial or short course.



SEP 2019

TURBOMACHINERY & PUMP SYMPOSIA 2019

Sept. 10-12, 2019
(Short Courses: Sept. 9)
Houston, TX

TPS is a vital industry event, offering a forum for the exchange of ideas between rotating equipment engineers and technicians worldwide through its technical program and exhibition.

OCT 2019

Learn more about each of these opportunities at turbolab.tamu.edu.

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