NOISE/NEWS INTERNATIONAL

Volume 27, Number 1
2019 March

A quarterly news magazine and online digital blog published by I-INCE and INCE-USA

- **INTER-NOISE 2019 in Madrid**
- **Upcoming INCE-USA Awards, Honors, and Student Awards**
- **Vibration Transmission and Isolation—Some Lesser-Known Facts**
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Features

Departments

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NOISE/NEWS INTERNATIONAL

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I-INCE

The International Institute of Noise Control Engineering (I-INCE) is a worldwide consortium of societies concerned with noise control and acoustics. I-INCE, chartered in Zürich, Switzerland, is the sponsor of the INTER-NOISE Series of International Congresses on Noise Control Engineering, and, with the Institute of Noise Control Engineering of the USA, publishes this quarterly magazine and its blog. I-INCE has an active program of technical initiatives. It currently has fifty-one member societies in forty-six countries.

INCE-USA

The Institute of Noise Control Engineering of the USA (INCE-USA) is a nonprofit professional organization incorporated in Washington, DC, USA. The primary purpose of the Institute is to promote engineering solutions to environmental noise problems. INCE-USA publishes the technical journal *Noise Control Engineering Journal* and with I-INCE publishes this quarterly magazine and its blog. INCE-USA sponsors the NOISE-CON series of national conferences on noise control engineering and the INTER-NOISE Congress when it is held in North America. INCE-USA members are professionals in the field of noise control engineering, and many offer consulting services in noise control. Any persons interested in noise control may become an associate of INCE-USA and receive both this magazine and *Noise Control Engineering Journal*.

NNI and Its Online Supplement

www.noisenewsinternational.net

The PDF and blog versions of *NNI* allow for links to references, articles, abstracts, advertisers, and other sources of additional information. In some cases, the full URL will be given in the text. In other cases, blue text will indicate the presence of a link. The *NNI* blog contains additional information that will be of interest to readers, such as the following:

- The current PDF issue of *NNI* available for free download
- Links to previous PDF issues of *NNI*
- An annual index of issues in PDF format
- A conference calendar for upcoming worldwide meetings
- Links to I-INCE technical activities and I-INCE technical reports

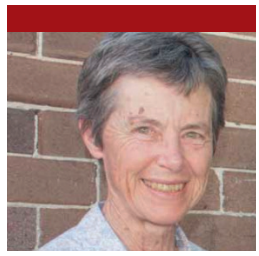
From the President of I-INCE

In 2018 the World Health Organization, Regional Office for Europe, published "Environmental Noise Guidelines for the European Region" (http://www.euro.who.int/en/publications/abstracts/environmental-noise-guidelines-for-the-european-region-2018). This document is well researched, and the guidelines have been developed "*based on the growing understanding of these health impacts of exposure to environmental noise*." The process of developing the guidelines was very comprehensive with a systematic review of available studies on noise effects, and the outcomes were further reviewed by teams of experts. On first read the noise levels in the recommendations appear to be very low, and these numbers have been used incorrectly in various media reports by not properly referring to the time-weighted metric used for each one. However, it is important to have a goal so that governments and organizations do not become complacent regarding the current status but make efforts to further reduce noise. The guidelines may well receive increased coverage around the International Noise Awareness Day on Wednesday April 24, 2019 (http://chchearing.org/noise/day/).

This March 2019 issue of *NNI* includes information on INTER-NOISE 2019, to be held in Madrid in June. This will be the main 2019 international gathering of those working in noise control engineering as well as a celebration of 50 years of the Spanish Acoustical Society. The comprehensive technical program will be well balanced by the social program.

As outlined in the accompanying editorial from our I-INCE treasurer, the major proportion of I-INCE income is spent on technical activities, with a great emphasis on providing encouragement and assistance for those entering the field. The Young Professionals Congress Attendance Grants are competitive, and in 2019, it was a challenge to select 20 recipients from 56 high-quality applications to receive the support. In addition, a Young Professionals Workshop is held one afternoon and comprises presentations on topics including networking, publications, starting a job, and so on, followed by the presentations of the awards and an informal networking social event. A recent initiative, again focused on young professionals, is a School on the Practice of Noise Control held on Sunday morning. Following the strong response to the first one held in 2018, a school is being organized by our VP Technical Activities, Patricia Davies, for INTER-NOISE Madrid. Another recent initiative is the provision of a YouTube video for the I-INCE lectures, with two from 2017, one from 2018, and a further one scheduled from a plenary lecture in 2019. The board welcomes suggestions for other initiatives from the member societies, and these can be raised with board members at any time as well as during the general assembly, held on Sunday afternoon before the commencement of the INTER-NOISE Congress.

Marion Burgess
President, I-INCE



Marion Burgess

From the I-INCE Treasurer

I-INCE, founded in 1974, is a worldwide consortium of organizations concerned with noise control, acoustics, and vibration. This editorial gives an overview of I-INCE from a financial perspective. Historical and the latest financial reports are available on the I-INCE website (http://i-ince.org/finances.php).

The institute is funded by annual fees from four categories of membership (small, medium, large, and sustaining and institutional) as well as from a small share of the fees from the annual INTER-NOISE congress that I-INCE sponsors. Most years, these two contributions are similar in size. However, as INTER-NOISE fees to I-INCE are proportional to the number of attendees, this is a potentially more variable source of income.

% income	Members	INTER-NOISE	Other*
2017	70	35	–5
2016	54	44	2
2015	46	56	–2
2014	40	44	15
2013	47	50	3

** "Other" covers losses written off, donations, online database contributions, and so on.*

We ensure that the vast majority of the institute's expenses contribute toward scientific activities and have successfully ensured that over 80 percent of our expenses are spent in this way. Scientific support is primarily financial support to young professionals to help ensure a healthy future for our profession, for *NNI* to promote noise control and communicate with our members, and more recently, the online conference database that gives all members access to all INTER-NOISE and NOISE-CON conference proceedings, thus helping research, paper writing, and network building. In addition to these activities, a number of activities are supported on a trial basis with the view to identifying areas of useful investment. These include I-INCE lectures available on YouTube and the Professional Practice School. A full list of initiatives is available on our website.

In addition to being reliant on voluntary resources, both the treasurer and the secretary general seek to minimize administrative costs.

% expenses	Scientific	Administrative
2017	86	14
2016	83	17
2015	82	18
2014	88	12
2013	96	4

In the last five years, there have been two years of loss, the others resulting in a profit. This has typically been due to lower expenses than budgeted for. Over time, the Institute has built up a healthy equity, in line with recommendations for organizations similar to I-INCE, to enable it to support significant initiatives, most likely of a one-off nature, if it so chooses. The institute is aware that it is a nonprofit organization and does not aim to further increase equity. However, care is taken not to commit I-INCE to additional large long-term commitments but to focus on a number of regular activities and a number of ad hoc activities.

% (compared to income)	Profit	Equity
2017	–17	537
2016	66	431
2015	16	434
2014	22	348
2013	–21	348

From a treasurer's perspective, recent years have focused on a range of activities:

- Reviewing and updating of I-INCE's financial reporting methodology and format to provide enhanced insight and transparency
- Increasing follow-up on outstanding member fees from previous years, with the result that this post has been effectively eradicated
- Ensuring a clear and legal definition of I-INCE as a nonprofit organization, including ensuring that banks have I-INCE's updated address, particularly in relation to governmental reporting requirements
- Setting up a second account in another bank as part of I-INCE's risk management strategy, as there is maximum guaranteed €100,000 compensation from each bank
- Distributing invoices by email for cheaper and faster communication and transferring bank correspondence to email where possible to help minimize administration costs
- Ensuring that treasurer activities are performed in line with the updated milestones in the I-INCE Rules and By-Laws for better alignment with the general assembly

Douglas Manvell

With this, I feel that I-INCE is well equipped to promote noise control, with a strong equity available for supporting worthy causes, while dealing with the challenges of the modern world.

Douglas Manvell
Treasurer, I-INCE

Editor's View

Welcome to the March 2019 issue of *NNI*.

In this issue you will read about some lesser-known facts related to vibration transmission and isolation, details on the upcoming INTER-NOISE conference in Madrid, some open grants and awards for students and young professionals, as well as the latest links between transportation noise and public health outcomes.

We are also introducing a new feature in this issue, "From the Archives." *NNI* enjoys a rich history, and has existed, in some form, since the very beginnings of I-INCE. Because of this, we thought it would be a good idea to revisit different articles from our archives and provide readers with an update to these articles. To kick us off, we catch up with one of our contributors to this issue, Dr. Eric E. Ungar, who, by a happy coincidence, was featured in the very first issue of *NNI* in 1993.

As ever, we have updates from all around the world in NOISE/NOTES. You can follow us online on Facebook and Twitter under our handle NNIEditor, and we are about to launch our own Instagram account. Our Instagram account will feature short video tutorials about some basic acoustic principles—stay tuned for more updates on that.

I hope you enjoy this issue of *NNI*.

Eoin A. King, PhD

Eoin A. King, PhD

NOISE/NOTES

Eoin A. King, *NNI* Editor

Eva Von Dell, *NNI* Social Media Assistant

Brianna Cervello, *NNI* Social Media Assistant

NNI is on Facebook and Twitter—we try to keep our readers informed with noise news from all across the globe by highlighting interesting research and projects. Here is a roundup of some of the stories that have been making headlines. Follow @NNIEditor to stay up to date with all noise-related news.

WHO and ITU release new standard for personal audio device

The World Health Organization (WHO) and the International Telecommunication Union (ITU) have issued a new international standard for the manufacture and use of personal audio devices (including smartphones and MP3 players) to make them safer for listening. It is estimated that 1.1 billion young people may be at risk of hearing loss due to prolonged and excessive exposure to loud music. The standard was developed under WHO's "Make Listening Safe" initiative, which seeks to improve listening practices especially among young people.

City may help music venues soundproof in an effort to curb neighbors' noise complaints

The *San Francisco Examiner* reports that city authorities have proposed the Music Venue Sound Mitigation Assistance Program, which would offer grants of up to $25,000 to bars, restaurants, and music venues in order to pay for soundproofing. Priority would go to those that "demonstrate a commitment to hiring local musicians and a pressing need for sound mitigation work."

A noise-cancelling doghouse!

Dog owners know that when a thunderstorm comes, their pets cower and hide from the noise. Ford Europe has created a space for "man's best friend" to calmly stay inside, utilizing acoustic panels and speakers that counter the incoming frequencies. Check out more in a recent article on WebUrbanist.com.

Noise control using graphene

Could graphene, a material made of sheets of carbon a single atom thick, change the noise absorptive game entirely? Physics.org reports that a new high-tech low-cost soundproofing foam invented at the University of Adelaide could help.

Life in the Spanish city that banned cars

The *Guardian* reports on life in Pontevedra, a city in Spain that banned cars from the city center, where "the usual soundtrack of a Spanish city has been replaced by the tweeting of birds and the chatter of humans."

New York City lawmakers call for less piercing emergency vehicle sirens

NPR reports that lawmakers in New York City have argued that the shrill sound of police cars, fire trucks, and ambulances has got to go. They would prefer emergency vehicles change their sirens within two years to an alternating high and low sound similar to that heard in many European countries.

From the Archives: We Catch Up with Dr. Eric E. Ungar

NNI enjoys a rich history and has existed, in some form, since the very beginnings of I-INCE. One predecessor to *NNI* was *Noise/News*, first issued in 1972 as a newsletter for the newly established INCE-USA. Later, in 1974, shortly after the founding of I-INCE, it was recognized that this organization also needed a means to communicate, and the *International INCE Newsletter* was started. Some 20 years after that, in 1992, it was decided that it would be of benefit to both I-INCE and INCE-USA to combine *Noise/News* and the *International INCE Newsletter* and launch a new publication: *Noise/News International* was born!

Drawing on this rich history, we have decided to feature, from time to time, an article that appeared in an earlier issue of *NNI*. In this issue there is also a tutorial on some lesser-known facts concerning vibration transmission and isolation, authored by Dr. Eric E. Ungar. By a happy coincidence, Dr. Ungar was featured in the very first issue of *NNI* in 1993. This original article has been reproduced here, and I also asked Dr. Ungar to write another article reflecting on what has changed since this first appeared all those years ago.

Eoin A. King, PhD
NNI editor

People—Eric E. Ungar *(as originally appeared in March 1993)*

Dr. Eric E. Ungar Affiliates with Acentech

Acentech Incorporated has announced that Dr. Eric E. Ungar will work for the company in a part-time capacity as chief engineering scientist. He continues his primary employment as chief consulting engineer for Bolt Beranek and Newman, Inc. (BBN), where he has worked since 1958. Dr. Ungar served as president of INCE-USA in 1985 and was a member of the INCE-USA Board of Directors from 1980 to 1982 and from 1985 to 1987.

At Acentech, Dr. Ungar will be responsible for bringing his technical expertise to bear on a wide variety of vibration and noise problems, particularly relating to buildings and industrial facilities and equipment. At BBN, he will continue to work on federally funded research and development programs and the solution of problems in the fields of marine systems and active vibration control.

Over the past two decades, Dr. Ungar has worked on several leading-edge projects concerned with facilities that accommodate highly vibration-sensitive equipment or that require high resistance to vibration-induced damage or malfunction.

With more than 40 years of engineering research and consulting experience in acoustical technology, Dr. Ungar has received numerous honors. He recently served as president of the Acoustical Society of America. Additional honors and professional society affiliations include Fellow, Acoustical Society of America; Life Fellow, American Society of Mechanical Engineers; member and past president of the Institute of Noise Control Engineering; and Associate Fellow, American Institute of Aeronautics and Astronautics.

Dr. Ungar has written and contributed to numerous books, papers, and technical reports. His papers have appeared in the *Journal of the Acoustical Society of America*, *Sound and Vibration*, and several ASME journals. A 1951 graduate of Washington University, Dr. Ungar received his MS at the University of New Mexico (1954) and his Eng. Sc.D. at New York University (1957). Acentech Incorporated, with offices in Cambridge, Mass., and Los Angeles, is a consulting firm specializing in noise and vibration control; industrial and environmental acoustics; architectural acoustics; and sound system, audiovisual, and video system design. Originally a subsidiary of BBN, senior management purchased a majority interest in the firm in 1991.

From the Archives: The Past Quarter Century

Eric E. Ungar

The editor of *NNI* has invited me to reflect on what has changed over the last 25 years, noting that I was mentioned in the 1993 issue of *NNI*, a quarter century ago. That is not an easy task for someone like me, who thinks of everything in the past as "yesterday" and who has been in the acoustics/vibration field for almost 60 years. Nevertheless, here are my views, based predominantly on my experience and undoubtedly on my prejudices.

* * *

About 25 years ago, US government entities that had sponsored advancements in intellectual tools, such as statistical energy analysis (SEA),[1] began changing their focus to supporting projects aimed at hardware development. Thus, research organizations outside of academia also switched to hardware-related projects and to industrial consulting work, causing many of their employees to move to jobs in industrial firms. As a result, such firms have developed greater acoustics capabilities and better information relating to the acoustical and vibration aspects of their products.

In the past few decades, such government entities as the Environmental Protection Agency, the Federal Transit Administration, and the Occupational Health and Safety Administration promulgated regulations and sponsored investigations related to the control of vibration and noise; it is my perception that they have more recently been relatively inactive in our field. However, many communities have picked up the ball and promulgated noise ordinances of various levels of complexity. In recent years the idea of "soundscapes"—the environmental acoustics analog to landscapes—has obtained some traction, but it has not yet found widespread application.

It is no surprise that the increased use of computers and networks has had a great effect on us in the noise and vibration community, as on so many others. Many program packages, some based on finite-element methods, have become available for the prediction and analysis of noise and vibration information, enabling practitioners to obtain results relatively quickly and inexpensively.[2] Of course, we all have become avid users of personal computers for computation, word processing, and for finding and storing information. The perception that everything can be found online has virtually made reference books obsolete, particularly in the minds of younger practitioners.[3]

The burgeoning demand for computer components and the like has led to the construction of a considerable number of facilities for the production of microelectronics and other high-technology devices and also for nanotechnology research. These facilities typically require extremely benign noise and vibration environments and have given rise to industries and specialty consultants that provide guidance and equipment aimed at achieving these environments.

The increased availability of microelectronic components for

transduction and data processing in the recent decades has led to vast practical improvements in our ability to acquire data. Measurements that used to require the use of heavy and bulky instruments now can be done by means of equipment that fits into a shoebox or even into a shirt pocket. The newer instrumentation has greater analysis and recording capability, with some including features for remote monitoring. Widespread Wi-Fi and cell coverage has enabled the remote performance of long-term measurements, observation of results, adjustments of the instruments, and the downloading of data—all without a person at the measurement site. As a result there has been increased demand for more data and more sophisticated data analysis.[4] The resulting greater amount of data, requiring increased data storage, also has put pressure on our networks and servers.

The advanced instrumentation and computation means have given rise to so-called active control systems for counteracting unwanted sound and vibration. Much theoretical work was done early on and has more recently led to

the commercial availability of consumer items like "noise-cancelling" headphones and industrial equipment like vibration isolation platforms that vastly reduce the vibrations transmitted from facility floors to electron microscopes and the like. The aforementioned means have also led to the development of "auralization" systems—arrangements that enable one to hear the acoustics expected in a space, such as a concert hall or classroom that may exist only on paper—enabling one to understand the acoustics better than one could from data plots and charts.

* * *

It has been an interesting time. I wonder what the next 25 years will bring!

1. SEA in essence was the brainchild of Richard Lyon, whose company was described in the 1993 issue immediately after the article that referred to me and who passed away at the beginning of 2019.
2. But the accessibility of such programs has made it possible for users without a good understanding of the underlying science to arrive at computed predictions and evaluations without being able to judge whether their results make much practical sense.
3. This is especially true of physics and engineering handbooks, and even of compilations such as the 1997 *Encyclopedia of Acoustics* and the 2007 *Handbook of Noise and Vibration Control*, both edited by Malcolm Crocker. I have been unable to find takers for many books I have been trying to give away as I contemplate retirement.
4. I often wonder how much of the data we take is really useful and whether those who demanded the measurements undverstand what all the data mean.

Apply Now!
Become INCE-USA Board Certified

The next INCE Board Certification exam will be given at the Sheraton San Diego Hotel And Marina Sunday, August 25th at 8:00am.
This is the Sunday before NOISE-CON 2019

INCE Board Certification applications are currently being accepted. If you are interested in becoming INCE Board Certified, or know someone who is, please go to the following web link for all application materials and instructions:

https://inceusa.org/careers-education/become-board-certified-in-noise-control/

APPLICATION DEADLINE: May 1, 2019

All applications received by that date will be notified regarding approval to take the exam by June 1, 2019.

Professional references and academic transcripts are required as part of the application, so please allow time to obtain these documents by the application deadline.

Upcoming INCE-USA Awards and Honors for 2019

For NOISE-CON 2019, the INCE-USA and the INCE Foundation are excited to be accepting nominations for two major awards:

- the INCE-USA George C. Maling Award for Excellence in Noise Control Engineering, and
- the INCE-USA Outstanding Noise Control Educator Award.

These awards will be presented at the upcoming NOISE-CON 2019 meeting in San Diego, California, August 26–28, 2019. A brief summary for each of the awards, including submission/nomination deadlines, is provided below.

To receive an application for the George C. Maling Award for Excellence in Noise Control Engineering, Outstanding Noise Control Educator Award and or the Hirschorn IAC Prize Student Project Award nomination, please send a request to:

Dana M. Lodico, PE, INCE Bd. Cert.
INCE Vice President, Honors & Awards
email: vp_awards@inceusa.org

For more information about the INCE-USA Awards program, including a complete list of past awardees, please see the Awards page on the INCE-USA website.

George C. Maling Award for Excellence in Noise Control Engineering

Engraved memento and honorarium of $3,000

Nomination deadline: **April 22, 2019**

The George C. Maling Excellence in Noise Control Engineering Award is intended to provide, and disseminate widely, recognition for an outstanding project, product, or process in the applied practice of noise control engineering. The project, product, or process should demonstrate a significant contribution toward a quieter environment. The precise nature of the project, process, or product is not rigorously defined by policy but is left to the nominator to establish and the judges to evaluate. Some examples of possible nominees may include but are not limited to the following:

- Innovative consumer or industrial products developed specifically for the purpose of noise control or noise reduction
- Improvements to existing consumer or industrial projects to significantly reduce noise levels or noise exposure
- Development of new or improved techniques, materials, or products for noise control, for buildings and construction
- Development or improvement of noise policy, guidance, or standards resulting in greater or more consistent noise control engineering application or practice
- New or innovative techniques used in noise assessment or control for large transportation, energy, or industrial projects, including environmental studies, design, or construction projects
- Development or improvements of tools, equipment, processes, practices, computer programs, and applications for use in noise analysis and control

Nominations may be made to recognize an individual or group of individuals for closely related contributions that, in the opinion of the nominator, constitute collectively a significant specific contribution to noise control engineering. The award shall consist of an engraved memento and an honorarium of $3,000. A suitable nomination package for this award is not trivial and will require some time to prepare, so please request the nominating instructions at least one month before the submission deadline. There will be no extension of the submission deadline.

INCE-USA Outstanding Noise Control Educator Award

Award amount: $2,000 cash grant

Submission deadline: **May 6, 2019**

The INCE Outstanding Educator Award for excellence in the teaching of noise control engineering is intended to honor a person who has significantly advanced the technology and practice of noise control engineering through unique contributions to the education of future noise control engineers, as demonstrated by *one or more* of the following qualifying accomplishments:

- Excellence in teaching, whether through the inspired dissemination of the principles of noise control engineering or by inspiring students to attain high achievement in the field of noise control engineering
- The notable improvement of tools such as textbooks, handbooks, laboratory experiments, courses, and student projects for the teaching of noise control engineering
- Excellence in disseminating the principles of noise control engineering outside of a university setting through the teaching of short courses and seminars; by promoting cooperation among academic, industrial, or government sectors, or with other

disciplines; or by advancing the public's understanding of the benefits of noise control technology

- Enhancing and diffusing the knowledge of noise control engineering through seminal research, scholarly publications, or patents; or the development of noise control materials, products, techniques, or programs
- Providing sustained and effective leadership for the educational programs and activities of the Institute of Noise Control Engineering

A suitable nomination package for this award is not trivial and will take some time to prepare, so please request the nominating instructions at least one month before the submission deadline. For complete Award rules and application requirements, please contact the I-INCE vice president for honors and awards.

Calling All Students! Upcoming INCE-USA Student Awards for 2019

As you may already be aware, NOISE-CON 2019 is being held August 26–28 in San Diego, California. This should prove to be a very exciting event! Dana Lodico, the current vice president of honors and awards for INCE-USA and the student volunteer coordinator for the conference, writes to let readers know of some upcoming awards and honors.

This year, INCE-USA and the INCE Foundation are pleased to announce the following student awards:

Student Paper Competition

INCE-USA is pleased to announce a Student Paper Competition for NOISE-CON 2019, with up to five awards given to the most outstanding papers. The winners of the Student Paper Competition Awards will receive $500, plus an additional $500 award if they attend the NOISE-CON 2019 Awards Ceremony. If a winning paper is expanded and accepted after peer review for publication in the *Noise Control Engineering Journal*, the student will receive an additional $500 award.

"Classic Papers in Noise Control Engineering" Competition

INCE-USA is sponsoring a special session of seminal noise control papers open to students, "Classic Papers in Noise Control Engineering," for NOISE-CON 2019. Students will present on one of the classic papers listed in the entry form. An award will be given based on the student's presentation itself. The abstract should focus on the main thrust of the original paper and the focus of the presentation, which could also include additional work that has been done by the student presenter. The additional work could include reproduction of the results in the original paper, additional analysis, or influence of the original paper on subsequent research or noise control practice, and so on. A winner, as determined by the INCE-USA judging panel, will receive $1,000 if she or he attends the NOISE-CON 2019 Awards Ceremony.

Michiko So Finegold Award for Graduate Student/Young Professional Travel

For the sixth year, INCE-USA is pleased to offer the Michiko So Finegold Award, supporting US graduate students and young professionals traveling to NOISE-CON 2019 to present their work on noise effects, development of noise policy, and related aspects of noise control engineering. Qualified graduate students/young professionals need to apply using the form available here. Applications will be processed as received, **but must be submitted by July 25, 2019**. This award is funded by the INCE Foundation through an endowment from the Michiko So Finegold Memorial Trust.

Hallberg Foundation Award for Student Travel

For the third year, INCE-USA is pleased to be able to offer the Hallberg Foundation Award, supporting North American undergraduate or graduate students traveling to NOISE-CON 2019 to present their work in any areas of noise control engineering. Multiple awards will be offered. As with the Michiko So Finegold Award, qualified students need to apply using the form available here, and applications will be processed as received, **but must be submitted by July 25, 2019**. This award is funded by the INCE Foundation through an endowment from the Elizabeth L. and Russell F. Hallberg Foundation.

Further Information

More details about awards and their submission dates are available on the NOISE-CON 2019 website.

If you have further questions, or would like to request a nomination form, please reach out to vp_awards@inceusa.org.

Seeking Student Volunteers

We are also looking for student volunteers to provide back up support to the organizers and technical session chairs. Students will receive free registration in exchange for volunteer efforts. Occasionally, we have been able to obtain reduced rate hotel rooms as well. Past volunteer responsibilities have included assisting in technical sessions, registration, and/or paper upload room. Sessions will be assigned to match the student's interests and availability (to present papers, etc.). If you know of any student(s) who might be interested in this opportunity, please forward this to them and have them contact vp_awards@inceusa.org.

Thank you, and I hope to see you all in San Diego!

Summary of Transportation Noise and Public Health Outcomes: Biological Markers and Pathologies

As the world's population increases, so too do our urban environments and transportation. While the growth of transportation may be necessary to accommodate a growing population, increasing levels of transportation cause increasing levels of noise pollution, particularly within urban environments, and there exists an extensive body of literature that empirically demonstrates how transportation noise can cause negative health impacts. Based on such research, the World Health Organization recommends that the general population should not be exposed to road traffic noise greater than 53 dBs (annual average), and 40 dBs at night; for railway emission, noise greater than 54 dB (annual average), and 44 dB at night; and for aircraft emission noise greater than 45 dBs (annual average), and 40 dBs at night. In terms of severity, research indicates that aircraft noise produces the most harmful effects, followed by road traffic noise, railway noise, and industrial noise. However, due to its prevalence, road traffic noise affects the majority of exposed populations. Approximately half the population of the European Union is estimated to be exposed to road traffic noise considered to have negative impacts on health and well-being. More generally, approximately 65 million people in Europe are believed to be exposed to levels of noise exceeding recommended levels. As populations increase, exposure level is likewise expected to increase. Such populations are at a high risk of developing serious conditions related to morbidity and mortality.

The link between transportation noise and annoyance, sleep disturbance, and related health impacts such as cardiovascular disease, hypertension, and tinnitus is now well established. However, emerging literature also indicates a link with breast and colorectal cancer; diabetes and obesity; fertility; and fetal, infant, and child development. Exposed populations are at risk of experiencing sleep disturbance, which in turn results in an increased risk of serious health outcomes. In the context of breast cancer, recent studies have indicated that sleep disturbance inhibits the production of melatonin, which potentially reduces breast carcinogenesis, therefore increasing the risk of developing breast cancer. In the context of obesity and diabetes, sleep disturbance also lowers leptin hormone levels, while increasing ghrelin hormone levels, which can lead to risks of obesity and diabetes. In the context of childhood development, it has also been found that sleep disturbance among children negatively impacts physical growth and cognitive development. This is because children need a continuous recuperative sleep cycle in order to fully develop. In addition to sleep disturbance, populations exposed to excessive levels of transportation noise experience increased levels of stress and stress-related annoyance. In the context of breast cancer, increased stress can induce an overproduction of glucocorticoid cortisol, thereby increasing the risk of breast cancer. While in the context of fertility, stress has been shown to potentially reduce the production of semen in males.

From the extensive empirical literature linking exposure to excessive levels of transportation noise, it can be concluded that increasing global populations will inevitably result in increasing levels of population exposure, thereby emphasizing the need for noise reduction measures to be implemented in problem areas since noise is no longer considered as merely an irritant but has been empirically associated with considerably high risks associated with morbidity and mortality.

Editor's Note

This is a summary of work presented in Murphy E., and J. P. Faulkner. 2018. "Transportation Noise and Public Health Outcomes: Biological Markers and Pathologies." *Proceedings of INTER-NOISE 2018*, Chicago, IL, USA.

Vibration Transmission and Isolation—Some Lesser-Known Facts

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Abstract

Vibration transmission and its reduction—that is, vibration isolation—play important roles in practice. It is pointed out that force transmissibility and motion transmissibility obey the same relation, not only for simple systems, but also for complex linear systems. The phenomena that cause mass, stiffness, and damping to affect transmissibility differently in different frequency domains are discussed. It is noted that vibration reductions provided by added masses (inertia bases) may be compromised by the practical limitations of the isolators supporting these masses. The magnitude of the vibrations transmitted to the support of a resiliently supported machine with a rotating imbalance is shown to be virtually independent of the machine's rotational speed. The principle of reciprocity—the fact that the force-to-response ratio remains the same if the excitation and response measurement points of an elastic structure are interchanged—is delineated and discussed.

1. Introduction

Practitioners in the areas of noise and vibration control typically are familiar with the concepts of vibration isolation, particularly as characterized in terms of transmissibility. This article discusses several less well-known aspects of vibration transmission and isolation, which often are helpful in addressing real-world problems. Since the intent here is to provide practical insights, the discussions focus on simple configurations and rely on only a minimum of mathematics.

2. Force and Motion Transmissibilities

Almost every vibration textbook discusses vibration isolation in terms of a mass-spring-damper system represented by a diagram like that of figure 1 or figure 2. It shows a mass m supported on rigid support (represented by a heavy line) via a parallel arrangement of a spring with stiffness k and damper with viscous damping coefficient c. A sinusoidal force $F\cos(\omega t)$ at radian frequency ω is taken to act on the mass. The resulting motion of the mass compresses the spring and the damper, causing these elements to exert forces on the support, the sum of which makes up the total force $F_T\cos(\omega t + \phi)$ transmitted to the support. The present discussion is concerned only with the magnitudes of the applied and transmitted forces: thus, the phase angle ϕ is not of interest here.

The ratio of the magnitude of the applied force to that of the transmitted force is called "force transmissibility"; it is defined as

$$T_F = F/F_T \tag{1}$$

and may be shown to obey[1]

$$T_F = \sqrt{\frac{1+\eta^2}{\left[1-\left(\omega/\omega_n\right)^2\right]^2+\eta^2}} \tag{2}$$

where $\omega_n = 2\pi f_n = \sqrt{k/m}$ denotes the radian natural frequency of the system, with f_n representing its cyclic natural frequency. The driving frequencies are similarly related and given by $\omega = 2\pi f$.

The symbol η denotes the system's loss factor. For idealized structural damping the loss factor is independent of frequency; for viscous damping—the situation covered in most textbooks—the η in the foregoing equation is replaced by $c\omega/k = 2\zeta\omega/\omega_n$. (The second form of this relation is written in terms of ζ, the ratio of the viscous damping coefficient c *to* the critical viscous damping coefficient $c_c = 2\sqrt{km}$.)

Note that for the case where the driving frequency is considerably greater than the natural frequency and damping is small, the foregoing equation reduces to

$$T_V \approx X/X_T. \tag{2a}$$

Now, instead of dealing with an applied force, consider the case where the support of a mass-spring-damper system vibrates with a displacement $X\cos(\omega t)$, causing the mass to move with a displacement $X_T\cos(\omega t + \varphi)$, as shown schematically in figure 2. The ratio of the magnitude of the base motion to that of the motion transmitted to the mass is called "motion transmissibility"; it is defined as

$$T_V \approx X/X_T. \tag{3}$$

Although the motion transmissibility here has been stated in terms of displacements, it may equally well be expressed in terms of velocity or acceleration.

It turns out that the expression for the motion transmissibility is the same as that for the force transmissibility, as given by equation (2). This equality of the force and motion transmissibilities, as discussed

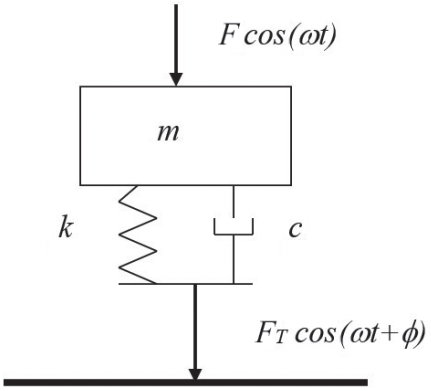


Figure 1. Force transmissibility

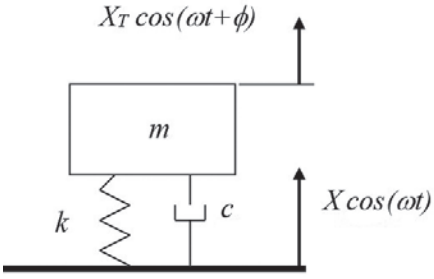


Figure 2. Motion transmissibility

for the single-degree-of-freedom system of figures 1 and 2, holds not only for such simple systems, but also for any mathematically linear system, regardless of its number of degrees of freedom.[2]

3. How a Mass, Spring, and Damper Contribute to Transmissibility

Figure 3 shows how transmissibility varies with frequency for several values of structural and viscous damping, as found from equation 2.

At frequencies well below the natural frequency the transmissibility may be noted to be only slightly greater than 1. Regarding force transmissibility (see fig. 1), this implies that the force F_T that is transmitted to the foundation is essentially equal to the force F that is applied to the mass. Regarding motion transmissibility (see fig. 2), this implies that the displacement X_T transmitted to the mass is essentially equal to the displacement X of the foundation. At these low frequencies, the inertia of the mass plays no significant role, so that an externally applied force applied to the mass is undiminished as it is transmitted to the spring, and this ideally mass-less spring transmits the force that is applied to it. Similarly, a motion of the foundation is transmitted undiminished to the mass, because the mass's small inertia produces no appreciable deflection of the spring.

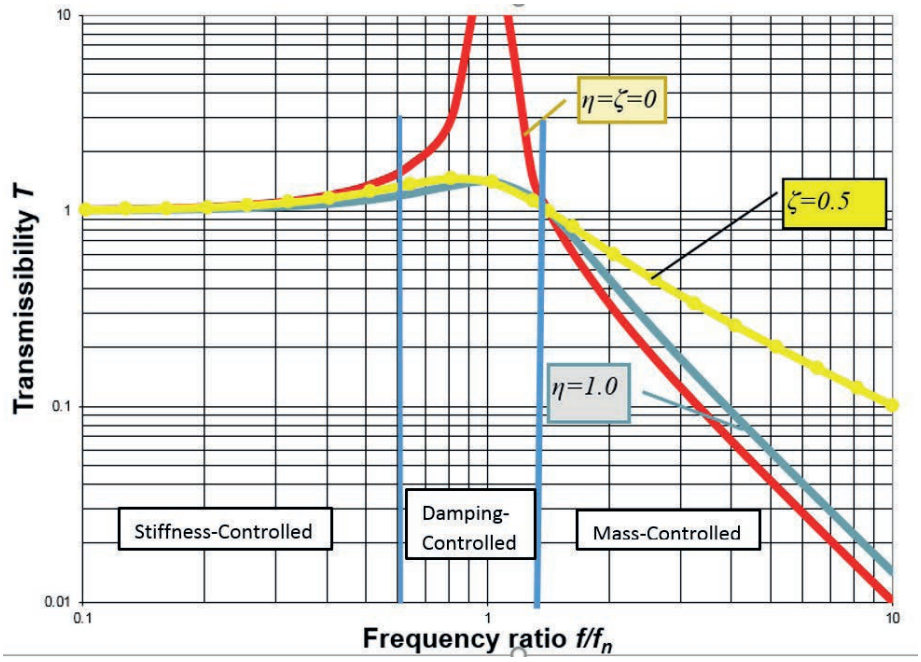


Figure 3. Transmissibility regions

In contrast, at frequencies that are considerably higher than the system's natural frequency the inertia of the mass plays a predominant role. Since the inertia effect increases with increasing speed of the mass's motion, the motion-opposing effect of the mass increases with increasing frequency, thus resulting in lesser transmission of forces and displacements at higher frequencies.

At frequencies near the system's natural frequency the spring-force and the mass's inertia force in effect cancel each other, so that motion is controlled by damping. In this regime the energy that is supplied to the system per cycle by an external force or motion is equal to the energy dissipated by the system (i.e., by the damper) per cycle—and since greater damping limits the motion more severely, greater damping results in smaller transmissibility.

A damper that is connected between the foundation and the mass (in parallel with the spring) also transmits forces and motions between the two. A damper's effect is small at low frequencies because the relative motions of its ends here are small, but its effect can be significant at high frequencies, particularly for viscous dampers that generate forces proportional to the velocity difference across them. Note that in figure 3 the red curve corresponds to zero damping, whereas the yellow curve corresponds to a viscous damper with the rather high damping ratio of 0.5. The yellow curve indicates that this viscous damper results in transmissibility values that are considerably greater than those for zero damping. The blue curve, which corresponds to the high structural loss factor value of 1.0, may be noted to deviate only slightly from the curve for zero damping, even though its transmissibility peak value (at essentially the natural frequency of the system) is

equal to that of the yellow curve. This more benign behavior of a damper with structural damping is due to the damper's force being proportional to its displacement, rather than to its velocity.

4. Effects of Inertia Bases

We often hear, "Add an inertia base to improve isolation." Is this a good recommendation? Clearly, an added inertia base in effect increases the mass *m* and thus results in reducing the natural frequency $f_n = 2\pi\sqrt{k/m}$ of a mass-spring system, with the consequence of reducing the transmissibility (improving the isolation) at excitation frequencies that are greater than the natural frequency ($f > f_n$). The tacit assumption in the foregoing statement is that the spring stiffness remains unchanged. However, practical limitations on the carrying capacity of practical resilient elements (springs or pads) may lead to the use of more or stiffer elements, partially negating the natural frequency reduction and the isolation improvement due to the added inertia base.

As noted before, in the aforementioned high-frequency range ($f > f_n$) the inertia force of the mass is much greater than the forces produced by the other elements of the system, so that the displacement amplitude of the mass in essense obeys $X \approx F/m\omega^2$. Thus, additon of an inertia base (i.e., an increase in the mass) may be expected here to result in reduced excursion of the mass due to a given magnitude of applied force, unless the effective stiffnes of the resilient elements is increased to such a great extent that the system's natural frequency is no longer below the excitation frequency.

5. Isolation of Machine with Rotating Unbalance

Here is another often-heard statement: "Running a machine faster reduces transmitted vibrations." Is this correct? It is true that higher rotation speeds result in increased f/f_n and thus in reduced transmissibility if the machine's isolation is sufficiently resilient. But that is not the whole story.

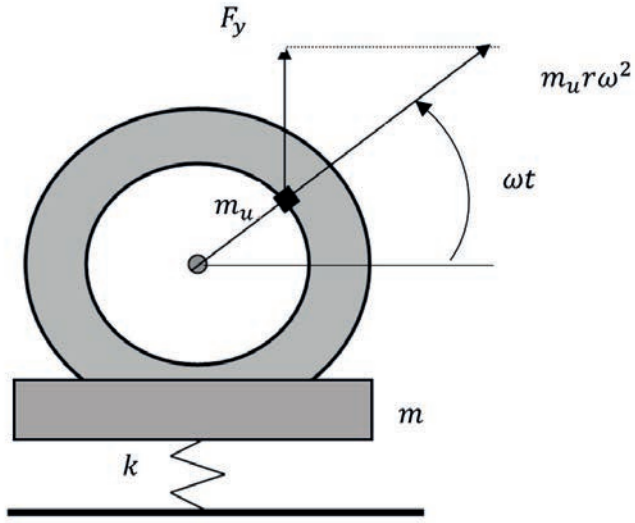


Figure 4. Machine with rotating unbalance

Consider an isolated machine of mass *m* with a rotor that has an unbalanced mass m_u at a radius *r*, as sketched in figure 4. If the rotor spins at an angular velocity of ω radians per second (=2π rpm/60), this rotating unbalance produces a centrifugal force of magnitude $m_u r\omega^2$. The vertical component of this force then is $F_v = m_u r\omega^2 \sin(\omega t)$, and the magnitude of the vertical force transmitted to the support is given by $F_T = m_u r\omega^2 T_F$. With the force transmissibility from equation 2a (for $\omega >> \omega_n$ (and negligible damping) given by $F_T \approx \left(\omega_n/\omega\right)^2$ the transmitted force becomes

$$F_T \approx m_u r\omega_n^2 = krm_u/m \qquad (4)$$

Which is independent of the rotational speed.

Not only is this force independent of the rotational speed, but the displacement amplitude of the machine's vibration produced by a rotating unbalance here by $X = rm_u/m$ and also does not depend on the rotational speed. This relation indicates that if one knows the mass of the machine, one may deduce the magnitude of the imbalance rm_u of a machine mounted on resilient supports by measuring its vibration amplitude. This is the reason that the unbalance specifications of machines are often stated in terms of limits on the vibration amplitudes.

6. Reciprocity

The principle of reciprocity, which applies to any mathematically linear system, in essence states that interchanging the force application and response observation points does not change the force-to-response ratio.

For a more precise description, let us refer to figure 5, in which the extended rectangle represents a general elastic structure.

Consider first that a force F_A is applied to the structure at a given point in a given direction and that a resulting velocity V_A is measured at another given point in another given direction. (The corresponding force and velocity symbols are shown in frames in the figure.) Then consider that a force F_B is applied at the location where V_A was measured and in the direction in which V_A was measured and that there results the velocity V_B at the point where the force F_A was applied and in the direction in which that force acted. (The symbols corresponding to this second case are shown without frames.) Then, according to the reciprocity principle, $V_A/F_A = V_B/F_B$.

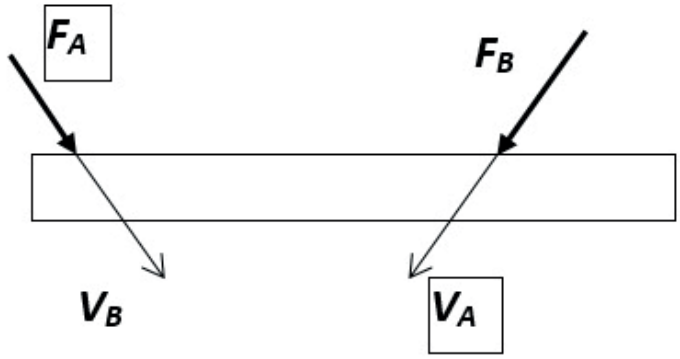


Figure 5. Reciprocity

Reciprocity often can be useful for analytical or experimental work, where one or the other of the variables may be difficult or cumbersome to measure or compute. For example, if one wants to determine the relation between a force acting in the interior of a machine structure (perhaps on an engine's cylinder) and the vibrations it produces at a location on the exterior of that structure, it is rather difficult to apply a controlled force in the interior. It may be much easier to apply the force to the exterior and measure the interior vibrations (perhaps by means of a small accelerometer).

7. Concluding Remarks

A thorough understanding of the underlying background of the widely used vibration isolation relations should enable practitioners dealing with the reduction of vibration and the attendant noise to make better-informed judgments concerning the effects of changes in a system's parameters. It should also facilitate appropriate consideration of the effects of inertia bases and of rotating unbalance.

Consideration of the equality of motion and force transmissibilities may allow one in some situations to replace a given problem by one that can be addressed more readily. Similarly, application of the reciprocity principle may permit one in some practical cases to replace an experiment or analysis by a less burdensome alternative.

1. For example, see W. T. Thomson, *Theory of Vibration with Applications* (New York: Prentice-Hall, 1981).

2. Y. E. Large, M. M. Neve, N. M. M. Maia, and D. Tchernick, "Force Transmissibility versus Displacement Transmissibility," *Journal of Sound and Vibration* 333 (2014): 5706–22.

Calling All Young Professionals! INTER-NOISE 2019 Grants and Activities

Interesting in attending INTER-NOISE 2019 in Madrid? Have a look through several of the grant opportunities and activities for young professionals on offer. For full details please visit the conference website here.

Spanish Acoustical Society (SEA) Travel Grants for Young Acousticians

The goal of this program is to support young acousticians (YA)—undergraduate or postgraduate students, postdoctoral, or young noise control engineers working in industry, from Spain or Portugal, in attending the 49th International Congress on Noise Control Engineering, **INTER-NOISE 2019**, to be held in Madrid, June 16–19, 2019. SEA offers six YA travel grants of €500 each. The YA travel grant includes the payment of registration fees for the congress and the remainder amount (€500 less registration fees) will be available at the congress secretariat. See the SEA website for conditions of these travels grants.

I-INCE Practice of Noise Control School for Young Professionals

Sunday, June 16, 11:00–16:00 (times subject to change)
(by invitation only)

Four case studies will be presented on successful applications of noise control. Presenters are practitioners of noise control with long histories of working on noise problems. This is an opportunity to learn about practical application of theory and also to learn about the careers of the presenters. The presenters will have worked in different areas of noise control. For example, in 2018, the Practice of Noise Control School included presentations on environmental and community noise, appliance noise control, automotive noise control, and active noise control and the presenters had worked as consultants, in large companies, and small companies, and some had started their own businesses. Lunch is included in the workshop, and this will be an opportunity for attendees to have more interactions with practicing noise control engineers.

I-INCE Young Professional Workshop

Monday, afternoon, June 17

The goals of the Young Professional Workshop are to provide mentorship and advice to young professionals and to give them opportunities to talk to I-INCE leaders and practicing noise control engineers. Once the winners of the Young Professionals Grant have been determined, all the participants are invited to this workshop to gain valuable contacts and view presentations by noise control professionals. The invitation is also extended to most students who register for the congress.

The program will be posted when finalized. In the past it has included presentations on professional networking, preparing to start a new job in industry or academia, making technical presentations, and writing journal articles.

Welcome to INTER-NOISE 2019 MADRID

MADRID
inter.noise 2019
June 16 - 19
NOISE CONTROL FOR A BETTER ENVIRONMENT

The **Spanish Acoustical Society (SEA)** on behalf of the **International Institute of Noise Control Engineering (I-INCE)** is organizing **INTER-NOISE 2019** in Madrid. It will be held from **June 16–19, 2019,** at the **IFEMA Palacio Municipal de Madrid**.

The congress will be attended by more than 1,000 experts from 60 countries, and along with 107 technical sessions, 1,000 papers will be presented in 16 parallel rooms.

The **MAIN TOPICS** of the congress are as follows:

1. Acoustic Materials
2. Active Control of Sound and Vibration
3. Aircraft Noise
4. Architectural and Building Acoustics
5. Environmental Noise
6. Flow Induced Noise and Vibration
7. Industrial Noise
8. Noise and Health
9. Psychoacoustics
10. Railroad and Road Vehicle Noise
11. Signal Processing
12. Sound Quality and Product Noise
13. Soundscape
14. Underwater and Maritime Acoustics
15. Vehicle Noise and Vibration
16. Vibroacoustics
17. Other

The following **plenary lectures** will be presented by worldwide recognized experts:

Opening Lecture: "Rolling Noise in Road and Rail Transportation Systems"
Ines Lopez Arteaga
Mechanical Engineering Department at Eindhoven University of Technology (the Netherlands) and at the Marcus Wallenberg Laboratory for Sound and Vibration Research (MWL), KTH Royal Institute of Technology (Sweden)

Plenary Lecture: "To Infinity and Beyond: The Amazing Uses of Infinite Structure Mobility Theory"
Stephen A. Hambric
Penn State's Center for Acoustics and Vibration (CAV) (USA)

Plenary Lecture: "Zone Reproduction Using Loudspeaker Array"
Jun Yang
Key Laboratory of Noise and Vibration Research at CAS (China)

I-INCE Plenary Lecture: "The Perception of Acoustic Environments and How Humans Form Overall Noise Assessments"
Andrè Fiebig
HEAD acoustics GmbH

During the congress the following **activities** will be held:

- I-INCE Board meetings
- Congress Selection Committee Meeting
- I-INCE General Assembly
- FTCP meetings
- Young Professionals Workshop and Social Networking
- I-INCE Practice of Noise Control School

In parallel with the congress, a **technical exhibition** with more than 50 exhibitors will present the latest product developments in the different fields of noise control.

The **social activities** will include three tapas-cocktails and the performance of a Spanish classical ballet with the occasion of the **50th anniversary of the Spanish Acoustical Society**. Accompanying persons will have an interesting program with guided tours to old and new Madrid, including a visit to the Prado Museum and the Thyssen-Bornemisza Museum.

The congress venue, IFEMA Palacio Municipal, is a modern building with excellent connections by the metro with the airport and the city.

INTER-NOISE 2019 MADRID will be an excellent occasion to learn about the latest technologies on noise control and to enjoy the city of Madrid, a fascinating destination with many leisure and cultural options, including large numbers of bars, cafés, restaurants, and markets where you can taste much of the Spain's gastronomy. Finally, please do not miss the Madrid nightlife, the world-renowned *movida* ("Madrid movement").

More information can be found on the congress website: www.internoise2019.org.

Important Dates

Early registration deadline: **April 15, 2019**
Standard registration deadline:
May 31, 2019
On-site registration from **June 16, 2019**

Language

The official language of the congress is English.

About Madrid

Medieval Madrid
Magerit: "land rich in water." This is what the Arabs called this area on the central plain of the Iberian Peninsula, close to Sierra de Guadarrama, where King Phillip II of Spain would establish the royal court. Later, it grew into the city that it is today.

Madrid and the Hapsburg Monarchy
Throughout the sixteenth and seventeenth centuries, Madrid was the capital of a huge empire. However, the buildings and landmarks didn't truly reflect the city's standing. The churches and palaces were built in a simple style that had little in common with ostentatious courts elsewhere in Europe. *Austerity* was the second name of the Hapsburg dynasty (or *Austrias*, as they were called in Spanish).

Madrid and the Bourbon Kings
From Philip V (1701), the first Bourbon, a comprehensive urban development plan was developed to adapt Madrid to the taste of European royal courts. The Bourbons built fountains, gardens, triumphal arches, and the new Royal Palace, all of which helped change the appearance of the city.

Modern Madrid: *La Movida*
In the early 1980s, the Malasaña district witnessed the birth of the *movida madrileña*, the underground movement that changed Madrid's image forever.

The Prado Museum, 1819–2019: The Bicentenary of the Museo del Prado
https://www.museodelprado.es/en
https://www.esmadrid.com/en/tourist-information/museo-del-prado

"A place of memory"

The Museo del Prado opened to the public on November 19, 1819, as a Royal Museum of Painting and Sculpture. In 2019, it celebrates its bicentenary, a commemoration that will reveal the path covered since 1819 until today.

The Prado Museum is the crown jewel of one of the capital's most visited tourist itineraries: the Paseo del Arte (Art Walk). Its walls are lined with masterpieces from the Spanish, Italian, and Flemish schools, including Velázquez's *Las Meninas* and Goya's *Third of May, 1808*. Its collection comprises 8,600 paintings and over 700 sculptures, so we recommend you decide what you want to see before stepping into the museum.

Thyssen-Bornemisza National Museum
https://www.museothyssen.org/en
https://www.esmadrid.com/en/tourist-information/thyssen-bornemisza-national-museum

Fachada Palacio de Villahermosa
Foto: Hélène Desplechin

Located on the Art Walk, this museum's collection traces the history of European painting from the Middle Ages through to the late twentieth century.

Given the wealth and variety of its treasures—more than a thousand works of art—you should start your visit in the section that most interests you. Italian primitives, the German Renaissance, nineteenth-century American art, Impressionism, German Expressionism, and Russian Constructivism are the most widely represented schools and movements in the museum.

Reina Sofía Museum
https://www.museoreinasofia.es/
https://www.esmadrid.com/en/tourist-information/museo-reina-sofia-mncars

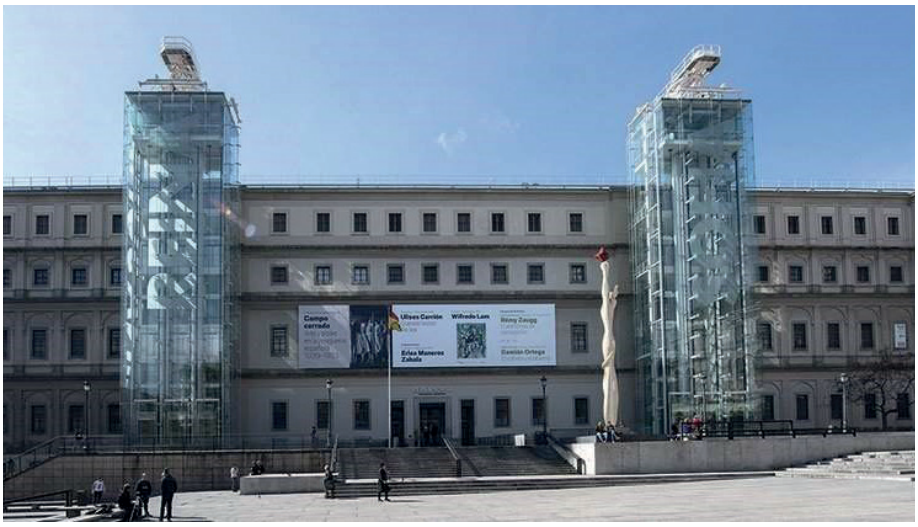
Located on the Art Walk, the Reina Sofía houses works by Dalí, Miró, and Juan Gris as well as Picasso's masterpiece, *Guernica*.

The Royal Palace
https://www.esmadrid.com/en/tourist-information/royal-palace

Home to the Kings of Spain from Charles III to Alfonso XIII, Madrid's Royal Palace takes us on a journey through the history of Spain. Though it is no longer the royal family's home, it continues to be their official residence.

The construction of the palace that stands today was ordered by the King Philip V after a fire burnt the Palace of Austrias, a fourteenth-century fortress, in 1734.

It comprises over 3,000 rooms, including the **Main Staircase**, designed by Sabatini with over 70 steps; the **Throne Hall**, featuring a ceiling painted by **Tiepolo**; the **Hall of Halberdiers**, which Charles III turned into the Guards Room; the **Gasparini Room**, with its grand eighteenth-century decoration on a floral theme; the **Royal Chemist's**, with natural



medicine cabinets, ceramic pots made by **the La Granja factory**, and even prescriptions given to members of the royal family; and the **Royal Chapel**, which is home to a collection of string instruments made by the legendary Antonio **Stradivari**.

The **Royal Armoury** is one of the most significant collections of its kind, housing weapons and armor worn by the kings of Spain and other members of the royal family since the thirteenth century.

The **Painting Gallery** is home to a large number of artistic treasures, including *Virgin with Child*, by Luis Morales; *Portrait of Isabella the Catholic*, by Juan de Flandes; *Salome with the Head of John the Baptist*, by Caravaggio; and works by such artists as Velázquez, Goya, Federico Madrazo, and Sorolla.

The **Royal Kitchen** reopened in October 2017 after a major renovation: the palace's splendid "*Real Cocina*" are the oldest well-preserved kitchens of a European royal residence, notable for their size and the excellent state of their accessories.

Santiago Bernabéu Stadium
https://www.realmadrid.com/en/santiago-bernabeu-stadium
https://www.esmadrid.com/en/tourist-information/santiago-bernabeu-stadium

Real Madrid is one of our city's five professional football teams. Holder of multiple European and international titles, the club opens its doors 363 days a year for football and sports fans to explore its historic stadium, an absolute must on your trip to Madrid.

Named after the legendary club president who headed Real Madrid between 1943 and 1978, the Santiago Bernabéu stadium was opened in 1947. It has a capacity for 81,044, with 245 VIP boxes and four restaurants.

The Bernabéu tour takes visitors around the club's most iconic spots and explores the history of Real Madrid in the Trophies Exhibition.

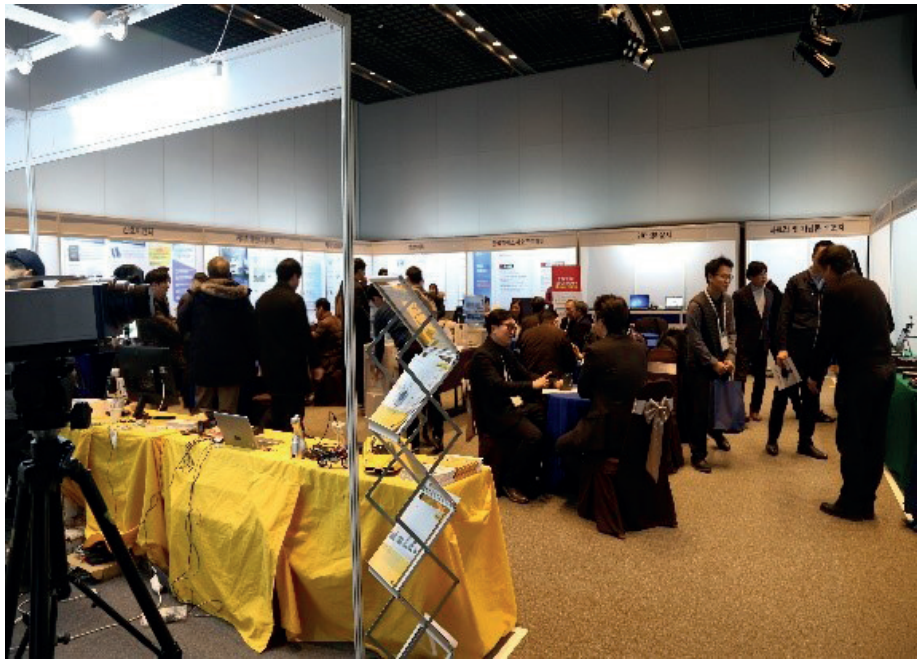
Regional News

Asia Pacific News

The Korean Society for Noise and Vibration Engineering (KSNVE) Annual Spring Conference 2019

The Annual Spring Conference of the Korean Society of Noise and Vibration Engineering (president: Hong Jae Yim) was held February 20–22, 2019, at the Phoenix, Pyeongchang.

Under the conference theme of "Noise and Vibration in Sensibility," more than 212 papers were presented along with 1 invited special lecture, 1 tutorial, and the Hyundai Motor Company session. The conference was attended by more than 550 participants, with 28 corporate exhibitors, while the dynamic winter sports (ski, snowboard) added to the excitement.



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2019 International Congress on Noise Control
Madrid, Spain
http://internoise2019.org/

August 25–28, 2019
NOISE-CON 2019
San Diego, CA, USA
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