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Canadian Acoustics is published four times a year - in March, June, September and December. This quarterly journal is free to individual members of the Canadian Acoustical Association (CAA) and institutional subscribers. Canadian Acoustics publishes refereed articles and news items on all aspects of acoustics and vibration. It also includes information on research, reviews, news, employment, new products, activities, discussions, etc. Papers reporting new results and applications, as well as review or tutorial papers and shorter research notes are welcomed, in English or in French.The Canadian Acoustical Association selected Paypal as its preferred system for the online payment of your subscription fees. Paypal supports a wide range of payment methods (Visa, Mastercard, Amex, Bank account, etc.) and does not requires you to have already an account with them. If you still want to proceed with a manual payment of your subscription fee, please use the application form from the CAA website and send it along with your cheque or money order to the secretary of the Association (see address above). - Canadian Acoustical Association/Association Canadienne d'Acoustique P.B. 74068 Ottawa, Ontario K1M 2H9 Canada - - - secretary@caa-aca.ca - Dr. Roberto Racca

L'Acoustique Canadienne publie des articles arbitrés et des informations sur tous les aspects de l'acoustique et des vibrations. Les informations portent sur la recherche, les ouvrages sous forme de revues, les nouvelles, l'emploi, les nouveaux produits, les activités, etc. Des articles concernant des résultats inédits ou des applications ainsi que les articles de synthèse ou d'initiation, en français ou en anglais, sont les bienvenus.

Acoustique canadienne est publié quantre fois par an, en mars, juin, septembre et décembre. Cette revue trimestrielle est envoyée gratuitement aux membres individuels de l'Association canadienne d'acoustique (ACA) et aux abonnés institutionnels. L'Acoustique canadienne publie des articles arbitrés et des rubriques sur tous les aspects de l'acoustique et des vibrations. Ceci comprend la recherche, les recensions des travaux, les nouvelles, les offres d'emploi, les nouveaux produits, les activités, etc. Les articles concernant les résultats inédits ou les applications de l'acoustique ainsi que les articles de synthèse, les tutoriels et les exposées techniques, en français ou en anglais, sont les bienvenus.L'Association canadienne d'acoustique a sélectionné Paypal comme solution pratique pour le paiement en ligne de vos frais d'abonnement. Paypal prend en charge un large éventail de méthodes de paiement (Visa, Mastercard, Amex, compte bancaire, etc) et ne nécessite pas que vous ayez déjà un compte avec eux. Si vous désirez procéder à un paiement par chèque de votre abonnement, merci d'utiliser le formulaire d'adhésion du site de l'ACA et de retourner ce dernier avec votre chèque ou mandat au secrétaire de l'association (voir adresse ci-dessus). - Canadian Acoustical Association/Association Canadienne d'Acoustique P.B. 74068 Ottawa, Ontario K1M 2H9 Canada - - - secretary@caa-aca.ca - Dr. Roberto Racca

Éditorial invité
Guest Editorial


Édition spéciale : Acoustique canadienne des villes

C'est avec grand plaisir que nous vous présentons le numéro spécial sur les activités régionales dans le domaine de l'acoustique et des vibrations dans la région du Grand Toronto (GTA). Ceci est le deuxième numéro spécial, après celui publié l'an dernier pour la région de Montréal. Le domaine de l'acoustique est un large sujet qui emploie des centaines de spécialistes au pays dans divers domaines tels que l'enseignement, la recherche, la consultation, l'industrie, et bien d'autres. La Revue "Canadian Acoustics Journal" a commencé cette série de numéros spéciaux «régionaux» pour tenir compte de cette diversité de domaine d'activité et pour aider ses membres à découvrir de nouveaux professionnels dans leur région, Cette série de numéros donne l'occasion aux particuliers, aux groupes et aux entreprises situées dans les grande zone métropolitaine du Canada d'avoir une vitrine pour présenter leurs domaines de spécialisation.

Une lecture des articles présentés dans ce numéro spécial par des équipes ou des individus provenant du domaine de la recherche, des laboratoires, des universités, des sociétés de conseil ainsi que des secteurs industriels donne une indication de la quantité énorme de travail acoustique menée dans la GTA. Les outils de diagnostique et équipement relatif aux questions de santé et de sécurité liées au bruit, les évaluations d'énergie renouvelable en usine ou la construction de produits d'isolation

Special Issue: Canadian Acoustics Cities

It is with great pleasure that we are presenting the special issue about regional activities in acoustics and vibrations in the Greater Toronto Area (GTA). This is the second special issue, after the one published last year for Montreal. Acoustics is a broad subject matter that employs hundreds of specialists across the country in diverse fields such as teaching, research, consulting, industry, and others. To reflect such a diversity and to help each of us discover new professionals in the neighborhood, the Canadian Acoustics Journal started the current series of special “regional” journal issues to give an opportunity to individuals, groups and companies located within the greater areas of major cities in Canada to show case their chosen areas of specialty.

A cursory perusal of the articles presented in this special issue by teams and individuals from research, laboratories, academia, consulting companies, and industrial sectors, would indicate the tremendous amount of acoustical work conducted in the GTA. Diagnostic tools and equipment for health and safety sound related issues, renewable energy factory assessments or building sound insulation products are some of the areas you will find reviewed in this special issue. On the other hand, the effervescent activity is also palpable in the consulting sector. There are papers about architectural acoustics, human activity noise

acoustique sont quelques-uns des domaines que sont discutés dans ce numéro spécial. L'activité effervescente est également palpable dans le secteur du conseil. Vous trouverez dans ce numéro des articles sur les activités liées à l'acoustique architecturale, contrôle du bruit de l'activité humaine, les parcs éoliens ainsi que d'autres sujets intéressants. Cognition musicale, bio-acoustique, impacts physiologique du bruit sont des sujets également abordés dans la région du GTA. Il est important de mentionner que la plupart des sociétés de conseil locales ont signalé des projets entrepris à l'étranger, un expertise locale que nous avons tendance à négliger.

Il nous faut souligner que seule une partie des acousticiens de la région du GTA sont couverts dans ce numéro spécial et nous espérons que les acousticiens passés sous silence pourront soumettre des articles à la revue de manière à être reconnue par la communauté acousticienne du Canada. Nous vous souhaitons une agréable lecture, avec l'espoir que cet inventaire vous sera utile dans les années à venir.

Nous aimerions remercier M. Mathieu Cardinal de Aiolos Engineering pour la traduction en français de nombreux résumés et de cet éditorial.

Umberto Berardi et Ramani Ramakrishnan
Rédacteur invité

control, wind farms as well as other interesting topics. Music cognition, physiological and psychological impacts of noise on humans, and bio-acoustics, are tackled in the GTA. It is important to mention that many of the local consulting companies have reported projects undertaken overseas, a local expertise we often neglect.

Only a portion of the GTA acousticians are covered in this special issue and we hope the ones missing from the issue would submit articles to the journal so as to be recognized by the acoustical community of Canada. We wish you a pleasant reading, with the hope that this inventory will be useful in the years to come!

We would like to acknowledge and thank Mr. Mathieu Cardinal of Aiolos Engineering for translating many abstracts and the editorial from English to French.

Umberto Berardi and Ramani Ramakrishnan
Guest Editor

SPECIAL ISSUE: CANADIAN ACOUSTICS CITIES

KINETICS NOISE CONTROL, INC. – MANUFACTURER OF NOISE CONTROL AND VIBRATION ISOLATION PRODUCTS

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Résumé

Fournir d'importante réduction de bruit pour les équipements de CVC extérieurs peut être difficile. Des méthodes simples pour le traitement, tels que des enveloppe acoustiques conçus de parois de masse peuvent fournir une certaine réduction du bruit, mais souvent n'apporter la réduction pression acoustique à des niveaux acceptables. Afin de fournir des niveaux de réduction de bruit important des enceintes acoustiques conçues sur mesure peuvent être mises en œuvre.

Mots-clés: contrôle du bruit, bruit ambiant, enceinte acoustique, persiennes acoustiques, silencieux

Abstract

Providing significant noise abatement for outdoor HVAC equipment can be challenging. Simple methods for treatment, such as mass-loaded acoustical wraps can provide some noise abatement, but often cannot bring the environmental sound pressure down to acceptable levels. To provide significant levels of noise abatement, custom acoustic enclosures can be designed and implemented.

Keywords: Noise control, environmental noise, acoustical enclosure, acoustical louver, silencer.

1 Introduction

Kinetics Noise Control, Inc. (Kinetics) has extensive experience in designing and manufacturing innovative products to control noise and vibration. Established in 1958 Kinetics continues to be an industry leader in eliminating unwanted noise and vibration.

Kinetics' manufacturing plant in Cambridge, Ontario, houses 60,000sqft of manufacturing space, and produces a wide range of noise control products for the light commercial to heavy industrial markets. Alongside with domestic manufacturing, the Cambridge office also offers custom engineered noise control solutions. These custom treatments can be engineered from standard components to keep cost at a minimum, or can be fully customized to offer maximum performance for the given restraints.

2 Product Line

The Cambridge manufacturing facility fabricates Kinetics' family of sheet metal products. The main noise control product produced is the silencer. The silencer attenuates noise along an airflow path via absorption of the sound wave, and comes in standard rectangular, circular or elbow configurations – or in virtually any other non-standard shape or arrangement (Figure 1).

Kinetics also offers acoustic louvers that are capable of providing noise reduction across a short length, and are suitable for building envelope applications (Figure 2).

The Kinetics NoiseBlock™ acoustic panel is a versatile product that can be adapted to form any shape of acoustic plenum, enclosure or barrier wall (Figure 3).

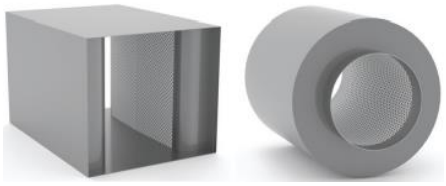

Figure 1: Kinetics Rectangular and Circular Silencer

Figure 2: Kinetics Acoustic Louvers

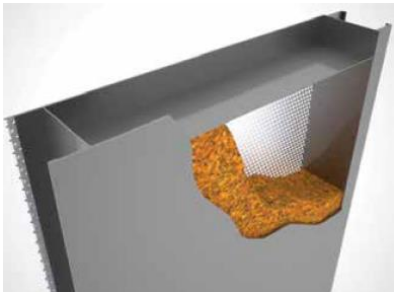

Figure 3: NoiseBlock™ Acoustic Panel

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With these three core noise control products a variety of custom solutions can be engineered to meet nearly any need.

3 Sample Project – Outdoor Air-Cooled Chiller

An outdoor air-cooled chiller was determined to be an environmental noise source. Within the chiller, the screw compressor generated middle and high frequency noise, and the up-blast fans generated low frequency noise. This produced a noise reduction need across the low to middle/high spectrum. The baseline sound pressure level of the installed chiller was measured to be 88 dBA at 10'. To mitigate this noise source a custom NoiseBlock™ enclosure was designed and engineered.

Figure 4: KNC Air-Cooled Chiller Enclosure

3.1 Design Aspects

Care must be taken when enclosing a piece of mechanical equipment. For the air-cooled chiller, a critical design aspect of the treatment was the aerodynamic condition placed on the unit. The air-cooled chiller required specific fresh air volumes, without a significant pressure drop increase across the up-blast fans. Also, maintenance access and structural loading had to be considered.

3.2 Treatment

The acoustic enclosure utilized three standard noise control products to create a fully customized solution. The majority of the enclosure comprised of NoiseBlock™ acoustic panels to provide the bulk of the absorption and transmission loss. To allow intake air flow, acoustic louvers were placed on the sides of the enclosure. These louvers allowed air to enter the enclosure, while still providing attenuation through the air passage. For the exhaust path, the enclosure had an open top with acoustic pergola baffles providing attenuation through the opening.

Figure 5: Interior of Enclosure and Pergola Baffles

3.3 Results

Before installation of the acoustic enclosure, the sound pressure level of the unit was measured to be 88 dBA, at a 10' distance.

After installation, the sound pressure level was measured to be 69 dBA, at a 10' distance.

The sound pressure spectrum on the pre and post-installation conditions can be seen in Figure 6.

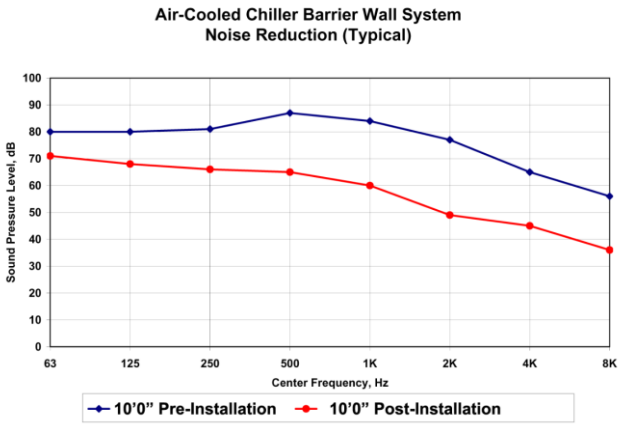

Figure 6: Sound pressure level measurement

The acoustic enclosure provided an overall noise reduction of 19 dBA, with an added pressure drop of only 0.1"wg placed on the unit up-blast fans.

AECOM – ACOUSTICS, NOISE, AND VIBRATION

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Abstract

AECOM is a worldwide provider of technical services with approximately 85,000 employees, with over 120 practitioners providing acoustics, noise and vibration services with expertise in architectural acoustics, environmental, transportation, and construction noise and vibration. With a wide range of skills and experiences, our practitioners handle projects and problems of various sizes and complexities. This paper is a summary of the services provided by AECOM's team of acoustics, noise and vibration practitioners located in the Greater Toronto Area.

Keywords: Acoustics, Noise, Vibration, Buildings, Environment, Transportation

Résumé

AECOM est un fournisseur mondial de services techniques comptant environ 85.000 employés, dont plus de 120 spécialistes fournissant des services dans le domaine de l'acoustique, du climat sonore et des vibrations dans les domaines de l'acoustique architecturale et environnementale, le transport, et le climat sonore (bruits) d'activités de construction et les vibrations. Fort d'un large éventail de compétences et d'expériences, nos spécialistes gèrent des projets et des problématiques de toutes envergures et complexités. Ce document est un résumé des services fournis par l'équipe de AECOM oeuvrant dans les domaines de l'acoustique, du bruit et des vibrations, dans la région du Toronto.

Mots clefs : Acoustique, bruit, vibrations, niveau sonore, climat sonore, Bâtiments, Environnement, Transports

1 Introduction

AECOM is a global network of professionals working with clients, communities and colleagues to develop and implement innovative solutions to the world's most complex challenges. The team of acoustics, noise and vibration practitioners located in the Greater Toronto Area (GTA) can draw on expertise in noise and vibration from other AECOM teams worldwide, as well as the combined resources of multi-disciplinary staff, to solve problems and accomplish project goals.

This acoustics team has an extensive background working with project teams and groups in many jurisdictions, with varying levels of experience and knowledge about acoustics, noise and vibration. We work with internal project teams within AECOM and with external clients including architects, the industrial sector, and large municipalities.

2 Services

AECOM's acoustics, noise and vibration team in the GTA has expertise in service areas such as:

- Facility environmental noise
- Transportation noise and vibration
- Architectural acoustics
- Mechanical noise and vibration
- Construction noise and vibration
- Building services equipment and footfall vibration

2.1 Facility Environmental Noise

In Ontario, environmental noise is regulated under Section 9 of the Environmental Protection Act, and implemented by the Ministry of the Environment and Climate Change primarily through environmental compliance approvals. Depending on the situation, different approaches to the assessment of facility noise is required. For example, on projects undergoing Environmental Assessments (EA), local noise level limit requirements are applicable, however the expected change in noise level from the existing conditions and the perception of the noise level change is critical.

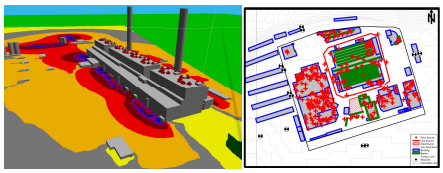

Figure 1: Environmental noise models

AECOM's local team in the GTA has experience working with a wide variety of clients and facility types, from small, family-operated woodworking shops, to large private and public sector clients such as mining/quarry operations, wind power and coal-fired power plants. Experience in investigating noise complaints is useful for obtaining viewpoints from both sides of the table: the producer and the receiver of the noise of concern. The local team has worked in most Canadian provinces and parts of the US. The team also includes international experience with staff members from the United Kingdom and Australia.

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2.2 Transportation Noise and Vibration

Most transportation noise projects fall under the road and rail categories. Typically, the bulk of the analysis is completed during the EA stage of the project, with updates during the detailed design. During a typical project, noise-sensitive areas are identified, as well as locations where the worst case noise levels are predicted. Noise from localized sources is also considered (e.g. crossovers).

AECOM's local team in the GTA has experience working on a variety of transportation projects, from municipal road widenings to provincially regulated expressway/freeway expansions; rail projects including the investigation of noise complaints and the assessment of rail corridor expansions for all-day commuter train service. The team has completed transportation projects in many jurisdictions across Canada, in the US and in Australia.

Vibrations induced by road traffic are of concern in specific situations. Railway traffic is the typical source of concern for ground-borne vibration and noise (Figure 2). Special trackwork such as turnouts and switches also increase the level of localized vibration. The impact of ground-borne vibration from transportation manifests in three main effects, perceptible vibration, noise caused by vibrating items in buildings, and ground-borne noise.

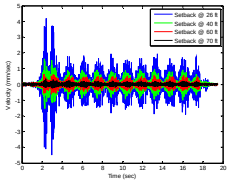

Figure 2: Vibration of train traffic at various setbacks

AECOM's local team in the GTA has completed vibration assessments for a variety of railway projects. Methods and techniques used include measuring vibration from existing tracks, vibration propagation testing, and conducting numerical analysis to predict vibration for different land uses. Diverse mitigation measures can mitigate the effect of vibration on sensitive receptors adjacent to new and existing tracks.

2.3 Architectural Acoustics and Mechanical Noise Control

There are many components contributing to the sound environment within a space, including the mechanical heating, ventilation and air conditioning (HVAC) system, the build-up of noise from sounds within the space, layout and quality of sound sources for Public Announcement/Voice Alarm (PA/VA) systems, and noise intrusion from adjacent spaces. The behaviour of direct and reflected sound within a room can be designed to achieve a desired condition specific to the room's function.

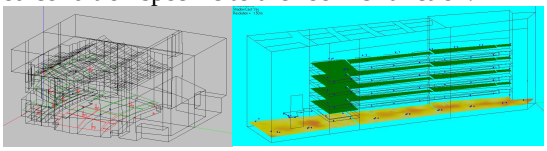

Figure 3: Digital interior acoustic models

AECOM's local team in the GTA has experience with a wide range of project types, from private residences to large arenas and commercial buildings in Canada and the United States. The team also has experience in conducting in situ measurements of the critical performance requirements of the space. The measurements typically performed would be sound isolation and reverberation, and in some situations speech intelligibility and room impulse response.

2.4 Construction Noise and Vibration

Construction noise is typically short in duration with a high noise impact. The requirement for controlling construction noise varies among jurisdictions; however, most assessments and reviews concentrate on minimizing the potential for noise complaints. Depending on the client's noise complaint risk tolerance, the degree and amount of noise mitigation can be adjusted. Monitoring can be conducted if a noise level limit is set.

Construction activities produce different types of ground-borne vibration with varying impact levels. Buildings and structures adjacent to construction sites respond to vibration, with results ranging from barely perceptible effects, to low rumbling sounds and perceptible vibrations, and cosmetic damage (e.g., cracks in drywall) at the highest typical levels. Structural damage is not expected from typical construction activities.

On-site testing for vibration propagation and establishing the site and equipment specific vibration propagation formulas, allows relatively precise zones of influence (areas where vibration exceeds specified limits) to be calculated.

AECOM's local team in the GTA has completed construction assessments for projects such as tunnel boring, transportation corridors, bridge replacement, facility construction, vibration adjacent to fragile buildings and hospital facilities housing vibration-sensitive imaging equipment in various jurisdictions.

2.5 Building Services Equipment and Footfall Vibration

Mechanical equipment in buildings can be a source of irritation to people with improper installation. Inadequately isolated air conditioning units or commercial washing machines can cause vibration and structure-borne noise. In office spaces, vibration from mechanical systems can cause interruptions, reduce staff concentration and productivity.

Dynamic loading (e.g. walking, jumping) on supporting elements, such as long-span floors or staircases, will vibrate at amplitudes unacceptable either to the occupants or for the intended use of the structures. Effects can include office furniture rattling and cause discomfort to workers. Vibration generated from footfall can also interfere with sensitive equipment in healthcare facilities and high-tech laboratories.

AECOM's local team in the GTA has been involved in several vibration assessments dealing with mechanical equipment and footfall vibrations. Analysis was completed using Finite Element Analysis, numerical simulation of footfall and measurement of rotating machinery vibration.

AMEC FOSTER WHEELER

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Abstract

Amec Foster Wheeler is a global consulting engineering company that employs over 40,000 people in more than 55 countries. The Acoustic Centre of Expertise is a group within Amec Foster Wheeler that supports acoustics, noise and vibration engineering services. We are based out of the Mississauga, Ontario, Canada and support projects throughout North and South America. Our expertise includes environmental noise, transportation noise, building acoustics, vibration and monitoring in support of our oil and gas, clean energy, environmental and infrastructure and mining markets.

Keywords: environmental noise, transportation noise, building acoustics, vibration, noise measurements, noise monitoring, vibration measurements, vibration monitoring, oil and gas, clean energy, environmental, infrastruture, mining

Résumé

Amec Foster Wheeler et une entreprise de consultation et ingénierie qui emploie 40 000 employés œuvrant dans plus de 55 pays. Au sein d'Amec Foster Wheeler est le Centre d'Expertise en acoustique qui soutient services d'ingénierie dans les domaines de l'acoustique, du bruit et des vibrations. Nous sommes établis à Mississauga, en Ontario Canada et on soutien de projets à travers l'Amérique du Nord et du Sud. Notre expertise comprend les domaines du bruit ambiant, le bruit des infrastructures de transport, l'acoustique du bâtiment, la surveillance et les vibrations en appui de nos secteurs du pétrole et du gaz, de l'énergie propre, de l'environnement et des infrastructures et des mines.

Mots clefs : bruit dans l'environnement, bruit des infrastructures de transport, acoustique du bâtiment, vibrations, mesures de bruit, contrôle du bruit, mesures de vibrations, contrôle des vibrations, pétrole et du gaz, énergie propre, l'environnement, infrastructures, exploitation minière

1 Introduction

Amec Foster Wheeler designs, delivers and maintains strategic and complex assets for its customers across the global energy and related sectors. We design, deliver and maintain strategic and complex assets and employ around 40,000 people in over 55 countries worldwide.

Our operation spans across four key markets: Oil & Gas, Mining, Clean Energy, and Environment & Infrastructure. In each market, the range of services provided to our customers is very similar and runs right across the lifecycle of assets. Our engineering and project management activities are managed by four business units: Americas, Northern Europe & CIS (NECIS) and Asia, Middle East, Africa & Southern Europe (AMEASE) and Global Power Group (GPG). We are proud of our core values: delivering on promises, developing full potential and doing the right thing. Amec Foster Wheeler is driven by delivering value to our clients, providing safe and sustainable project solutions, developing the full potential of our people and contributing to the communities we work in.

Amec Foster Wheeler's Acoustics Centre of Expertise is located in Mississauga, Ontario, Canada, and supports the North and South American geographies in our various key markets. The concept of a Centre of Expertise is an exciting new and growing area for Amec Foster Wheeler. We rely on collaboration between multiple offices across the Americas and the globe to deliver quality driven work to our clients. The Acoustic Centre of Expertise was founded in 2013, and its key members, a core group of senior engineering practitioners, have a combined collective experience of over 50 years in acoustics, noise and vibration. We offer consultancy, engineering, and project management services in the core areas of environmental noise, transportation noise, building acoustics, monitoring of noise and vibration, including both assessment and mitigation of noise and vibration. We also collaborate with our other Amec Foster Wheeler acoustics practitioners in the UK.

2 Areas of Focus

We are experienced with environmental noise and vibration as they relate to industrial and manufacturing facilities, construction and blasting activities, renewable energy, and occupational health. We have also completed many transportation noise projects involving the impact on the acoustic environment from transportation sources including roads, aircraft, and rail. We bring our extensive expertise with transportation (e.g. All Aboard Florida High Speed Rail Project and various TTC Projects) and environmental (e.g. Pampa de Pongo Mining Project, Ontario Power Generation) concerns, an understanding of regulatory and policy requirements, and experience with handling community

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consultation for our environmental and transportation clients – both locally and across the Americas.

The successful design and operation of any building involves incorporating various engineering disciplines - including architectural, mechanical, electrical and structural. These disciplines continue to evolve in their need to address noise and vibration. We have extensive successful experience delivering building acoustic projects (e.g. UofT Innis Town Hall and Cinema Retrofit) by ensuring the integration of acoustics throughout the entire design, delivery and commissioning process.

We have the knowledge and experience to address vibration generating activities and associated impacts to buildings and structures (e.g. Deloro Mine Site Cleanup Project Blasting). Typical sources of vibration we address include construction equipment, rail transportation and explosive blasting.

The measurement and monitoring of noise and vibration is a requirement for a variety of projects and diverse jurisdictions. We are continually involved in the measurement of individual sources of noise and vibration, as well as monitoring construction for on-going noise and vibration impacts to communities (e.g. Edmonton Downtown Tunnel Construction Vibration) as well as long-term operational noise monitoring from facilities and transportation corridors.

3 Sample Projects

3.1 Rumble Strip Noise

Amec Foster Wheeler conducted a detailed assessment of rumble strip noise for the Ontario Ministry of Transportation. Noise levels (both interior and exterior to the car) were investigated and a classification of noise characteristics for the different designs was developed. From this investigation, we were able to identify various design characteristics (width, distance between strips, angled) that contributed to overall noise levels, and tonal components, of rumble strip designs.

Figure 1: Rumble strip noise testing

3.2 UofT Innis Town Hall and Cinema Retrofit

Amec Foster Wheeler was choosen to provide acoustic design for the retrofit of the University of Toronto Innis College Town Hall and Cinema. The Acoustic Centre of Expertise integrated with the project team from the early stages of conceptual and detailed design, tendering and construction. We were successful in meeting the interior reverberation time criteria for the cinema, while significantly upgrading the sound isolation to adjacent spaces in Innis College through wall and door construction upgrades.

Figure 2: University of Toronto Innis College Town Hall and Cinema

3.3 Edmonton Downtown Tunnel Construction Vibration

The Amec Foster Wheeler Acoustic Centre of Expertise, in collaboration with the local Edmonton office, has and is continuing to conduct vibration monitoring for the City of Edmonton's Downtown Intensification project. This involves standard vibration monitoring for drop shaft construction and tunnel boring activities, as well as specific vibration monitoring of Nuclear Magnetic Resonance (NMR) spectroscopy and experimental labs at the MacEwan University.

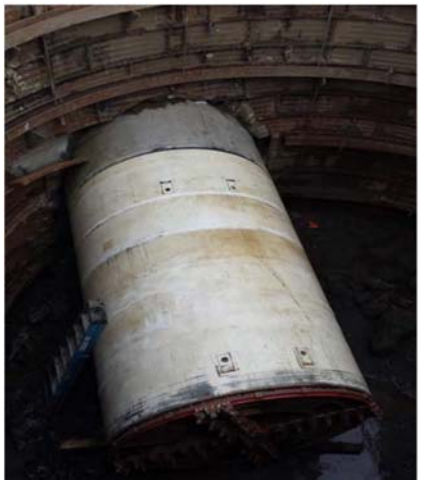

Figure 3: Tunnel boring machine breaking through receiving shaft

THE ACOUSTIC RESEARCH IN THE DEPARTMENT OF ARCHITECTURAL SCIENCE RYERSON UNIVERSITY

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Résumé

Le laboratoire de la science du bâtiment dans le département de sciences architecturales a les capacités pour mener des expériences d'évaluation des propriétés de matériaux acoustiques. Quatre tubes d'impédance sont disponibles pour évaluer le coefficient d'absorption et un certain nombre de propriétés associées. Les tests utilisant un système a deux microphones ainsi que les tests utilisant un système à trois microphones peuvent y être effectués. Un soufflerie à échelle réduite peut être utilisée pour des expériences de localisation de sources. Modélisation détaillée par éléments finis, en utilisant COMSOL, peut être utilisé pour prédire la performance acoustique des silencieux passifs, les résonateurs de Helmholtz ainsi que la propagation du son dans des souffleries. La simulations Aero-acoustiques est également possible en utilisant le puissant logiciel "ACTRAN". Enfin, la recherche acoustique reliée au auditorium et salle sont réalisées en utilisant à la fois les outils de simulation ainsi que des études expérimentales. Les détails de la recherche seront mis en évidence dans ce bref résumé.

Mots clefs : propriétés des matériaux, aéro-acoustique, conception de contrôle de bruit

Abstract

The building science laboratory in the Department of Architectural Science has capabilities to conduct research activities in the field of room acoustics and noise control. Four impedance tubes, with both two-microphone and three-microphone systems, are available to evaluate the absorption coefficient as well as a number of other material properties. A scale model wind tunnel is also available for source localization experiments. Detailed finite element modelling, through COMSOL, are used to predict acoustic performance of passive silencers, Helmholtz resonators as well as sound propagation in the available wind tunnels. Similarly, aero-acoustic simulations are also possible by using the software ACTRAN. Finally, auditorium and room acoustic researches are conducted through simulations as well as through in field measurements.

Keywords: Room acoustics, material properties, aero-acoustics, noise control design

1 Introduction

The Department of Architectural Science (DAS) at Ryerson University has two faculty members whose teaching and research focus on acoustics and noise control.

Two acoustics courses catered to architectural science students are being offered at the undergraduate level. The third year course teaches basic acoustic materials on room acoustics and sound transmission. The fourth year course (also available to graduate students) deals with acoustics of performance spaces.

The main areas of the acoustics research are described below.

2 Architectural Acoustics

Sound represents one of the most valid and often underestimated ways to experience a space. The acoustics of heritage buildings is often crucial. This new attention to cultural heritage has fostered the study of the relationship between the architecture and its acoustics. Within this context, the acoustics of Italian historical buildings (mainly churches [1, 2] but also theaters [3]) was researched by Dr. Berardi over the last decade. Similarly, the music rooms were researched through both simulations and site measurements by Ramakrishnan and Dumoulin [4]. Room acoustics studies have been performed using both detailed analysis as well as software simulations with EASE, CATT and/or ODEON.

3 Acoustic Materials

The characterization and testing of new building materials and building systems is among the most active area of research in the DAS Acoustic Lab at Ryerson. Sustainability principles and new design criteria provide the impetus to study new systems composed of natural materials (mainly vegetative fibers) for sound absorption treatments [5]. Based on their microscopic configurations, both porous absorbing cellular as well as fibrous materials have been considered (Fig.1). Sound absorption, air resistivity, open porosity, and tortuosity measurements have been conducted and the results

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were used to develop theoretical model to predict the behaviour of these materials. In addition, the acoustic behaviour of nanotechnologies, such as aerogel, in room acoustic applications, has been of recent interest. Four impedance tubes (Fig.2) are available in the laboratory and the research is continuing to determine the effect of compression on porous materials [6].

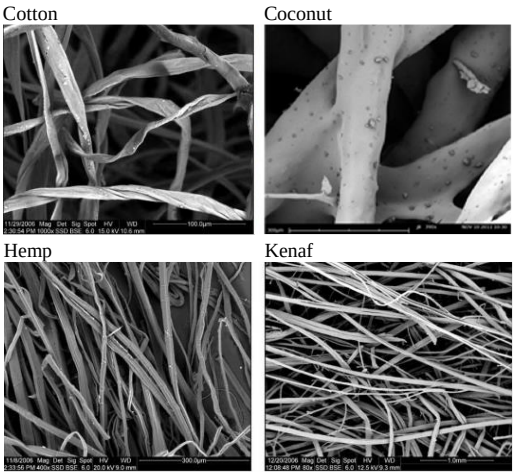
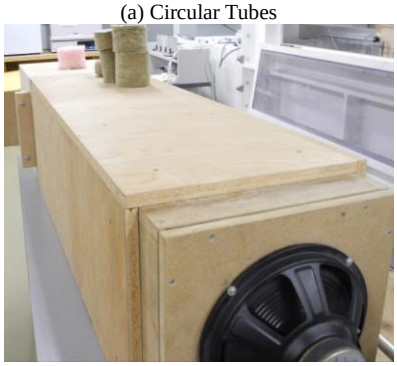


Figure 1: Materials studied for acoustic applications (from [5]).

(a) Circular Tubes



(b) Square Tube

Figure 2: Photos of the impedance tubes.

4 Aero-Acoustics

The acoustics lab has been gifted with a pilot wind tunnel (PWT) with a top speed of 250 kph. The PWT, shown in Figure 3, has been used to study the acoustical performance of wind tunnel components such as corner vanes and the use of Helmholz resonators to attenuate the very low-frequency circuit resonances. In addition, numerical calculations can be undertaken with the use of software such as COMSOL multiphysics and Actran. One such simulation study evaluated the acoustic performance of large corner vanes with varying treatments is reported in [7].

Figure 3: Photo of the pilot wind tunnel

5 Noise Control

Various aspects of noise control research have been conducted, such as the evaluation of the performance of elbow silencers [8]. Basic research in experimental methods of building acoustics is also a primary research area [9]. In addition, research is on-going in understanding wind turbine noise sources as well as realistic prediction methods [10].

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ACOUSTICAL PERFORMANCE OF ROXUL CORE SOLUTIONS (OEM) PRODUCTS

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Abstract

ROXUL® Core Solutions (OEM) is committed to making other manufacturers' products better, safer and quieter. As a key business unit of ROXUL Inc., North America's largest manufacturer of stone wool insulation, ROXUL Core Solutions (OEM) offers custom solutions and two versatile product lines to meet the demands and requirements of a variety of OEM applications. ROXUL OEM products are engineered to stand up to the rigors of fabrication and can be used to meet the production requirements of various acoustic applications, such as acoustical panels, acoustical partition walls, roadside walls, speakers, mufflers and more. All products can be split, cut, faced and fitted while maintaining unique benefits exclusive to stone wool.

Keywords: acoustics, acoustical, solutions, sound proof, OEM

Résumé

L'équipe de Solutions de base ROXUL® (en anglais, ROXUL® Core Solutions) (OEM) s'est engagée à améliorer les produits d'autres fabricants, et à les rendre plus sécuritaires et plus silencieux. En tant qu'unité opérationnelle clé de ROXUL Inc., le plus grand fabricant de produits isolants de laine de roche en Amérique du Nord, les Solutions de base ROXUL® (OEM) offrent des solutions sur mesure et deux gammes de produits versatiles qui répondent aux demandes et aux exigences de nombreuses applications OEM. Les produits OEM de ROXUL sont conçus pour résister aux rigueurs de la fabrication et peuvent être utilisés pour satisfaire aux exigences de production de diverses applications acoustiques, tels les panneaux acoustiques, les cloisons acoustiques, les murs longeant les routes, les haut-parleurs, les silencieux, entre autres. Tous les produits peuvent être fractionnés, coupés, revêtus et ajustés tout en conservant leurs avantages uniques exclusifs à la laine de roche.

Mots-clés : acoustique, solutions, insonore, FEO (fabricant d'équipement d'origine – en anglais, OEM ou Original Equipment Manufacturer)

1 Introduction

Through resources centred on research, development, standardized testing and certifications, ROXUL® Core Solutions is focused on growing its OEM business to address the unique requirements of the acoustics industry.

Offering custom solutions and two product lines—CONROCK® and FABROCK™—products range in density and dimension to meet many production requirements, whether it be for speakers, acoustical panels, acoustical partition walls, roadside walls or other acoustical applications [1]. A ROXUL Core Solutions (OEM) video gives an overview of how its products are used around the home and in everyday life [2].

2 Products

Several ROXUL stone wool insulation products are fabricated to fit a variety of acoustic applications. CONROCK® 60 is a board insulation designed specifically for application in sandwich panel systems where acoustic properties are required. This rigid board has excellent acoustical dampening properties and features a non-directional fibre structure that dissipates sound waves for a quieter environment.

FABROCK™ DD is a dual-density board insulation that is designed to be fabricated while maintaining its integrity. A higher density upper layer and a lower density bottom layer work together to give the product compressive resistance and excellent sound absorbency. It's ideal for use in acoustic panels, but is not limited to this OEM application.

In addition, FABROCK™ Batt is a light density batt insulation engineered to be fabricated and used in various OEM applications. Historically used in spas and transportation applications, it has excellent sound and thermal properties. All ROXUL products are dimensionally stable, vapor permeable and naturally resistant to rot, mold, mildew and bacterial growth. A full list of products and applications is available on ROXUL's website [1].

ROXUL Core Solutions (OEM) makes other manufacturers' products better, safer and quieter. It offers a variety of high-quality insulation products well suited for acoustical OEM applications, which are manufactured to stand up to the rigors of fabrication, ranging in density and dimension to meet customer requirements. Appreciating that the acoustical industry is unique, ROXUL offers customized

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solutions, backed by superior quality, innovation, reliability and service to ensure its customers' long-term success. This is evident throughout the process, from research and development, prototype and testing, production, monitoring and support.

ROXUL Technical Innovations department and Core Solutions (OEM) Sales work with customers to create custom solutions for many acoustical OEM applications and offer expertise to assist with complex specifications, design and implementation. ROXUL has a comprehensive understanding of industry standards, protocols and certification requirements and is committed to ongoing quality reviews and technical support.

3 Case Study

The Core Solutions (OEM) segment at ROXUL works closely with customers like Perdue Acoustics to ensure ROXUL products and tailored solutions meet specialized needs, provide benefits and add both quality and value to the finished product. ROXUL Core Solutions aims for a technically flawless integration in every application with comprehensive support through all levels of the process.

Perdue Acoustics specializes in controlling sound—churches, schools, athletic facilities and commercial buildings use Perdue to create more comfortable spaces that embrace sound and music or control unwanted noise for quiet environments. ROXUL insulation is incorporated into Perdue's patented acoustical wall and ceiling products and was chosen due to its sound dampening qualities across a wide range of frequencies. ROXUL insulation is seamlessly integrated into Perdue's patented systems to create sound panels, Baffles, Wedges™, Drum Booths and other diffusing or reflecting sound technology. The unique non-directional structure of ROXUL stone wool insulation is more dense than other insulation products, effectively reducing airflow and, as a result, reducing sound transmissions. Higher air flow resistivity means better sound attenuation. ROXUL was the only company with the manufacturing process and expertise capable of meeting Perdue's stringent technical requirements.

Figure 1: ROXUL insulation is used in Perdue's products; the treatments are then wrapped in fabric or vinyl to meet the acoustic and aesthetic needs of any facility.

Figure 2: Perdue's acoustical wall treatments are made out of ROXUL Stone Wool Core, high-impact random strand mat and 100% recycled fabric.

4 Conclusion

ROXUL Core Solutions (OEM) products are engineered specifically for OEM applications. They can be split, cut, faced and fitted while maintaining performance and integrity. ROXUL's tailored solutions and exclusive CONROCK® and FABROCK™ series of products provide a wide range of unique benefits exclusive to stone wool. Non-combustible stone wool insulation has a high melting point of approximately 1,177°C (2,150°F) and doesn't promote smoke or flame spread in the event of a fire. All products have outstanding thermal resistance and sound control, due to their denser composition and non-directional fibre structure. They are also dimensionally stable, water resistant and do not promote mold or mildew growth. Visit ROXUL's website for more information [1].

References

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PLITEQ INC. – 2015 RESEARCH IN ARCHITECTURAL ACOUSTICS

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Résumé

Pliteq Inc. est une société d'ingénierie basée à Toronto spécialisée en acoustique architecturale. Le PDG Paul Downey est répertorié comme l'inventeur de 7 brevets d'atténuation liées au son et aux vibrations. Les lignes de produits GenieMat™ et GenieClip™ sont testés pour leur efficacité sur différentes structures pour diverses applications utilisant des laboratoires tiers indépendants et des procédures de test tel que définie par l'ASTM. En 2015, plusieurs programmes d'essais furent complétées, les résultats sont présentés dans cet article. Les sujets de recherche inclus l'évaluation de la performance de; GenieMat™ FIT produits de revêtement de sol pour l'isolation contre les impacts lourds, l'utilisant d'un système de plusieurs couches de GenieMat™ FF pour obtenir une faible fréquence naturelle et une rigidité dynamique des planchers flottants, en utilisant la GenieClip™ pour réduire les bruits d'impact dans la construction à ossature de bois et, enfin, en utilisant tous les types de produits mentionnés ci-dessus pour réduire la transmission des bruits d'impacts et sons aériens dans les construction utilisant le bois lamellé-croisé (CLT).

Mots-clés: isolation impact lourd, IIC, STC, CLT, atténuation acoustique

Abstract

Pliteq Inc. is a Toronto based engineering company specializing in architectural acoustics. CEO Paul Downey is listed as the inventor of 7 sound and vibration mitigation related patents. The GenieMat™ and GenieClip™ product lines are tested for efficacy on various structures for various applications using independent third party laboratories and ASTM test procedures. In 2015 we completed numerous test programs and the findings are presented in this article. Research topics included assessing the performance of; GenieMat™ FIT flooring products for heavy impact isolation, using multi-layer GenieMat™ FF systems to achieve low natural frequency and dynamic stiffness response of floating floors, using the GenieClip™ to reduce impact sound in wood frame construction and finally using all of the above mentioned product types to reduce impact and airborne sound transmission in cross-laminated timber (CLT) construction.

Keywords: heavy impact insulation, IIC, STC, CLT, sound attenuation

1 Introduction

In 2015 engineers at Pliteq Inc. completed more than 100 independent laboratory acoustical tests to determine improvements in impact and airborne sound attenuation as a result of using various products on different structures. The information was presented in numerous papers completed for INTER-NOISE 2015 proceedings in San Francisco. A summary of the work completed for the purpose of those papers is provided here.

2 Research Topics and Test Programs

2.1 Performance of fitness flooring assemblies

Fitness facilities around the world are increasingly more prevalent in mixed use buildings and on the second floor and above. Consequently, vibration in structures as a result of heavy weight drops is a growing and challenging engineering problem. Data was collected from heavy weight drops on a wide variety of impact vibration reducing floor types [1]. These include floating plywood systems and various fitness flooring surfaces. We compared the results of using input from a tapping machine to much higher energy input sources such as heavy/soft and heavy/hard (7 kg and 45 kg) impact sources. Both acoustic and vibration data was obtained. The figure below is an example taken from the study.

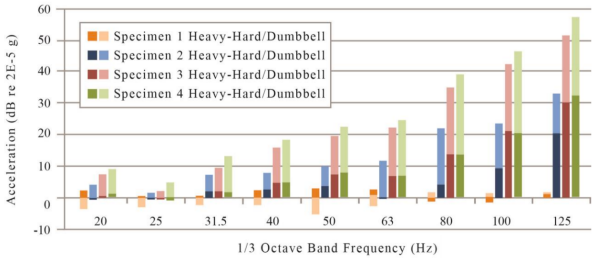

Figure 1 – Acceleration deltas normalized off the 8mm baseline product

2.2 Effect of impact sound transmission

Experiments were used to collect data from impact testing on different variations of typical fire-rated components in open-web wood truss assemblies [2]. Data was obtained by performing ASTM E492 test methodology in a laboratory environment. A comparative analysis was presented for

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three different scenarios. The effects of changing the channel spacing of the drywall isolation clips, the effects of adhered vs. floating vinyl flooring with a resilient rubber underlayment, and the effects of an assembly with and without a layer of poured gypsum underlayment. All data is presented in table and plot format and the relevant 1/3 octave band data is analyzed. An example of one of the test assemblies is below.

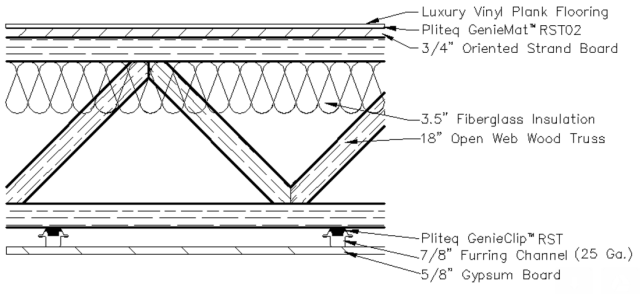

Figure 2 – Section view of the tested open web truss floor assembly

2.3 Performance of Re-bonded Recycled Rubber Underlayment

The use of re-bonded recycled rubber to form a compressible elastomeric noise control underlayment for architectural noise control is well known [3]. This includes the use of single and dual layered underlayment with and without a repeating bi-directional sinusoidal bottom surface (GenieMat^{TM} FF). Until now these dual layer systems used two identical thickness mats with the same wavenumber sinusoidal patters. Recent experimentation into the dynamic stiffness of various combinations of layers of different thicknesses hinted that greater performance might be achieved with two mismatched layers. This paper will correlate the dynamic stiffness of the underlayment combinations with the Impact and Airborne Sound Transmission in laboratory environments. « Table 7 below is taken from the study and shows the improved dynamic properties resulting from the mismatched layers.

Table 1 – Apparent dynamic stiffness, s't, for various sinusoidal profiled rubber interlayer configurations

No. layers	Configuration	Total Thickness (mm)	Average Dynamic Stiffness (MN/m^3)	Average Resonant Frequency (Hz)
1	6	6	37	68
1	10	10	25	55
2	6 + 6	12	20	51
2	10 + 6	16	8	32
1	17	17	15	44
2	10 + 10	20	12.6	40
1	25	25	13	41

2.4 Performance of cross-laminated timber panel construction

Cross laminated timber panels (CLT) are a relatively new method of constructing multi-family structures in North America [4]. The panels are composed of numerous layers of wood, each perpendicular to the adjacent layers. Wood is a renewable resource and producing the components of CLT panels consumes roughly half of the energy of concrete. 12-storey buildings are possible with cross-laminated timber. While this has been used in other parts of the world, it has not yet been widely adopted in North America. In an effort to better understand how a CLT floor ceiling structure will perform in impact and airborne sound attenuation testing, we constructed a 175mm thick floor assembly in the laboratory and conducted numerous tests (STC-ASTM E90 and IIC-ASTM E492) with different floor toppings and with and without a ceiling assembly. Plywood installed over resilient underlayment of various thicknesses was tested in addition to finish floor installed directly over resilient underlayment. A resiliently mounted ceiling with insulation was also tested. The test data collected is compared to other labs including testing done by the National Research Council of Canada (NRC). As a result of the test program we can hope to design IBC section 1207 code compliant CLT assemblies, better understand lab variations with this type of structure and compare it to conventional concrete slabs of equivalent thickness. A summary table from the study is shown below.

Table 2 – Overall STC and IIC performance of various CLT assemblies

Test Report #	Assembly	STC	IIC
E5958.01	Bare 175mm CLT	39	25
E5958.02	GenieMat™ FF10 + ¾" Advantech	43	41
E5958.03	GenieMat™ FF10 + 2 x ¾" Advantech	45	42
E5958.04	GenieMat™ FF25 + 2 x ¾" Advantech	48	44
E5958.05	GenieMat™ FF25 + 2 x ¾" Advantech w/ ceiling	61	55
E5958.06	Bare CLT w/ ceiling	58	45
E5958.07	Vinyl Plank on GenieMat™ RST05 w/ ceiling	58	58
E5958.08	Vinyl Plank w/ ceiling	57	54

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HGC ENGINEERING –ACOUSTICS, NOISE AND VIBRATION CONSULTING

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Abstract

HGC Engineering is one of the largest and most experienced, dedicated acoustical consulting firms in Canada. Our principal engineers have each been consulting in acoustics for 25 to 35 years and, with a team of engineers, technologists and scientists from a wide variety of disciplines, the firm offers a comprehensive range of expertise spanning all aspects of acoustics and vibration.

Keywords: noise, vibration, acoustics, built environment, industrial noise, renewable energy, wind power, vibration, expert witness, peer review

Résumé

HGC Engineering est un des plus grands bureaux d'études en acoustique et vibrations au Canada. Avec ses ingénieurs principaux, qui ont entre 25 et 35 ans d'expérience dans l'industrie, et son équipe d'ingénieurs, de techniciens, et de scientifiques issues de disciplines variées, l'entreprise offre une gamme complète d'expertise dans tous les aspects de l'acoustique et des vibrations.

Mots clefs: bruit, vibrations, acoustique, bruit de bâtiment, bruit industriel, énergie renouvelable, énergie éolienne, témoin expert, examen par les pairs

1. Introduction

HGC Engineering is one of the largest and most experienced, dedicated acoustical consulting firms in Canada. We are an employee-owned, Canadian-based acoustical consulting group that was founded in 1994. At that time, the regulatory environment for noise and vibration in Ontario was rapidly evolving and growing ever more stringent (a scenario that still holds true today). The province was one of the first jurisdictions in North America to designate noise as an environmental pollutant with the potential to impact community health and well-being. We have been fortunate to leverage our experience working in this environment of intensive noise regulation into a worldwide reputation in the measurement, assessment and mitigation of acoustics, noise and vibration challenges.

2. Global Services

HGC Engineering has worked internationally to provide site-wide noise assessments and mitigation solutions of large petrochemical and refinery complexes such as the Braskem-Idesa, Etileno XXI Facility, in Coatzacoalcos, Mexico (Figure 1), HGC Engineering provides services in construction vibration monitoring; whole building vibration isolation and analysis; as well as isolating the impact of vibration on hypersensitive equipment used in healthcare and scientific institutions. The vibration investigation projects have included the KK Hospital in Singapore, the Riverbend Residences in Chicago, and Canary Wharf in London, UK.

Figure 1. Braskem-Idesa, Etileno XXI Facility, Coatzacoalcos, Mexico

3. Acoustical Services for Condominiums

Toronto is currently the "Condominium Capital" of North America and HGC Engineering provides comprehensive acoustical consulting services for more than a hundred projects in the city, its suburbs and well beyond. Notable projects include The Aura at College park, Canada's tallest and largest residential building at 78 floors high; and Absolute World (Figure 2), a two tower, 56-storey residential development that was, in 2012, judged to be the best tall building project in North America by the respected International Council on Tall Buildings and Urban Habitat. Many of the high-rise developments have included ancillary blocks of townhouses. In Ontario, HGC Engineering has also been involved in the Tarion Bulletin 19R review process since its inception.

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Figure 2. Absolute Towers, Mississauga, Ontario

4. Acoustical Services for Commercial Projects

HGC Engineering has also participated in commercial projects that have added to the urban skylines of major cities, both in Canada and around the world. Office tower projects in Canada include: The Bay Adelaide Centre East and West, in Toronto; and the Tour Deloitte in Montreal, both of which are the first office buildings in their respective cities to be LEED Platinum targeted. International Projects include The Goldman Sachs office tower in Jersey City, (which at 42 stories is the tallest building in New Jersey); and the Manama's Bahrain Financial Harbour Complex (The site's twin-towers are the tallest structures in Bahrain – Figure 3).

Figure 3. Bahrain Financial Towers, Manama, Baharain

5. Other HGC Engineering Projects

The company also provides ongoing consulting as part of both Planning, Design, Compliance (PDC) and Design-Build (DB) teams on many P3 projects that include large scale, complex and often LEED targeted developments such as healthcare, academic and civic institutions such as the Papadakis Integrated Sciences Building at Drexel University, Philadelphia; the MaRs Discovery District in Toronto, and the Edmonton Clinic Health Academy at the University of Alberta in Edmonton. We are also involved in major infrastructure projects: from roads, railways, highways, tunnels, and bridges to sewage, potable water, power, and oil and gas distribution systems. The company has contributed to many land-use studies for mixed-use, master-planned communities including the Waterfront Revitalization in Toronto and The Barton-Tiffany Lands Redevelopment in Hamilton. The Barton-Tiffany Urban Design Study, which HGC Engineering contributed to, won a 2015 Hamilton Urban Design Award for Excellence in Community Planning (Figure 4).

Figure 4. Barton-Tiffany Lands Redevelopment, Hamilton Ontario

6. Wind Farm Noise Issues

HGC Engineering is extensively involved with the burgeoning global wind energy industry. The company is a leading participant in the adoption of new acoustical measurement standards and techniques related to wind turbine noise. HGC Engineering was the acoustical consultant for Cerro de Hula, the first wind power plant in Honduras and the largest wind farm in Central America. (Figure 5).

Brian Howe, President of HGC Engineering is the current chair of the Canadian Standards Committee on Acoustic Noise Measurement of Wind Turbines. He developed "Wind Turbines and Sound: Review and Best Practice Guidelines" for the Canadian Wind Energy Association (CanWEA). The guide is used extensively by leading industry developers and operators. Brian Howe was part of an expert panel brought together by the prestigious Council of Canadian Academies to examine wind turbine noise and human health.

Recently The Standards Council of Canada (SCC) granted the company lab accreditation for acoustic noise testing of wind turbines in accordance with CAN-P-4E (ISO/IEC 17025:2005) for acoustic noise measurements as per IEC 61400-11 acoustic noise testing standard for wind turbines. This accreditation means that HGC Engineering has demonstrated both the technical competence and management system requirements to consistently produce valid test and measurement results.

Figure 5. Cerro de Hula, wind power plant in Honduras

JADE ACOUSTICS INC.

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Abstract

Jade Acoustics Inc. is an acoustical engineering firm providing consulting services to both the private and public sectors. The work includes the control of noise and vibration in the development of land, as well as in the design of buildings and industrial facilities. This includes the impact of a variety of sources such as road traffic, railways, aircraft, industry and mechanical equipment on both residential and institutional uses. Both original work and peer review of work prepared by others are conducted. The company was founded in 1989. Our office is located in Vaughan (Concord), Ontario.

Keywords: noise control, vibration, acoustics, environmental, assessment, peer review

Resume

Jade Acoustics Inc. est une firme d'ingénierie acoustique offrant des services de consultation à la fois aux secteurs public et privé. Les travaux comprennent le contrôle du bruit et des vibrations dans le développement des terres, ainsi que dans la conception des bâtiments et des installations industrielles. Cela inclut l'impact d'une variété de sources telles que le trafic routier, ferroviaire, aérien, l'industrie ainsi que l'impact des équipements mécaniques autant sur les utilisations résidentielles qu'institutionnelles. La compagnie réalise ses propres travaux originaux ainsi que mène des revues des travaux préparés par ses pairs. La société a été fondée en 1989. Notre bureau est situé à Vaughan (Concord), Ontario.

Mots-clés: lutte contre le bruit, les vibrations, l'acoustique, l'environnement, l'évaluation, l'examen par les pairs

1.0 Introduction/Expertise

Jade Acoustics offers consulting engineering services in the following areas:

- Environmental Noise Assessment and Control
- Vibration Assessment and Control
- Environmental Compliance Approvals
- Industrial Noise Control
- Internal Building Acoustics
- Design and Troubleshooting
- Expert witness testimony

Examples of the types of project we have completed are outlined below.

2.0 Railway Projects

Jade Acoustics has conducted noise and vibration studies for developments proposed adjacent to railway lines and rail yards as well as prepared the noise and vibration reports as part of the Federal approvals required by the railway companies for new facilities and upgrades to facilities. In addition, we have investigated noise and vibration complaints arising from rail operations in response to orders issues by the Canadian Transportation Agency (CTA) throughout Canada.

Our work involves on-site sound and vibration measurements, prediction of sound levels using various computer based modelling software, formulation of mitigation measures, preparation of the noise/vibration reports for submission to the approval authorities, participation at Public Meetings, expert testimony at the Ontario Municipal Board (OMB), and presentations at the CTA.

An in depth understanding of rail operations is required in the design of rail facilities as well as for the review of proposed sensitive receptors adjacent to existing rail facilities. As the noise/vibration guidelines vary in different jurisdictions, Jade Acoustics has used the various analysis techniques and guidelines to properly design new developments as well as new rail infrastructure.

3.0 New Sensitive Land-Uses

In Ontario, the Ministry of the Environment and Climate Change (MOECC) has developed specific guidelines to address the sensitive land uses adjacent to road, rail, airports, commercial facilities and industrial operations. Most

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municipalities in Ontario have adopted the MOECC guidelines, with some adapting the MOECC guidelines to the specific needs of the municipality. Jade Acoustics prepares environmental noise and vibration reports to satisfy conditions of approval for new residential/sensitive land uses.

This requires obtaining data related to the sources either through information provided by others or on-site measurements, prediction of the sound levels, formulation of the mitigation measures needed to meet the applicable criteria and preparation of the report. Once the report has been approved and the development is proceeding we are required to review the architectural drawings, grading plans and landscape plans to ensure that the required mitigation is incorporated into the design. After the construction is completed inspections of the installed mitigation is undertaken and the final clearance letter is prepared. An understanding of the planning process as it applies to acoustical assessments is mandatory to ensure the appropriate reports are prepared.

As part of the planning process, land-use proposals must follow a specified approach that includes Public Meetings and presentations at Council. Jade Acoustics has presented at numerous public meetings and Council sessions. This involves formal and informal presentations and responding to questions raised by the public and members of Council.

When adjacent land owners or the municipality do not approve of the project, the proposed development may be contested at the Ontario Municipal Board. When this occurs, Jade Acoustics provides expert testimony related to the acoustic assessment and the feasibility of the proposed mitigation.

4.0 New Commercial/Industrial Uses

The MOECC and most municipalities require that a noise and/or vibration report be prepared when a new commercial or industrial use is proposed adjacent to sensitive land-uses. In many cases an Environmental Compliance Approval (ECA) is required for specific sources.

The evaluation of these types of sources is undertaken through on-site measurements, predictions or a combination of these approaches. Understanding the sources, the assessment methods, the prediction methods and the possible mitigation options is important to comprehensively evaluating the acoustical impact of commercial and industrial sources to ensure compliance with the applicable guidelines.

5.0 Internal Building Acoustics

In multi-tenant buildings the separation between spaces needs to be designed to ensure compliance with specific codes and publications. This involves the review and design of mitigation between residential suites, mechanical systems and residential suites, commercial spaces and residential suites and amenity areas and residential suites. This work is conducted for the proponent of the building to satisfy the requirements of the Ontario Building Code as well as the requirements of Tarion Bulletin 19R and to provide a good acoustical environment for the owners/tenants of the residential suites. The potential issues are addressed at the beginning of the project through the review of the architectural, mechanical and electrical plans. Input is given to the design team regarding the wall and floor/ceiling construction, mechanical equipment vibration isolation, mechanical equipment noise mitigation and special construction techniques that may be required before the final design is complete and the construction goes to tender. Prior to construction, shop drawings are reviewed to ensure that the proper equipment and mitigation are specified. During the construction process, on-site inspections are undertaken and sound/vibration tests are conducted to ensure compliance.

The objective is to comply with the necessary approval regime, provide a good acoustic environment and reduce the incidence of complaints.

6.0 Peer Review

Peer review work is conducted when the approval authority does not have the expertise on staff to review noise and vibration reports, land-owners adjacent to a proposed project want the noise and vibration report prepared on behalf of the proponent reviewed or when a proponent would like a second opinion on the noise/vibration work conducted by the acoustical consultant they retained to prepare the noise and vibration report as required for their application.

Any peer review work undertaken by Jade Acoustics Inc. is conducted in a professional, thorough manner while maintaining respect for the professionals that prepared the noise and vibration reports.

7.0 Other

Jade Acoustics is an active member of the Canadian Acoustical Association. In addition, we maintain membership in various professional organizations.

Jade Acoustics has participated in the review of MOECC guidelines; federal guidelines, including Health Canada and has given courses and instruction in acoustics to private entities, provincial and municipal agencies and colleges and universities.

In order to conduct the best work for our clients, while maintaining the public interest, it is important to understand the science of acoustics, the regulatory framework, the implications of our work and to maintain a working relationship with professionals in many disciplines, including the acoustics field.

HATCH NOISE AND VIBRATION

Tim Kelsall
Hatch Noise and Vibration Group, Mississauga, Ontario

Résumé

Hatch est une importante firme de génie-conseil mondiale dont le siège social est situé à Mississauga, près de Toronto, au Canada. Hatch a été fondée en 1955 et, depuis les années 1970, le groupe Bruit et vibrations de Hatch fait figure de chef de file en aidant ses clients dans les secteurs des mines, de la métallurgie, de l'énergie et des infrastructures pour les questions liées au bruit au sein des communautés, au bruit d'origine industrielle et au contrôle du bruit et des vibrations.

Mots-clés : Hatch, génie-conseil, acoustique, bruit, vibration, mines, énergie, infrastructures

Abstract

Hatch is a major global Consulting Engineering firm headquartered in Mississauga, near Toronto, Canada. Hatch was founded in 1955 and since the 70's Hatch's noise and vibration group has been a leader in assisting their clients in mining, metallurgy, energy and infrastructure with community noise, occupational noise, noise and vibration control.

Keywords: Hatch, engineering, acoustics, noise, vibration, mining, energy, infrastructure

Hatch started with two main focuses: metals and subways. Engineers at Hatch designed the University subway, the first of its kind in Toronto and have designed subways and transit systems in Toronto, Vancouver, Buffalo, Los Angeles, Washington, Sydney and others. Working with CN and CP, Hatch designed and construction managed the replacements for the rail tunnels under the St. Clair river between Canada and the US. Each of these projects also required noise and vibration services to design quiet tunnel ventilation systems, to control ground borne vibration, station acoustics and to assess noise on the surface. Hatch also designed and managed a hydro tunnel under the city of Niagara Falls bored using the largest hard rock tunnel boring machine in the world (Figure 1), including assessing construction noise and vibration.

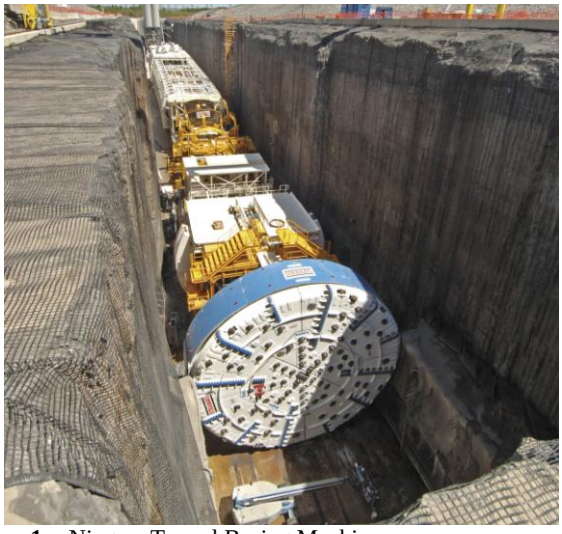

Figure 1. - Niagara Tunnel Boring Machine

Mining, smelting and forming metals has always had the potential to create noise. Electric arc furnaces (Figure 2) can produce over 110 dBA nearby and employees and the community need to be protected. Mining involves underground and above ground noise including large mine ventilation fans, heavy equipment and considerable material handling. Since their location is determined by ore bodies and towns tend to grow up around major mines noise can be a major factor in their design and operation. Hatch has done major work on noise and vibration control for such storied Canadian names as INCO, Falconbridge, Kidd Creek, Stelco, Dofasco and Noranda and more recently for Arcelor Mittal, US Steel, Vale, Mosaic and Glencore.

Figure 2. Electric Arc Furnace - Typically >110 dBA @ 10m

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Hatch has designed and managed construction of major multi-billion dollar projects around the world. For the Stelco plant on Lake Erie, Hatch developed a computer model of the sound emissions back at the time when such models ran on computer cards. This model formed a basis for the CSA standard industrial noise proopagation prediction developed in the 80s.

From steel mills to rail yards, from mines to quarries, Hatch has predicted, assessed and controlled noise in the community and occupational noise exposure in the workplace, especially heavy industry (Figure 3). Occupational noise measurements at Molson Breweries and IPSCO pipe mills helped develop the techniques that were later embodied in CSA Z107.56, the world's first standard on measuring occupational noise exposure, a standard still used across Canada and providing input into the ISO 9612 occupational noise measurement standard and the ANSI equivalent. Indeed, Hatch has been active in CSA acoustical standards for nearly 40 years.

Figure 3. Heavy Industry Noise a Specialty

Energy projects are now a major part of the Hatch portfolio and noise assessments and control have been an important part of hydro, wind, thermal and diesel power plants of all sizes around the world. These have included hydro power plants in Ottawa, St. Catharines and Surinam, diesel generating stations in the Dominican Republic, Mauritania, and the Canadian Arctic and wind farms in Canada, the US and Australia.

Our noise and vibration offices in Canada and Australia service clients around the world. Featuring advanced CADNA-A software for community noise, Operation Deflection Shapes (ODS) analysis, Operating Modal Shape (OMS) analysis and Structural Dynamic Modelling, multiple 1/3 octave Class 1 noise monitors and the ability to measure over 20 channels of vibration simultaneously, including significant low frequency capability, Hatch Noise and Vibration helps Hatch clients in a variety of heavy industries and transportation networks. Recent projects include:

- Using lasers to measure the clearance between a moving train and tunnel walls
- Diagnosing and correcting a crane cab which moved violently enough to injure operators
- Measuring vibration to assess passenger comfort as commuter trains moved through switch banks
- Measuring low frequency vibration at a major hydro dam

Hatch has undertaken noise and vibration projects for large and small clients, from multi-billion dollar projects down to assisting homeowners with noise complaints, and many in between.

Hatch has a large fraction of engineers with advanced degrees and specialties. What this means in noise and vibration is that no matter the industry, no matter the machine, Hatch noise and vibration specialists can call on the service of world class expertise. Such knowledge of our client's process, machinery and operations allows us to design noise and vibration controls which work successfully while allowing maintenance and operation to continue unabated. Examples include patented silencers for metal converters and a patent on a modal silencer able to effectively operate in dirty, wet and hot environments.

Some memorable projects include:

- Double silencers for mine ventilation fans achieving <25 dBA at the nearest residence,
- Low frequency silencers for large diesel generators
- Introducing STI to specify sound system performance in transit stations,
- Using simple metal baffles to break up standing waves in fan coolers
- Diagnosing and correcting whistling radiators

Consulting is an important part of Hatch's mandate. Typical projects have included

- Helping resolve major (and minor) community noise complaints,
- Assisting with municipal noise bylaws
- Hearing conservation advice
- Noise advice while purchasing major equipment
- Court appearances and other hearings

Helping keep multi-billion dollar projects from disturbing neighbourhoods and protecting the hearing of employees is useful and satisfying work. Hatch is proud to have been involved in helping major and minor clients solve these issues for over 40 years. For more information see: https://www.hatch.ca/Engineering/Noise_Vibration/default.htm

PINCHIN LIMITED – ACOUSTICS AND VIBRATION TEAM

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Résumé

Pinchin fait partie du groupe Pinchin, un réseau de quatre entreprises au niveau régional en propriété exclusive, avec plusieurs bureaux à travers le Canada de St. John, Terre-Neuve à Victoria, Colombie-Britannique. La société est dotée d'une équipe de sept cents ingénieurs professionnels qualifiés et expérimentés, scientifiques, hygiénistes industriels, géologues, technologues et gestionnaires de projets qui peuvent offrir des solutions innovatrices pour des problèmes complexes. Pinchin a une équipe grandissante qui spécialise dans le domaine de l'acoustique et des vibrations. L'équipe comprend les besoins accroissant de notre clientèle, et est capable de fournir des services d'ingénierie acoustiques innovantes et efficaces.

Mots-clés: Acoustique, lutte contre le bruit, vibrations, son, Ingénierie, Environnement, Construction, Santé, Sécurité

Abstract

Pinchin is part of the Pinchin Group, a network of four regionally-owned companies, with several offices across Canada from St. John's, Newfoundland to Victoria, British Columbia. The Company is staffed by a team of seven hundred skilled and experienced professional engineers, scientists, industrial hygienists, geologists, technologists and project managers that can offer innovative solutions to complex problems. Following suit with the company's reputation and success Pinchin has strategically grown its Acoustics and Vibration team to provide innovative and effective acoustic engineering services and solutions to their clients ever expanding needs.

Keywords: Acoustics, Noise Control, Vibration, Sound, Engineering, Environment, Building Science, Health, Safety

1 Introduction

Pinchin Ltd., part of the Pinchin Group of Companies, is one of Canada's largest environmental, engineering, health and safety consulting firms. The company employs over 700 staff in over 30 offices across the country. Established in 1981 by Dr. Don Pinchin to provide consulting services to the asbestos abatement industry, the company now provides an exhaustive list of services to its clients whom range from small residential to large industrial facilities. The Acoustics and Vibration Team, part of the Emissions and Reduction & Compliance (ERC) group, are continually expanding their knowledge base and expertise in order to better serve their clients ever changing needs in sound and vibration, and work with and support the other groups within Pinchin.

The consideration of noise issues, for years, has been strongly related to Pinchin's work in environmental permitting and approvals. This has been important in order to manage and regulate the impact from commercial and industrial facilities on acoustically sensitive areas, as noise is considered to be a contaminant as defined by the World Health Organization.

Since this initial consideration, a number of additional factors have evolved; thereby, elevating the importance of noise and other acoustic concerns. Some factors of influence are:

- Building design construction continuing to utilize more cost effective and lightweight materials. This is increasing the necessity for both acoustic design and for sound transmission class (STC) testing of building partitions to ensure that appropriate acoustic separations have been implemented between critical spaces.
- Architectural design and innovation has also seen a movement toward more open spaces with acoustically hard surfaces which have the potential to compromise and diminish speech privacy in, for example, open plan offices. This requires consideration for space specific noise control, surface treatment and even sound masking systems in some cases.
- Research is also being done on how the acoustics of learning spaces has a direct impact on the ability of our children to learn effectively with comprehension in order to succeed in school. This requires special considerations for room acoustics treatment and noise control design.

In recognising the changing acoustic landscape, Pinchin's Acoustics and Vibration Team has been adapting and evolving in order to meet our clients' demands and capture the new opportunities being presented.

2 Expansion of Services

The Acoustics and Vibration Team has a very strong base in environmental noise and vibration assessment, given the company's roots in environmental, health and safety. The Acoustics and Vibration Team at Pinchin Ltd., is expanding its expertise to address growing clients' needs in testing and the requirement for solutions to challenging sound and vibration challenges.

2.1 Environmental Noise and Vibration

As the distance between industrial facilities and their neighbours' decreases, noise is becoming an increasingly common problem for plant managers to address. When land uses change around industrial areas, a proactive strategy in identifying potential noise concerns has the potential to limit costs and nuisance issues in the future. Our environmental services do not just cover the necessary compliance and approvals work. We also work with our clients alongside the other groups within Pinchin in order to resolve difficult issues and develop value added engineered noise control solutions that fit our client's needs and budget.

Figure 1: Roof top noise impacting nearby balcony in Toronto.

2.2 Building Acoustics

The established Building Sciences group at Pinchin offers a number of services with the overall goal to improve energy efficiency, building performance, reduced operating costs, minimize environmental impacts and enhance occupant comfort. It is in these areas where the Building Sciences Group leans on and collaborates with the Acoustics and Vibration Team to provide clients with value added services. This includes Acoustic Planning, Design Development and Commissioning, Environmental Noise in Land Use Planning, Acoustic Design in façade construction, indoor noise and vibration modelling of HVAC and power equipment, partition study reviews for speech privacy, ASTC testing, and room acoustics measurement and assessment. These services enhance the current offerings of the Building Sciences Group in Building Envelope Design, Building Sciences Investigation and Optimization, Condominium Management Support and Tarion Bulletin 19R certification.

Figure 2: Double stud wall construction for high STC partition.

2.3 Occupational Noise and Vibration

Within Pinchin there exists an already well established Occupation Health and Safety Group (OHSG). This team of Environmental, Occupational Health and Safety professionals is made up of Certified Industrial Hygienists (CIH), Registered Occupational Hygienists (ROH), Professional Engineers, Canadian Registered Safety Professionals (CRSP), and Lead Auditors (CEA, EMS, (LA)) to assist in meeting our clients' Health and Safety goals.

Figure 3: Human vibration assessment in the work environment.

With respect to acoustics and vibration, the OHSG has been independently conducting audits of workplaces to ensure compliance with the Ministry of Labour initiatives. In many cases, there is a requirement for developing engineering solutions to address and meet the appropriate noise and vibration exposure limits. The growth of the Acoustics and Vibration Team in terms of skills and capabilities has allowed an expansion of client services offered by the OHS. This includes engineered noise and vibration management programs, hand-arm and whole body vibration assessment, construction noise and vibration monitoring and assessment, noise and vibration measurement to investigate intrusion into office spaces and its impacts on employee comfort.

2.4 Noise and Vibration Control Design

Noise and Vibration Control Design is a key aspect of projects handled by the Acoustics and Vibration Team. The complexity and implications of approvals and permitting for multi building, multi-site facilities have significant cost implications for implementation of noise control in major urban centres & residential communities. In this case, a well thought out and strategic Noise and Vibration Control Plan is required to address both interior and exterior requirements.

Pinchin's consulting engineering and technical support services in noise, acoustics and vibration include: Environmental Noise and Vibration, Architectural Acoustics and Building Noise Control, Acoustic Audits and Assessment Reports, Mechanical Noise and Vibration Control, Acoustic Performance Verification Studies, Occupational Noise and Vibration Assessments with Engineered Control Programs, Environmental Permitting, Municipal Approvals such as Site Plan Control and Rezoning, Construction Noise and Vibration Monitoring, Noise and Vibration Control Design Development and Project Management services, Complaint Investigations and Sound Level Monitoring, Expert Municipal Board Testimony in rezoning, land use planning, proposed development, Policy development and negotiating, Acoustic Testing for proposed infrastructure and design/build projects.

Group One Acoustics Inc.

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Résumé

Groupe One Acoustics est un cabinet de consultants et de design spécialisé dans l'acoustique architecturale. Lors de l'établissement en 1983 l'objectif principal était la conception des installations pour les studios d'enregistrement de musique, la postproduction audio et de l'industrie du film. Dès le début des années 1990, le porte folio de projets a commencé à inclure les théâtres, les églises et les salles de cinéma maison. L'étendu de travail varie de simple modification de studio jusqu'à la conception complète d'installations polyvalentes.

Mots-clés: acoustique, musique, studios d'enregistrement, salles de spectacles

Abstract

Group One Acoustics is a design and consulting firm specializing in architectural acoustics. When established in 1983 the primary focus was facility design for music recording studios, the post audio and film industry. Beginning in the early 1990's, project began to include theatre, churches and home cinemas. Work scope varies from alterations of single studio rooms to complete design of multi-purpose facilities.

Keywords: acoustics, music studio's,

1.0 Introduction

GOA Inc. is operated by Terry Medwedyk whose work background began in recording studios in the late 1970's to early 1980's. Early work included some live performance mixing. Knowledge gained from years of field experience in a variety of environments; has been the primary education. Though the majority of work is in southern Ontario, project locations include India and North America

1.1 Group One's Clients

The client's include Canadian Broadcasting Corp. (CBC), Technicolor Inc., Corus Entertainment, Bell Media Metalworks Recording, Noble Street. Studios, Humber College, Sheridan College, Hope Fellowship Church, the Stratford Shakespeare Festival, Lawrence Park Community Church, the Meeting House, St. Leo's Parish, Dalhousie University, and the Kwanlin Dunn Cultural Centre.

1.2 Services

Group One's services include site evaluation, facility planning, acoustic design and room plan, noise control, construction details, acoustic measurements and analysis.

1.3 Project Range

The range of projects vary across music recording, post audio studios, control rooms and mix theatres, radio and broadcast facilities, private home studios, home cinemas, churches and performance spaces.

2.0 Selected Projects

2.1 CBC

Involvement began in 1993 with acoustic upgrades to select class 'A' control rooms at CBC's Toronto facility. Following these alterations the work expanded to 16 additional Radio and TV division audio control rooms and studios. Uses of rooms ranged from music recording, post audio studios, music and film mix control rooms and a Foley studio. Alterations focused on interior acoustics - some moderate, and others more extensive - in response to client requirements at the time. Consultation and design services were also provided to several new and existing control rooms/studios across Canada. One of the final projects was the redesign of studio 'Q' in Toronto.

2.2 Metalworks Recording Studio's – Mississauga

Metalworks has been, for many years, primarily a top music recording facility with its history beginning in 1979. In 2006 the studio expanded to include an Audio Institute. The total facility is approximately 15,000 sq.ft. Studios 1 to 6 occupy 9,500 sq.ft and the remaining 5,500 sq.ft is occupied by Metalworks Institute's lecture rooms, audio suites and sound stage.

Group One Acoutics' involvement included design of Control room, Studios 2 and 6 and the institute's audio suites. Control room 2, a 400ft2 music mix control room and its 250 sq.ft studio, were originally designed in 1988 and recently altered with a refreshed interior design. Original design challenges included noise control

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considering the condition of the base building concrete slab and space planning within an existing floor plan. Studio 6 (550 sq.ft) and its control room (600 sq.ft) were designed in 2001. The control room side view window design allowed the front speakers of its 5.1 system, to be at the ear level plus allow use of a projection screen. All front wall speakers are flush mounted and both control rooms are fitted with retractable video screens.

2.3 Noble Recording Studios, Toronto

The 6,000 square foot music recording complex is located in the west end of the city. In addition to being bordered by streetcar and railway lines, another issue was its proximity to the Canadian National Exhibition that hosts a three day Indy race event plus a three day air show. The Studio A portion of the building was constructed from the ground up and houses a 525 sq.ft Control room A, a 120 s.ft booth, a 1,100 sq.ft Studio A, sound locks, a full kitchen and large lounge area. There is a mezzanine level for offices and a composing suite. Studio B is on the second floor of an existing two story building.

Studio A room was built as an independent shell within the building resting on a 7" concrete slab with spring isolators. Perimeter dead loads were critical thus the 19' high walls are load bearing metal framing with four layers of boarding, supporting the studio ceiling which spans 35'. A feature of studio A is the 8' x 14' area of skylights with ¾" thick laminated glass, each section staggered in height. The interiors are a blend of geometry, absorptive and diffusive surfaces coordinated with Hvac systems and a 14' wide retractable screen. Control A is also built as an independent shell isolated from the base slab and supporting a joist isolation ceiling. The interior floor includes extensive wire troughs and rests on its own isolator pads. Side view windows from the control room to the main studio and booth were designed to allow the main front speakers to be at the ear level. Control Room B (325ft2) and its booth (100ft2) are in a self contained area with its own lounge (which can double as a production space) and kitchen. Due to dead load limitations in the B section of the building, extensive use of Roxul in select ceiling and wall area's combined with limited boarding was used with success in regards to noise control.

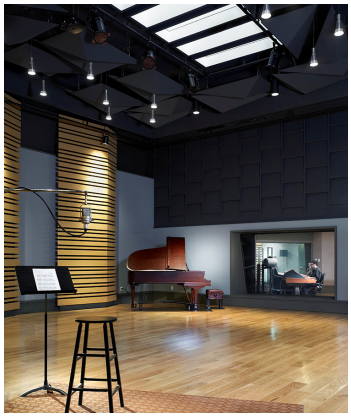

Figure 1: Noble Recording Studio.

2.4 Kwanlin Dunn Cultural Centre – Whitehorse

KDCC is a First Nations complex that includes a museum, meeting rooms and two convention halls. The larger of the two spaces known as The Longhouse (6,400 sq.ft with a 30' ceiling) exhibited an RT60 at 500 Hz of 2.7sec. The Multi-Purpose room (2,000 ft with a 25' ceiling) had an RT60 at 500 Hz of 2.2 sec. Work involved acoustic assessment and recommendations for HVAC noise and interior acoustics. Issues were not limited to the RT60; HVAC levels were NC 35-39; exhaust fans from the adjacent kitchen to the Longhouse were NC46 in the hall.

The original acoustic treatments were 3/8" hardboard with ¼" diameter holes on 4' centers, mounted on a 2" thick spacing frame along the long walls. The end or short walls were wood boarding directly on the partitions. The underside of ceiling is exposed wood planks and beams; floors are hardwood on concrete. Several solutions were proposed to the client but interior appearance was a strong driving element. Thus the final solution needed to remain a hard wood surface with vertical lines. New perforated wood finish panels (10% to 18% perforation) were arranged to fit the same wall area as the previous panels, but were mounted on slight angles. Cavities were light filled with insulation. Ceiling treatment was similar with new perforated panels covering approximately 25% of the ceiling area. End walls are to eventually have a portion devoted to First Nations emblems on fabric panels. Results have been extremely favourable with alterations to mechanical completed and a reduced RT60 of 1.4 at 500 Hz, with some treatments remaining to be completed.

Figure 2: Kwanlin Dunn Cultural Centre.

SVS CANADA - SYSTEM INTEGRATORS FOR ACOUSTIC AND VIBRATION TECHNOLOGY

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Résumé

Sound and Vibration Solutions Canada Inc. compte plus de 35 ans d'expérience dans les domaines de la mesure acoustique et vibratoire ainsi que dans l'instrumentation d'analyse. Nous sommes un représentant des fabricants canadiens offrant une assistance pour la prise de mesure ainsi que de la formation sur les technologies de pointe. SVS possède une vaste expérience dans le domaine de l'intégration personnalisée pour des solutions clés en main à la recherche d'un fournisseur singulier.

Mots-clés: instrumentation acoustique, vibration instrumentation, analyseurs, systèmes de mesure

Abstract

Sound and Vibration Solutions Canada Inc. has had over 35 years' experience in the fields of acoustic and vibration measurement and analysis instrumentation. We are a Canadian manufacturers' representative providing measurement assistance and training of advanced technology. SVS has extensive experience in the area of customized integration for turn-key solutions searching for one supplier source.

Keywords: Acoustic instrumentation, vibration instrumentation, analyzers, measurement systems

1 Introduction

SVS Canada Inc., a wholly owned and operated Canadian company, seeks noise and vibration product solutions from world leaders for the Canadian marketplace. The advancement of Canadian research and development relies on quick turn-key systems with out of the box solutions. We offer free consultation and direction for these solutions empowering our clients in a competitive marketplace and challenging new research. Andy Metelka, president and owner spent the first 15 years of his career with Nicolet Instrument Canada while working with both Nicolet Scientific and Nicolet Test Instruments. Nicolet Scientific (formerly Federal Scientific) was responsible for developing the first Portable FFT analyzer, while the Nicolet Test Instrument Division developed the first Digital Storage Oscilloscope. After Nicolet closed its operations world-wide Andy remained focused on the acoustics and vibration industries with a broader market and product selection by founding Novel Dynamics Test Inc. The company now has changed its name to better reflect the nature of its focus; Sound and Vibration Solutions Canada Inc.

SVS Canada specializes in Noise and Vibration Applications. Sound & Vibration Solutions Canada Inc. provides all these services to the Canadian Marketplace as a true solution-based Canadian Distributor. Andy has a background in instrumentation design with several research firms and a degree in Electronics Engineering Technology. He is long standing member of the CAA, CMVA, ASA, INCE, and IEEE. SVS Canada now provides consultation in measurement applications to find appropriate solutions.

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2 Product Line

SVS offers the following products:

- Sound Level meters
- FFT analyzers/recorders
- Laser Vibrometers
- Sound sources
- Measurement microphones, free field, Pressure, Random incidence, Outdoor, Array, Sound Intensity. KEMAR Head, Ear & mouth simulators.
- Studio Microphones
- Modal analysis acquisition and software
- Vibration Sensors & Vibration analyzers
- Acoustic imaging systems, Beam Forming Acoustic Holography
- Wind Turbine noise, vibration and infrasound measurement systems. Fig# 1, 2,and 3.
- Seismic measurement , monitoring PPV
- Building Vibration monitoring
- 3D- Acoustic imaging using particle velocity and sound intensity. Noise mapping 2D & 3D Noise mapping
- In-situ acoustic absorption.

Our clients include Universities, consultants, the automotive and aerospace industries, the military and more. An example of one such turn-key system solution is described below.

New technology will provide the means to understanding complex sources and propagation of low frequency pressure.

Currently low frequency pressure is not considered audible noise and future research requires new technology for simultaneous measurements of multi-dimensional complex transmission paths. Analysers with advanced recording capability custom programmed for these measurements have led to the discovery of complex blade-to-tower pressures indicating far field propagation and much more. Measurements, however, are complex functions of pressure amplitudes, frequency, time and space. Combining air flow, atmospheric conditions, temperature, humidity, wind gusts, wind direction and so on becomes an impossible task for a Sound Level Meter. SVS Canada Inc. has developed a turn-key flexible solution to synchronously correlate these and other parameters for the successful measurement of Wind Turbine noise, infrasound, vibration and weather parameters. Instrumentation and sensors used are traceable to the highest world recognized standards.

Fig.1 Rugged field portable advanced noise, infrasound and vibration System.

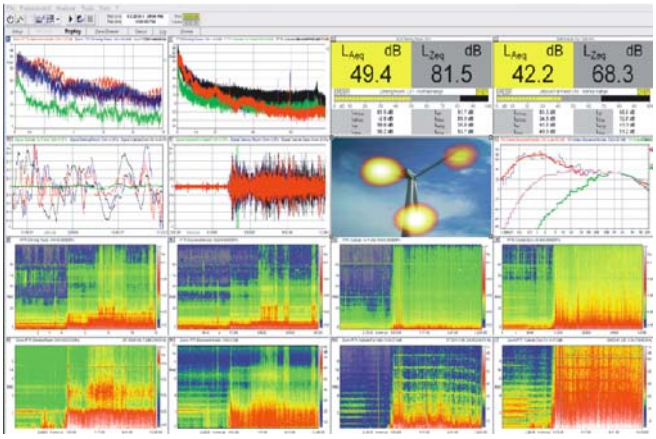

Fig.2 Real-time Display Example

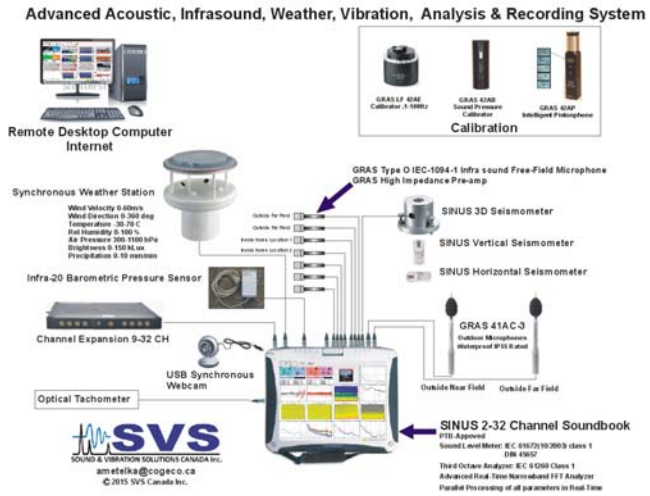

Fig.3 Layout diagram of advanced options and system expansion.

Fig.4 Advanced noise and vibration analyser with PTB approval**.**

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KR MOELLER ASSOCIATES LTD

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Résumé

K.R. Moeller Associates Ltd. (KRM) s'est consacrée exclusivement à la conception et la fabrication de systèmes de masquage de sons depuis 1978. Ses produits sont disponible mondialement et installées dans des dizaines de millions de mètres carrés à travers le monde pour des clients allant de petites entreprises aux tops 100 repris dans Fortune. Après des décennies d'offre du système populaire de masquage de sons Scamp®, la société est retournée à la planche à dessin. Le résultat? En 2003, ils ont révolutionné l'industrie quand ils ont lancé le premier réseau de masquage de sons du monde, le public-adress et la diffusion musicale: le Réseau acoustique LogiSon®. Il est maintenant un chef de file reconnu qui a obtenu plus de vingt récompenses pour l'innovation, la performance et la facilité d'utilisation.

Mots clefs : acoustique, masquage de sons, confidentialité, contrôle du bruit

Abstract

K.R. Moeller Associates Ltd. (KRM) has been exclusively dedicated to the design and manufacture of sound masking systems since 1978. Their products are available globally and installed in many hundreds of millions of square feet for clients ranging in size from small business to Fortune 100. After decades of offering the popular Scamp® Sound Masking System, the company returned to the drawing board. The result? In 2003, they revolutionized the industry when they launched the world's first networked sound masking, paging and music system: the LogiSon® Acoustic Network. It is now a recognized leader that has earned over twenty awards for innovation, performance and ease of use.

Keywords: acoustics, sound masking, speech privacy, noise control

1 Introduction

Prior to forming K.R. Moeller Associates Ltd. (KRM) in 1978, Klaus Moeller worked for German office furniture manufacturer and inventor of the modern open office concept, Quickborner Team. While with Quickborner Team, Moeller's experience in solving the acoustical problems that plague office environments grew. Moeller recognized that sound acoustical planning should be part of any workplace, providing him with the motivation to form KRM.

2 Technology

The first sound masking product marketed by KRM was the Scamp Sound Masking System, which used a decentralized masking architecture. Rather than locating sound generation, volume and frequency control in a central location, the electronics required for these functions were integrated into 'master' loudspeakers, which were distributed throughout the facility; hence, the 'decentralized' or 'distributed' name.

Each 'master' was connected to up to two 'satellite' loudspeakers, which repeated their settings. Therefore, the system's zones were only one to three loudspeakers in size (*i.e.* 225 to 675 ft^2), as opposed to the dozens or hundreds used in centralized masking architecture. This distributed design also inherently controlled phasing. In addition, because each small zone offered fine volume control, local variations could be addressed, allowing more consistent and, hence, effective masking levels to be achieved across a facility. However, there were limits to the adjustments that could be made with respect to frequency, which impacted performance. Furthermore, a technician had to make changes directly at each 'master,' making future adjustments challenging.

It is advisable to measure performance and modify a sound masking system's settings when changes are made to the physical characteristics of the space (*e.g.* furnishings, partitions, ceiling, flooring) or to occupancy (*e.g.* relocating a call center or human resource functions into an area formerly occupied by accounting staff). The likelihood that these types of change will occur during a sound masking system's 10- to 20-year lifespan is almost certain; therefore, one cannot take a 'set-it-and-forget-it' approach. KRM's engineers needed to develop a more practical way of adjusting the masking sound.

After three years of intensive in-house development, KRM launched the LogiSon Acoustic Network in 2003. In so doing, the company created an entirely new category of sound masking architecture: networked.

This technology leverages the benefits of decentralized electronics, but networks the system's components together throughout the facility—or across multiple facilities—in

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order to provide centralized control of the zoning/output of individual loudspeakers via a control panel and/or software. Changes can quickly be made following renovations, moving furniture or personnel, maintaining masking performance within the space without disrupting operations.

Figure 1: KRM's LogiSon Acoustic Network installed in a facility featuring an open ceiling.

When designed with small zones of one to three loudspeakers offering fine volume (*i.e.* 0.5 dBA steps) and frequency (*i.e.* 1/3 octave) control, networked architecture can also provide consistency in the overall masking volume not exceeding ±0.5 dBA, as well as highly consistent masking spectrums, yielding much better tuning results than possible with earlier architectures.

3 Research and education

Throughout its history, KRM has sought to raise awareness of sound masking technology and educate building professionals about its impact within applications such as corporate offices, hospitals, call centers, hotels, and green buildings, as well as the relative ease with which it can be implemented in occupied facilities. The company has also worked to expand use of the technology to routinely include closed rooms, allowing clients to realize construction savings by, for example, reducing walls' STC rating.

The company's most recent studies demonstrate the significant impact varying masking levels have on speech comprehension, a finding that strongly argues for a tightening of traditionally-accepted tolerances for spatial uniformity. Indeed, the adjustments a consultant or technician makes after a sound masking system is installed are an essential part of the commissioning process. To facilitate this process, KRM also developed a unique computerized tuning method called TARGET.

TARGET measures the masking, simultaneously recalculates two dozen controls, and automatically applies changes to achieve the specified curve. TARGET performs these steps in less than 1 minute per zone, while yielding the required results of ±0.5 dBA. Acoustical consultants who have used TARGET and evaluated its results have been extremely positive about the contribution it makes to tuning efficiency and masking performance.

4 Updating performance standards

Given its research findings, KRM is also heavily involved in improving specifications and standards related to sound masking. For instance, the company's Director of Strategic Relations, Ric Doedens, is part of an ASTM subcommittee specializing in speech privacy that is currently working on proposed standard *WK47433, Performance Specification of Electronic Sound Masking When Used in Building Spaces*. This subcommittee is also in the process of updating:

- *ASTM E1130, Test Method for Objective Measurement of Speech Privacy in Open Plan Spaces Using Articulation Index;*
- *ASTM E1374, Guide for Open Office Acoustics and Applicable ASTM Standards;*
- *ASTM E1573, Test Method for Evaluating Masking Sound in Open Offices Using A-Weighted and One-Third Octave Band Sound Pressure Levels, and*
- *ASTM E2638, Test Method for Objective Measurement of the Speech Privacy Provided by a Closed Room.*

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ANCL -AEROACOUSTICS AND NOISE CONTROL LABORATORY AT UOIT

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Résumé

Ce document met en lumière quelques-unes des activités de recherche et de développement effectuées dans le laboratoire d'aéroacoustique et de contrôle du bruit (ANCL), qui est situé à *University of Ontario Institute of Technology* (UOIT) à Oshawa. L'ANCL mène des projets de recherches et développement de pointe dans les domaines de l'aéroacoustique, de l'interactions fluide-structure, des écoulements turbulents, des vibrations et du bruit induit par un écoulement, du contrôle de vibration et de bruit. En outre, le ANCL a la capacité d'effectuer des évaluations de produits et équipements acoustiques pour assurer le respect des différents codes et normes. Le but de cet article est de mettre en évidence l'expertise disponible à ANCL et de promouvoir de nouvelles collaborations et de nouveaux partenariats avec les industries au Canada et à l'étranger.

Mots-clés: aéroacoustique, intéractions structure-écoulement-bruit, contrôle du bruit et des vibrations

Abstract

This paper highlights some of the research and development activities performed in the Aeroacoustic and Noise Control Laboratory (ANCL), of the University of Ontario Institute Of Technology (UOIT) in Oshawa. ANCL conducts leading edge research and development in the fields of AeroAcoustics, Fluid-Structure Interactions, Turbulent Flows, Flow-Induced Vibrations and Noise, Noise and Vibration Control. Moreover, the ANCL has the capability to conduct assessments of acoustic products and facilities to ensure compliance with different codes and standards. The aim of this paper is to highlight the expertise at ANCL and to promote new collaborations and partnerships with industries in Canada and abroad.

Keywords: aeroacoustics, flow-sound-structure interactions, noise and vibration control

1 Introduction

The objective of the research team in the Aeroacoustics and Noise Control Laboratory (ANCL) is to contribute to the advancement of AeroAcoustics and Flow-Sound-Structure Interactions. The majority of our research projects address a wide range of practical engineering problems related to the design and operation of automotive, aerospace, and energy systems. Wall-bounded and free shear flows are inherently unstable. A small disturbance in the flow field, caused by a structural vibration and/or acoustic perturbation, can be strongly enhanced which often leads to the generation of acute noise problems and/or excessive vibration. Our research aims to understand the physics underlying the flow-sound-structural interaction mechanisms in order to develop innovative active and passive control techniques to eliminate these undesirable effects and produce more desirable effects such as enhanced mixing and drag reduction on motor vehicles. The research team at ANCL has contributed significantly to the knowledge transfer through successful collaborations with industrial partners such as; Ontario Power Generation, Bombardier Aerospace, Vibro-Acoustics, WEGU Manufacturing, and VertiGo Digital Displays. The ANCL is equipped with cutting edge experimental and numerical facilities for noise, vibration, and flow characterization. Some of the recent projects performed at ANCL are summarized below.

2 Flow-Sound Interaction Mechanisms

Flow-excited acoustic resonance is a design challenge in many engineering applications such as tube bundles in heat exchangers, boilers, turbomachines, and reactor vessels. The resonance can lead to acute noise problems and/or excessive vibrations. The research team at ANCL has been investigating the fundamental mechanisms of the flow-sound interaction in tube bundles with both bare and finned cylinders in cross-flow, as shown in figure 1. The first objective of this work is to develop design guidelines to predict the occurrence of acoustic resonance, expected noise level and the dynamic forces acting on heat exchanger tube bundles to ensure efficient, safe and reliable operation of the equipment. The second objective is to develop practical control strategies that can be used to alleviate the occurrence of acoustic resonance in tube bundles of heat exchangers [1].

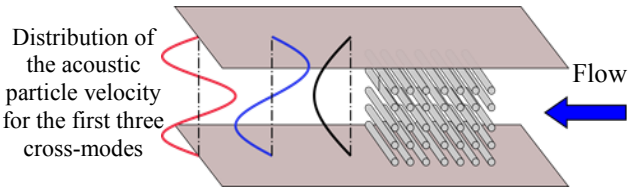

Figure 1: Flow-excited acoustic resonance in tube bundles.

3 Suppression of Flow-Induced Noise

The research team at ANCL has developed several passive control techniques for suppression of acoustic resonance excitation in shallow rectangular cavities, shown in figure 2. The first technique introduces secondary vortices generated by different spoilers located at the upstream cavity edge orthogonal to the main cavity shear layer. The second technique utilizes a high frequency vortex generator (i.e. control cylinder) placed in the vicinity of the upstream cavity edge. The last control technique introduces an upstream flow

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disturbance using wall mounted blocks. It is revealed from this work that the acoustic resonance is suppressed in the cavity due to either a reduction in the spanwise correlation of the free shear layer which, in turns, reduces its susceptibility to acoustic excitation, or an alteration in the impingement point at the downstream edge of the cavity, and thereby weakening the feedback cycle that controls the acoustic resonance excitation [2].

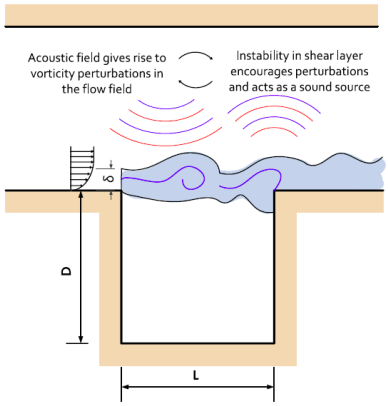

Figure 2: Fluid-resonant feedback mechanism in cavities.

4 Assessment of Test Facilities and Products

The ANCL Lab has the capabilities to test and characterize noise produced from industrial or residential facilities. Reverberation and anechoic chambers are essential facilities used for noise characterization. Figure 3 shows an on-site characterization of the reverberation time inside an industrial reverberation chamber using an impulse sound source. Moreover, the ANCL team performs full noise characterisation of industrial products and provides innovative solutions to eliminate noise problems. The tests are performed in state-of-the-art semi-anechoic chamber that has a background noise less than 29 dB.

5 Flow-Induced Vibration of Multi-Span U-Tubes

Steam generators in nuclear power plants have experienced tube failures caused by flow-induced vibrations. Two excitation mechanisms are responsible for such failures; random turbulence excitation and fluidelastic instability. The random turbulence excitation mechanism results in long-term failures due to fretting-wear damage at the tube supports, while fluidelastic instability results in short-term failures due to excessive vibration of the tubes. Such failures may require shutdowns, which result in production losses, and pose potential threats to human safety and the environment. Therefore, it is imperative to predict the nonlinear tube response and the associated fretting-wear damage to tubes due to fluid excitation. Strategic research collaboration between Prof. M. Hassan at the University of Guelph and ANCL has provided new insight into the dynamic response of loosely supported multi-span u-tubes, such as the one shown in figure 4, subjected to turbulence and fluidelastic instability forces. This work contributes significantly to the safety and reliability of tube bundles in nuclear steam generators [3].

Figure 3: On-site measurement of a reverberation time and noise characterization of a digital display unit in the semi-anechoic chamber.

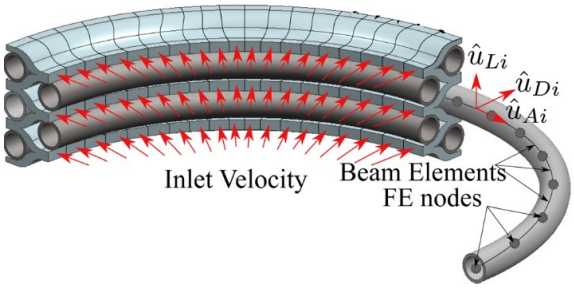

Figure 4: U-bend flow cell model.

6 Ergonomics and Dynamic Seat Comfort

Finally, the research team at ANCL has performed experimental and numerical characterization of the dynamic comfort in aircraft seats under different flight conditions using a multi-axis shaker table, shown in figure 5. Real flight data is used to assess the whole body vibration (WBV) exposures based on the international standard ISO-2631-1 and the British Standard BS-6841, thereby allowing for better development of aircraft seats at much lower costs and providing the customer with high quality products [4].

Figure 5: Evaluation of the aircraft seat comfort.

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OVERVIEW OF ACOUSTICS RESEARCH AT DRDC – TORONTO RESEARCH CENTRE

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Résumé

La recherche acoustique à Recherche et développement pour la défense Canada – Centre de recherches de Toronto est axée sur l'optimisation de la protection et de la performance auditive dans un environnement opérationnel militaire. Nous formulons des recommandations aux Forces armées canadiennes en ce qui a trait à la préservation de l'ouïe (au moyen de limites d'exposition et de mesures de protection) et à l'adoption de pratiques exemplaires de communication auditive efficace.

Mots clefs: bruit militaire, bruit impulsif, protection auditive, communication auditive.

Abstract

Acoustics research at Defence Research and Development Canada – Toronto Research Centre is focussed on optimizing auditory protection and performance in military operational environments. We make recommendations to the Canadian Armed Forces for hearing conservation (exposure limits and protective measures) and best practices for effective auditory communication.

Keywords: military noise, impulse noise, hearing protection, auditory communication.

1 Introduction

Acoustics research at Defence Research and Development Canada – Toronto Research Centre (DRDC – Toronto Research Centre) focusses on the optimization of auditory performance for the Canadian Armed Forces (CAF). CAF members require a high level of performance readiness for operations that may include extreme environments and conditions (e.g., heat and humidity, Arctic cold, high-performance aircraft) and prolonged or repeated exposure to high-level continuous and impulsive noise. In such conditions, hearing protection and communication issues are difficult to resolve, especially when compatibility with other personal protective equipment such as helmets or gas masks must be considered. As the operational requirements and CAF equipment change, and tactical communication and hearing protection technologies evolve, we continually adapt our research to meet these needs.

2 Equipment

DRDC – Toronto Research Centre has two main laboratories for hearing research: the noise simulation facility (NSF) and the hearing research laboratory (HRL). The NSF is a 10.6x6.1x3.1m^3 semi-reverberant room with a system of 16 loudspeakers at one end of the room, powered by 14 amplifiers (Figure 1). The background noise of the facility is about 28 dBA. The NSF was designed to simulate the acoustics of CAF operational environments (e.g., inside aircraft and armoured land vehicles) at noise levels of up to 130 dB SPL. The NSF is used for research on auditory overload, speech understanding with hearing protection devices (HPDs) and measurement of the insertion loss of HPDs and helmets with an acoustic test fixture (GRAS Sound and Vibration, Denmark). Psychoacoustic experiments are run using a Psychoacoustics Workstation (Tucker-Davis Technologies, Alachua, FL).

Figure 1: Speaker system and acoustic manikin in the Noise Simulation Facility. Photo credit: Jim Clark.

The HRL includes a doubled-walled 3.5x2.7x2.3m^3 audiometric booth (IAC acoustics, UK), a 2-channel clinical audiometer (Interacoustics, Denmark) and a programmable system for running several auditory perception protocols (Figure 2). We also have the capability to measure otoacoustic emissions (Intelligent Hearing Systems, Miami, FL). The HRL is used for studies of auditory detection, speech understanding and sound localization with HPDs as well as audiometric screening for study participants. We have access to many types of military and commercial off-the-shelf hearing protection and communication devices.

Our portable equipment for noise measurements in the field includes a number of high-amplitude and standard microphones (PCB Piezotronics, Depew, NY and GRAS),

sound level meters (Larson-Davis, Depew, NY), blast gauges (BlackBox Biometrics Inc., Rochester, NY), hydrophones (Ocean Sonics Ltd, Great Village, NS) and a four-channel Soundbook (SINUS, Germany). We have ANSI S12.42:2010 compliant equipment for measuring the impulse peak insertion loss (IPIL) of HPDs (GRAS).

Figure 2: Sound localization set up in the Hearing Research Laboratory. Photo credit: Jim Clark.

3 Research Themes

3.1 Impulse Noise and Blast

We are in the process of collecting noise data for in-service CAF weapons and ammunition to make recommendations for updating the hearing conservation doctrine for training safety. Data for small calibre weapons (i.e., hand-held rifles) have already been collected and analyzed [1]. Plans to collect and analyze artillery and blast data are in progress. We have completed IPIL measurements for several types of passive HPDs to account for their use in the calculation of the allowed exposures during weapons training [2].

In addition to weapon noise, some CAF personnel experience blast exposure in air and underwater. For tactical breaching training, instructors and students are exposed repeatedly to low-level blasts. We are quantifying the exposure levels and studying the effects on psychological and physiological function, including hearing. CAF clearance divers are exposed to blasts underwater, and safe stand-off distances are only defined for limited charge weights and conditions. To contribute knowledge in this domain, we have completed joint international trials to study underwater blast in shallow littoral environments [3].

3.2 Auditory Protection and Performance

Studies of sound localization with hearing protection and communication devices are not frequently reported in the literature. We have compared sound localization performance with communication headsets with passive and active noise reduction, and with the use of helmets [4]. The study results help to inform the CAF of how the ability to localize sounds and threats would be affected by wearing different types of hearing protection and communication headsets.

We have completed a series of studies looking at ways to mitigate auditory overload (from noise and radio communications) in command and control posts [5].We have studied speech understanding through military radio systems in our laboratory [6] and with hearing-impaired listeners through contractors [7]. Recognizing the high percentage of Francophones in the CAF, we have also studied the impact of non-fluency on speech understanding with radios [8,9]. Auditory communication research is also relevant to Royal Canadian Navy (RCN) platforms, and we are planning to conduct a noise survey and observation of communication interference at sea [10].

Acknowledgments

Funding for our work in auditory protection and performance is provided by the DRDC Personnel portfolio, Diagnostics and Health Protection project. Auditory communication in the RCN workspaces is supported by the DRDC Navy portfolio, RCN Crewing and Human Factors project, and the safe diver standoff work is supported by the RCN Naval Mine Countermeasures project.

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DESIGNING, SIMULATING, AND PROTOTYPING ACOUSTIC ARCHITECTURE

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Résumé

The John H. Daniels Faculté d'Architecture, Landscape et Design, à l'Université de Toronto développe un programme de recherche solide en mettant l'accent sur l'architecture acoustique. Construire sur des projets de recherche antérieurs qui ont démontré comment le son peut être intégré dans l'architecture des flux de travail de conception, de nouvelles recherches cherche à construire sur les progrès dans la conception architecturale et de calcul de la fabrication numérique pour développer des méthodes de conception sur mesure et des surfaces innovantes. Machines robotique avancée de fabrication permet la production de prototypes complexes, et des outils numériques permettent des performances acoustiques de la pièce peut être simulée. Détails du passé et les recherches futures seront mis en évidence dans ce bref résumé.

Mots clefs : Acoustique architecturale, simulation acoustique, fabrication numérique

Abstract

The John H. Daniels Faculty of Architecture, Landscape, and Design, at the University of Toronto is developing a robust research program focusing on acoustic architecture. Building on past research projects that have demonstrated how sound can be integrated into architectural design workflows, new research seeks to build on advances in architectural computational design and digital fabrication to develop bespoke design methods and innovative surfaces. Advanced robotic fabrication machinery enables the production of complex prototypes, and digital tools enable room acoustic performance can be simulated. Details of past and future research are highlighted in this short summary.

Keywords: Architectural acoustics, acoustic simulation, digital fabrication

1 Introduction

Human activities produce sound, and architecture constantly interacts with us through its modification of sounds; we hear space as much as we see it. Despite the uncontested fact of the importance of sound, acoustic performance is often an afterthought in current architectural practice, and so there is a pressing need to incorporate sound in architectural design processes. Virtually all architectural design is carried out using computer-aided design (CAD), making it the ideal platform in which to develop new techniques.

The aims of our research is to bring the developed aspects of acoustic science into the practice of architectural design; to study the relationship of complex surfaces and the resulting acoustic characteristics of the space; to create innovative acoustic surfaces that can be deployed within the architectural interior; to develop design workflows for architects that incorporate acoustic performance parameters; and to study the potential of digital manufacturing for the production of performance-based architecture. Advances in scripting interfaces are empowering architects to create their own bespoke design tools, the digital design environment is undergoing a perceptible shift in authorship [1].

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2 Capabilities

Our research prioritizes a performance-driven design paradigm, but considers this paradigm within the complexity of the architecture project and its social and cultural context. Projects use a research-by-design methodology in which experiments progressively gain more focus: “design probes” test formal aspirations and concepts; "design prototypes” study 1:1 detail, manufacturing tolerances, and material properties; and finally "demonstrators"—full-scale working prototypes test the architectural and acoustic condition under study. Established quantitative scientific methods for simulation, measurement, and qualitative listening tests are used to evaluate design proposals.

The primary design tools used are: digital 3D modelling (using Rhino or MicroStation), parametric modelling to create variable geometries (Grasshopper or Generative Components), computer programming to create new design tools (Visual Basic or Java), rapid prototyping for to create scale models (3d printing and laser cutting), digital fabrication to produce 1:1 prototypes (various kinds of CNC cutting and milling), and simulation to predict acoustic performance (Odeon or Pachyderm). The developed digital tools and workflows are evaluated within the context of specific projects and are modified throughout the design process in response to developments in the design brief.

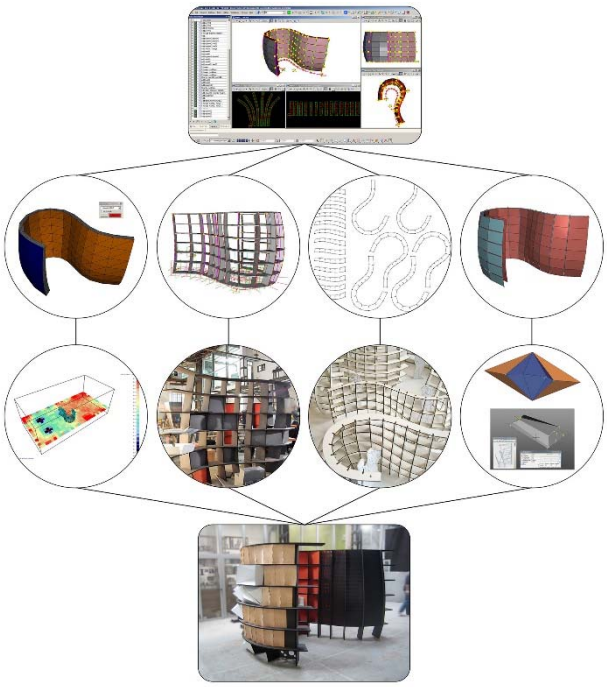

Figure 1: The computational model as organising element

3 Results and Discussion

The research is focused on the development of design tools, and on the development of new types of acoustic surfaces. The first prototypes—*Manufacturing Parametric Acoustic Surfaces* (Barcelona, 2010) [2], and *Distortion I* (Copenhagen, 2010) demonstrated that architectural surfaces can be formed and their material properties modified to define perceptually different types of acoustics spaces. In both experiments, the parametric model became a synthesis of all design ideas and contained multiple representations of project: for visualization, for simulation, and for fabrication.

Figure 2: Distortion I, Copenhagen, Denmark

Distortion II (Copenhagen, 2011) further developed the concept of "acoustic subspace", and introduced a new quantitative parameter (STV IA-diff) for the evaluation of personal acoustic experience [3]. The *FabPod* project (Melbourne, 2012) further investigated the potential to "tune" performance through material differentiation. Four digital workflows were developed to integrate acoustic simulation into architectural design: using computer acoustic simulation software, using plug-in software in architectural CAD, using a Boundary Element Method (BEM) simulation for calculating sound scattering, and developing a Finite-Difference Time-Domain (FDTD) technique for visualizing sound waves and sound scattering [4].

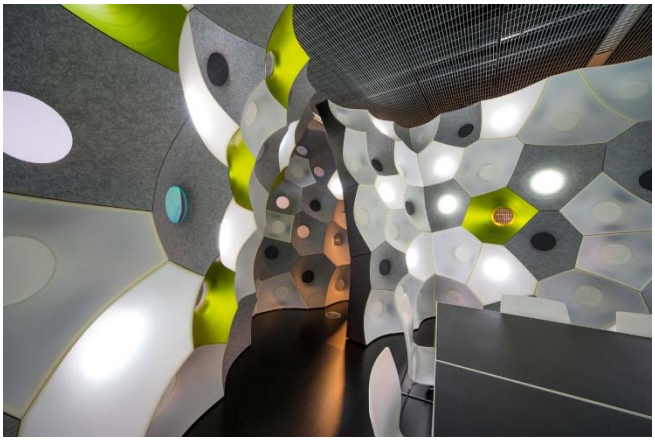

Figure 3: FabPod, Melbourne Australia.

4 Future Projects

Our research continues investigate the architectural potentials of parametric design, computer simulation, and digital fabrication through the prototyping and analysis of acoustic surfaces, and continues to develop the acoustic architecture toolkit. However, beyond coupling digital design to performance simulation, future projects will link acoustic design to robotic constructive processes. In the new Daniels Architecture building, our new lab will develop innovative complex surfaces that offer improved architectural acoustic performance, which will inspire new attitudes towards the role of sound in architectural design, and new limits for the potentials of robotic digital fabrication will be established.

Architecture is an instrument. Through the manipulation of geometry and surface, designers create spatial and experiential sonic effects. To design acoustic architecture is not to merely meet minimum standards, but to inspire new cultural and social meaning through extraordinary sound. There is a need for design tools that support this acoustic exploration and creative innovation. Architecture is a design process that extends from ideation through to realization; and, the incorporation of acoustic performance must therefore be considered in the design phase and integrated into the constructive logic of fabrication and assembly.

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dB NOISE REDUCTION (dBNR)

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Résumé

dB Noise Reduction (dBNR) a été créé en 2002 par des experts de contrôle du bruit spécialisés dans la conception des silencieux industriels et environnementaux. En tant que concepteurs et fabricants responsables, dBNR garantie que leurs conceptions sont performantes et que la qualité des produits assurent au client un cycle de vie du produit long et productif.

Mots-clés: Silencers, enceintes, conception de contrôle du bruit

Abstract

dB Noise Reduction (dBNR) was established in 2002 by noise control experts in advanced industrial and environmental silencer design. As responsible designers and manufacturers, dBNR warrants that their designs perform and the quality of the products guarantee a long and productive lifecycle for the customer.

Keywords: Silencers, enclosures, noise control design

1 Introduction

dB Noise Reduction's (dBNR) head office and engineering is located in Cambridge, ON with additional sales offices in Winnipeg, MB, Dublin, OH and Belvidere, IL. Our product manufacturing takes place at locations in the USA, Canada and Mexico. All are capable handling equipment sized up to 25,000 lbs. Our offices and facilities are ISO 9001:2008 certified in accordance with our strict quality control procedures.

2 Product Line

dBNR's product offering continues to grow, and along with silencers, mufflers, tuned-reactive and vent silencers, accompanying rain and weather hoods and accessories such as filter boxes and houses, flex connectors and acoustical flex connectors. We also offer Nois-eNvelope™ Architectural Environmental Noise Barrier Systems, shown in Figure 1, and Noise Control Enclosure Systems with our proprietary single-span panels UP TO 24"-0" long! We have expanded into Architectural Acoustics by offering easy to install wall and ceiling panels, floor underlayment's, as well as resilient sound isolation clips. These products contribute to improving individual comfort levels and workers productivity by improving STC and IIC ratings.

Our noise control application areas include - Refineries; Steel Mills; Power Generation; Mining and Tunnel Ventilation; Paper and Pulp; Gas Turbines; Nuclear Plants; Cement, Gas and Ethanol Production.

2.1 Areas of Application

In the area of architectural acoustics applications, we supply products to Health Facilities, Office Buildings, Learning Facilities, Places of Worship, Commercial Buildings and Residential Buildings.

Figure 1: dBNR Nois-*e*Nvelope™ noise barrier systems

An example of a stack silencer is shown in Figure 2 below.

Figure 2: Stack Silencer for South American Power Plant

3 Noise Control Example

3.1 Problem

A long established nickel and copper mine was in need of extensive upgrades to bring its operations into compliance with current environmental regulations. At the top of the list of potential improvements, was a retrofit for the noisy 140,000 ACFM mining ventilation system. After extensive

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internal discussions, a custom fan silencer system incorporated into a refurbished air intake building was selected as the optimal solution.

Since mining operations run twenty-four hours per day, seven days per week, the noise levels from the mine ventilation system were an on-going problem for employees and nearby residents alike. Complicating the project was the condition of the existing ventilation enclosure, which was in need of extensive clean up, including the removal of hazardous material.

The dB Noise Reduction team worked with the mining company's acoustical consultant to develop a customized industrial silencer solution for the noisy 104 dBA axial fan currently in use. An integral part of the project included disassembly of the existing steel structure to remove corrugated asbestos paneling.

Figure 3: Ventilation system before control

3.2 Solution

The dB Noise Reduction team addressed all phases of the mine ventilation system upgrades through a number of phases that were completed over a twelve week period. The first step was to clean up the existing structural steel using a high pressure water blasting process. This avoided the need for environmentally harmful materials and eliminated the potential for dust and debris. Minimizing particulate was essential during this process, as the ventilation fan needed to remain in operation. Once the cleanup process was complete, a protective paint was applied to the steel structure.

The next phase in the project included special precautions for the removal of the corrugated asbestos. This was the only part of the project during which the ventilation fan had to be temporarily halted, due to the potential for asbestos exposure.

The dB Noise Reduction team coordinated the hazardous material removal with a certified removal team, who completed the job in less than one day. Following the excavation of the area, the newly cleaned and treated steel structure was enhanced with the installation of four modular fan intake silencers, two absorptive acoustic walls, and an absorptive acoustic roof. The new fan silencer system designed, supplied and installed by the dB Noise Reduction team reduced the noise level from 104 dBA to 72 dBA, a 32 dBA reduction from the original noise level, and well below all applicable government noise regulations.

Figure 4: Ventilation system after control

SMART LAB RESEARCH: AN OVERVIEW

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Résumé

Notre recherche explore la science de la musique, la recherche auditive, et la technologie. Nous sommes intéressés par la perception musicale, les discours émotionnel, et par les paysages auditifs. Nous étudions l'utilisation de la musique pour réhabiliter divers troubles de communication et afin de développer de nouvelles technologies afin d'améliorer la perception musicale. **Mots clefs :** Musique, perception, auditif, recherche, perte auditive

Abstract

Our research spans the science of music, auditory research, and technology (SMART). We are interested in the perception of music, emotional speech, and soundscapes. We are also investigating the use of music to rehabilitate various communication disorders and the development of novel technologies to support the perception of music.
Keywords : Music, perception, auditory, research, hearing loss

Research in our lab is situated at the intersection of music, mind, and action. What follows is an overview of a few of the studies currently underway in the lab.

To support research in emotion communication, we released the Ryerson Database of Emotional Speech and Song (RAVDESS). The RAVDESS was spearheaded by Dr. Steven Livingstone, a former Post-Doctoral Fellow. The database consists of 7,356 recordings of 24 professional actors vocalizing matched statements in face-only, voice-only, and face-and-voice formats. Using the Stanislavski system for emotional induction, actors were recorded singing a standard text with five different emotional expressions (calm, happy, sad, angry, fearful) and speaking the text with seven different emotions (adding surprise and disgust), each with two levels of emotional intensity. The database (http://smartlaboratory.org/ravdess/) provides a balanced and validated set of stimuli to use in research on different aspects of emotional communication.

Figure 1: A still taken from a "Happy" RAVDESS video

Dr. Naresh Vempala, a research associate in the lab, has been researching the acoustic cues underlying emotion in speech and music and their physiological effects on the listener. Acoustic variables considered include pitch, spectral, and temporal measures. Using the results of a behavioural experiment, we developed a computational model for emotion perception in music [1]. We followed up this work by collecting physiological responses, such as galvanic skin response (GSR), breathing rate, heart rate, and electromyography (EMG) of the zygomaticus ("smiling") and corrugator ("frowning") muscles of the face. Using data collected from both of these studies we were able to model induced emotion in a normal hearing individual [1-3]. The current modelling work is geared towards hearing loss and hearing aids. Ultimately, this line of research will allow us to conduct rapid prototyping of new hearing aid algorithms with less reliance on testing of human participants.

Hearing impaired and hearing aided individuals have difficulty distinguishing emotions in speech. Gabe Nespoli, a PhD candidate in the lab, recently completed a project on physiological responses to emotional speech in normal hearing, hearing impaired and hearing aided listeners. Participants were presented with stimuli from the RAVDESS and asked to judge the emotion conveyed while we recorded electrophysiological responses. Results showed lower responsiveness to emotional stimuli in hearing impaired and hearing aided participants. These findings raise important questions about the signal processing strategies employed in modern digital hearing aids.

Hearing is the dominant sensory modality for perceiving music, but not the only one. Dr. Paolo Ammirante, a Postdoctoral Fellow in the lab, has been leading research on the ability to perceive music presented to the skin. Mechanoreceptors in the skin are structurally similar to those in the ear and exhibit frequency tuning enabling coarse pitch perception. Although the skin is only equipped with a few broadly tuned frequency channels and without a "place code", this appears to be enough to enable discrimination between complex vibrotactile waveforms that possess the same level and fundamental frequency (i.e., timbre perception; [4,5]). The skin is also capable of giving rise to the perception of rhythm; however, this capacity proves challenging in the face of complex rhythms [6].

The lab has a strong interest in neural entrainment. Using electroencephalography (EEG), neural entrainment to

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the beat has been found to vary as a function of stimulus parameters, as well as listener history. In a recent study participants were asked to listen to 30-second excerpts of popular songs that had been previously rated as low-, mid-, or high-groove [7], where groove refers to the urge to want to "move to the beat". Participants' brain activity was monitored with EEG while they rated the groove of each excerpt. Fourier analyses of the EEG activity linked to motor sources revealed that the extent of entrainment to the beat was correlated with participants' ratings of perceived groove. These findings suggest that neural entrainment to the beat is related to the subjective feeling of groove.

Figure 2: Groovy music induces motor entrainment

Groovy or not, music can play a long lasting role in shaping neuronal networks. For example aging musicians show less neuronal degeneration in auditory signal processing than non-musicians [8]. Currently, no evidence exists regarding whether music training can support the regeneration of neural networks supporting music and language. A project in the lab led by Master's student Ella Dubinsky is investigating the efficacy of a ten-week singing program for older adults with hearing loss. Early findings are very promising; participants show significant improvements in speech-in-noise perception, pitch discrimination, and the neural response to voiced sound, as well as cognitive measures of attention. These results lend support to the use of choir participation and musical training as an intervention for older adults, to help mitigate age-related declines in audition and cognition.

Figure 3: Participants involved in choir study

We are also interested in the dark side of music making. In particular, Alberto Behar, a Senior Research Fellow has been investigating the relationship between noise exposure and hearing loss in professional orchestra musicians [9]. Although our first study did not find evidence for clinically significant losses in these musicians, we found that some instrument groups experienced more loss than others and that the type of loss corresponded to the extent of noise exposure. For example, brass players had mid-frequency thresholds that were 15dB higher than those of their peers. By combining noise exposure and hearing loss assessment, this study provides information that extends current understanding of the occupational risks faced by professional orchestral musicians. This information may be particularly useful in the design and use of hearing protectors, such as earplugs. We are currently reassessing the same orchestra five years later; these longitudinal findings will help us to better understand the occupational risks faced by orchestral musicians.

While the effects of noise exposure on hearing health are reasonably well understood, less is known about its short-term effects on attention and cognition. In a busy city like Toronto, the often cacophonous auditory environment can make considerable demands on selective attention. In a recent experiment, we presented 30 two-minute soundscapes to participants and asked them to make visual judgments. Results indicated that soundscapes tend to have an immediate influence on visual attention, suggesting that sounds in our local environments can consume limited attentional resources. Our motivation for this research is to inform urban planners, architects and acousticians, in the ongoing dialogue about sound quality in our cities [10].

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CLARIFYING AMPLITUDE ENVELOPE'S CRUCIAL ROLE IN AUDITORY PERCEPTION

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Résumé

La plus grande partie de la recherche du laboratoire MAPLE explore le rôle de l'enveloppe d'amplitude - la «forme» d'un son au fil du temps. Le système de perception est sensible aux changements dynamiques dans les enveloppes d'amplitude des sons naturels, lesquels transmettent des informations importantes sur les événements et les sources. Toutefois l'étude de la perception auditive utilise souvent des tonalités d'amplitudes fixes dépourvus de telles informations. Nos études ont documentés des cas dans lesquels la recherche fondée fortement sur de tels sons néglige certain des aspects principaux et des capacités du système de perception. Ici, je résume certains de ces travaux et les lignes directrices des orientations futures.

Mots-clés: enveloppe d'amplitude, perception auditive, timbre, intégration audio-visuel, alarmes auditives

Abstract

Much of the MAPLE Lab's research explores the role of amplitude envelope – the "shape" of a sound over time. The perceptual system is sensitive to the dynamic changes in the amplitude envelopes of natural sounds, which convey important information about events and sources. However auditory perception research often uses amplitude invariant tones lacking such information. Our studies have documented instances in which research based heavily on such sounds overlooks key aspects and abilities of the perceptual system. Here I summarize some of this work and outline future directions.

Keywords: amplitude envelope, auditory perception, timbre, audio-visual integration, auditory alarms

1 The MAPLE Lab

Founded in 2009, the MAPLE Lab researches Music, Acoustics, Perception & LEarning (www.maplelab.net). This interdisciplinary team explores topics of relevance to psychologists, musicians, neuroscientists, and educators at the graduate and undergraduate levels in a recently renovated, CFI-Funded facility. Our work ranges from audio-visual and sensorimotor integration to the design of auditory alarms and the communication of emotion in music. As Canada's first research facility with a percussion focus, we are proud to house several professional level percussion instruments affording new research possibilities. Our interest in percussion led to novel insights on the importance of the amplitude envelopes of percussive sounds, and we are now working to explore implications of these insights for general theories of auditory processing.

1.1 Natural sounds vs. "tone beeps"

Natural sounds such as those produced by musical instruments, speech, and/or real world events generally exhibit dynamically changing amplitude envelopes. For example, notes produced by the piano or marimba decay rapidly, similar to non-musical objects excited by impacts. The perceptual system uses this decay to understand the types of materials involved in the impact. Sustained events such as notes played on a clarinet or French horn do not decay immediately, but still exhibit dynamic changes.

In contrast to these natural amplitude envelopes, sounds synthesized for auditory perception research often trapezoidal shapes with a rapid onset/offset surrounding a sustain period. These "flat" tones hold many advantages for scientific research. They are easy to quantify, facilitating re-generation for replications. Their crisp offsets also afford clear quantification of duration. However, auditory researchers have noted that the natural world is "[not] replete with examples of naturally occurring auditory pedestals [i.e., flat amplitude envelopes]" (Phillips et al., 2002) and even issued explicit calls for increased research with tones "closer to real-world tasks faced by the auditory system" (Joris et al., 2004).

1.2 The prevalence of amplitude invariant tones

Although sounds with flat envelopes hold certain methodological advantages, they can lead to theories of auditory perception failing to generalize to our perception of natural events. For example, although vision does not typically affect auditory judgments of event duration [3], this widely replicated finding does not generalize to impacts produced by a marimba [4] or piano [5]. This complements other demonstrations that dynamic changes in envelope serve as important cues for perceptual organization [6]. Overlooking the role of amplitude envelope can lead to inaccurate conclusions. Past claims that the "unity assumption" is specific to speech [7] overlooked the crucial role of amplitude envelope in this important process [8]. Flat tones suggest conclusions about multisensory

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integration [9] and audio-visual association [10] that do not apply to natural sounds.

To empirically explore flat tones in auditory researsch, we classified the amplitude envelopes of sounds from 222 experiments published in the journal *Music Perception.* Our surprising results reveal that 35% of the sounds encountered lacked definition of amplitude envelope! Many undefined sounds used tones that were "500ms in duration" – presumably flat (although this description could apply to other shapes). Therefore the key outcome from this and subsequent [11] surveys is that the majority of auditory stimuli used in perceptual assessments lack the dynamic variation characteristic of natural sounds [12]. We are currently exploring the degree to which theories derived from these experiments generalize to natural sounds.

1.3 Impact events differ from receding sources

Research on amplitude varying sounds has often focused on asymmetries in the perception of rising vs. falling tones. Although impact sounds with decaying envelopes may appear similar to previously used "falling" tones (Fig 1), they hold some important differences. Those tones simulate sustained sources decaying in volume as they move away from the listener. Consequently they are much longer in duration than impact sounds – from around two seconds [13] to over a minute in duration [14].

In contrast, sounds originating from impact events and tones synthesized to simulate such sounds [6], [15] involve stationary, singular events. Consequently they mimic fundamentally different sources. This distinction is crucial if the auditory system processes sounds as "events" rather than mere "stimulus properties" [16], as sustained vs. decaying sources may be processed using different underlying strategies [17].

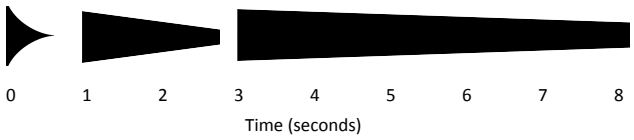

Figure 1: A sample percussive tone mimicking an impact occurring at a fixed location (left). This contrasts Nuehoff's (middle) or Teghtsoonian's (right) "receding tones" mimicking moving, sustained sources.

1.4 Future research directions

Flat tones often serve as the "default" stimulus for both research and applied purposes. For example, the International Electrotechnic Commission has previously recommended they be used exclusively for auditory alarms in certain medical devices – which may be one factor contributing to current problems with their design and usability. In the future we hope to clarify the important albeit underappreciated role of amplitude envelope in auditory perception. For more information on this work visit http://maplelab.net/overview/amplitude-envelope. We have also created software for synthesizing flat and percussive tones at maplelab.net/software to aid others interested in exploring this important acoustic property.

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NOISE REGULATION AT THE

ONTARIO MINISTRY OF THE ENVIRONMENT AND CLIMATE CHANGE

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Résumé

Dans la province de l'Ontario, la réglementation du bruit et des vibrations est effectuée par un petit groupe d'ingénieurs à l'effectif diversifié et regroupé sous la bannière de la Direction des Autorisations Environnementales du Ministère de l'Environnement et de l'Action en matière de changement climatique. Leur tâche principale est la vérification des études de bruits reliées aux demandes d'autorisations environnementales pour sites industriels. Certains de ces ingénieurs sont assignés au processus des autorisations de projet d'énergie renouvelable, et cette équipe s'occupe en majeure partie des demandes d'autorisation pour les parcs éoliens et les centrales solaires. D'autres fonctions effectuées par ces ingénieurs comprennent la vérification d'études de bruit soumises à l'appui des évaluations environnementales, l'enquête des plaintes de bruit, témoigner lors des audiences, et l'apport de clarifications pour la ligne directrice du bruit environnemental, laquelle est parfois utilisée telle quelle par certaines municipalités dans la formulation de règlements municipaux. Quoique l'administration des problèmes reliés au bruit en ce qui a trait à la planification de l'usage des sols fût transférée aux municipalités il y a plus de dix ans déjà, les ingénieurs du Ministère spécialisés en acoustique se sont quand même impliqués, avec succès, dans le dossier de la revitalisation du secteur riverain de Toronto lorsque trois paliers gouvernementaux en ont fait la demande. Puisque le Ministère n'a pas d'agence spécifique pour formuler la politique du bruit, contrairement à celles qui existent pour formuler les politiques de la pollution de l'air et les sites de déchets, ces ingénieurs acousticiens jouent aussi un rôle majeur dans la création de propositions pour changements de politique. Récemment, et avec la coopération de la communauté des consultants en acoustique, du secteur du développement, des municipalités, et des citoyens, les ingénieurs acousticiens du Ministère ont complété la première révision majeure en vingt ans de la ligne directrice relative au bruit environnemental.

Mots clefs: réglementation du bruit; autorisations environnementales; autorisations de projet d'énergie renouvelable; ligne directrice du bruit environnemental NPC-300

Abstract

Provincial regulation of noise and vibration in Ontario is carried out by a small and diverse group of engineers working for the Ministry of the Environment and Climate Change, in the Environmental Approvals Branch. Their primary activity is the review of the noise aspects of Air and Noise ECAs (Environmental Compliance Approvals) for industrial installations. Several noise engineers are also dedicated to the REA (Renewable Energy Approval) process, primarily related to wind and solar farms. Additional duties include review of Environmental Assessments, investigation of noise complaints, testifying at hearings, and clarification of the provincial noise guidelines, especially as used by some municipalities. Although dealing with noise issues around land use approvals was transferred to the municipalities over 10 years ago, the noise engineers stepped up when the Ministry received a request from three levels of government to become involved in the Toronto Waterfront Revitalization effort and were successful in resolving a serious noise-based conflict between developers and a significant industry. Since the Ministry does not have a separate agency for formulating noise policy, such as exists for air contaminants, the noise engineers also play a large role in implementing policy changes. Recently the noise group, in coordination with the noise consulting community, the development sector, municipalities and private citizens, completed the first major revision of the MOECC's noise guidelines in 20 years.

Key words: noise regulation; Environmental Compliance Approvals; ECA; REA; NPC-300

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1 Introduction

Provincial regulation of noise and vibration in Ontario is carried out by a team of Noise Review Engineers working for the Ministry of the Environment and Climate Change (MOECC), in the Environmental Approvals Branch located in midtown Toronto. This small group, normally numbering less than a dozen, is highly diverse in age from new engineers to near retirement, in background from a number of Canada's multicultural elements, and in experience, including private sector noise consulting, academia, marketing and the military.

2 Noise Team Qualifications and Experience

The most basic qualification for inclusion in the MOECC noise group is registration as a Professional Engineer under PEO. The majority are Mechanical engineers, although there are some other disciplines, such as Electrical and Civil. Most of the review engineers have at least some, and in some cases a great deal of university training in Acoustical Engineering. Helpful experience to bring to the task includes understanding of traffic and transportation noise, industrial noise, types of government jurisdiction over noise regulation, community reaction to various levels of noise, relative irritability/subjective loudness of different sound sources, typical sound levels of stationary sources and background/ambient sources, and of course, an instinctive grasp of logarithmic math. Also useful is experience in political, legislative and planning processes, and in consultation between government agencies, developers, legal teams and citizen groups.

3 Team Duties

The primary activity of the team is the review of applications for the noise aspects of Air and Noise ECAs (Environmental Compliance Approvals) for industrial installations. Emitter accountability is a strong principle of the Ministry, which requires that the applicant provide assessment of environmental impact, including specific abatement measures to address any identified excesses, without prompting by review staff. Thus, the review engineers act in an oversight role, ensuring that the submitted Acoustic Assessment Reports and Noise Abatement Action Plans fulfill MOECC requirements, that proposed solutions will occur in a timely fashion, and that environmental quality is protected for the citizens of Ontario.

An inherent part of the Noise Review Engineer's duties is coordination with Air Review Engineers, as noise approvals are normally part of Air and Noise ECAs and review of both air and noise submissions takes place concurrently. It is expected that each Air and Noise Review Engineer has a basic understanding of the review process of the other, although neither does detailed reviews outside of his or her own "medium". In recent years, "multimedia" approvals have been issued, in which such media as Waste and Wastewater are added to the process.

Additional duties for the noise engineers include review of Environmental Assessments, investigation of noise complaints, testifying at hearings, and clarification of the provincial noise guidelines, especially as used by some municipalities. As well, several noise engineers are dedicated to the REA (Renewable Energy Approval) process, primarily related to wind and solar farms. The noise engineers also stepped up when the Ministry received a request from three levels of government to become involved in the Toronto Waterfront Revitalization effort and were successful in resolving a serious noise-based conflict between developers and a significant industry.

4 Policy Work

Since the Ministry does not have a separate agency for formulating noise policy, such as exists for air contaminants, the noise engineers also play a large role in implementing policy changes. Recently the noise group, in coordination with the noise consulting community, the development sector, municipalities and private citizens, completed MOECC publication NPC-300, the first major revision of the MOECC's noise guidelines in 20 years.

The overall goal for NPC-300 was to streamline both residential development and industrial installations without increasing the noise impact on communities. Incorporating lessons from the Toronto Waterfront Revitalization process, three former guideline documents were combined into one guideline, providing consistent sound level limits for industrial regulation and land use planning activities, and including special considerations for infill situations and receptor-based noise mitigation for industrial sources. Thus far, it appears that the goals are being achieved.

5 Future Directions

The Ministry recognises that its ECA clientele is always interested in reducing the turnaround time for approvals. The required thoroughness of review for noise approval applications can range from very simple to highly complex processes, involving prolonged negotiations and multiple legal teams. Several screening methods have been put in place, and more are on the way, in an effort to assign the appropriate level of human resources to a given review.

6 Joining the Team

Low personnel turnover is evidence of the considerable job satisfaction to be found in the noise group. Still, from time to time there are permanent and temporary contract positions available. The temporary postings are highly recommended to noise consultants from the private sector as an unequalled way to gain insight into the noise regulation requirements and approval process in Ontario.

INDEPENDENT ENVIRONMENTAL CONSULTANTS (IEC): NOISE & VIBRATION SERVICES

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Résumé

Independent Environmental Consultants (IEC) a été fondée en 2015 et opère à partir de Markham, en Ontario. L'entreprise a pour objectifs de fournir aux clients des conseils de haut niveau et des conseils stratégiques sur les nouvelles et sur les questions environnementales continue, au sein de l'échelle locale, régionale et cadre réglementaire national, et pour informer l'industrie, les gouvernements et les citoyens dans l'atténuation et la prévention de futurs accidents ou événements critiques. Paul Kirby est vice-président des Services environnementaux, et supervise l'équipe de bruit et vibrations au IEC. Paul a plus de 20 ans d'expérience dans la qualité de l'air, le bruit et les vibrations des évaluations et la délivrance de permis. Nicholas Shinbin est le responsable technique pour l'équipe de bruit et de vibrations à la CEI, et a plus de 13 ans d'expérience dans la préparation de la qualité de l'air, le bruit et les vibrations des évaluations.

Mots clefs : acoustique, bruit, vibration, évaluation, la mesure, prédiction

Abstract

Independent Environmental Consultants (IEC) was founded in 2015 and operates out of Markham, Ontario. The firm's objectives are to provide clients with high-level consulting and strategic advice on new and on-going environmental issues, within the local, regional and national regulatory framework, and to advise industry, governments and citizens in the mitigation and prevention of future accidents or critical events. Paul Kirby is the Vice President of Environmental Services, and oversees the Noise and Vibration team at IEC. Paul has over 20 years of experience in air quality, noise and vibration assessments and permitting. Nicholas Shinbin is the technical lead for the Noise and Vibration team at IEC, and has over 13 years of experience in completing air quality, noise and vibration assessments.

Keywords: acoustics, noise, vibration, assessment, measurement, prediction

1 Introduction

Founded in 2015, Independent Environmental Consultants (IEC) provides experience and expertise in environmental science and engineering projects to clients across Ontario, Canada and worldwide. All of the founding members and affiliates have 20 to 40 years of experience working in consulting or industry, and have held senior-level management roles.

IEC is an independent, employee-owned operation based in Markham, Ontario. IEC's objective is to leverage the collective experience of its senior staff and affiliates and offer environmental consulting services, strategic advice and peer review services to Governments (federal/ provincial/ municipal), Industry, NGOs/ Special Interest Groups, First Nations, Lawyers, Engineering/Environmental Consulting Companies, International Financial Institutions and Overseas Governments. The senior staff and affiliates are supported by a team of highly skilled junior, intermediate and senior level personnel.

The noise and vibration services group is headed by Paul Kirby, who has 20 years of experience in completing and managing environmental noise and vibration projects throughout Canada and internationally.

The technical lead for the noise and vibration services is Nicholas Shinbin, who has 13 years of experience in environmental consulting, including the completion of detailed noise and vibration assessments for a broad range of clientele, as well as completing research in the field of acoustics at Ryerson University under the supervision of Professor Ramani Ramakrishnan of the Department of Architectural Science.

2 Service Areas

The Noise and Vibration team at IEC is able to provide services in the following areas:

- compliance permitting (e.g., ECA applications)
- environmental assessment (EA) support, including:
- industrial/manufacturing facilities
- transportation facilities (road, rail, transit)
- energy facilities (wind, solar, nuclear, natural gas, hydroelectric, biomass)
- mining and oil & gas facilities
- noise and vibration modelling
- source measurements, investigations and inventories

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- noise and vibration monitoring (community, remote sites, underwater)
- noise mapping
- compliance and due diligence auditing
- development of noise control strategies
- occupational noise and vibration assessment
- land use compatibility studies
- feasibility studies
- peer reviews
- regulatory and agency negotiation
- public engagement and consultation

3 Team Profiles

Mr. Paul Kirby is a Certified Engineering Technologist (CET), a Canadian Certified Environmental Practitioner (EP), and a Certified Environmental Auditor (EP-CEA). Paul is the Vice President at IEC, with 20 years of experience in air quality, noise and vibration assessments and permitting. To date, he has been involved in over 300 environmental approvals, and environmental assessment projects for a wide array of industrial, commercial and institutional clients. Designing/ performing monitoring campaigns, developing predictive models, determining the significance of human health and wildlife impacts and evaluating cumulative effects are all areas of his expertise. Paul has also completed a number of noise mitigation design projects for a wide variety of industries in the energy, mining and transportation sectors. His technical expertise has also been lent to stakeholder consultations from small local community groups to wider public forums.

Paul is also well versed in project management and quality assurance and control methods and is principally responsible for initiating, planning, executing, monitoring and controlling noise and vibration projects at IEC. He has successfully managed a wide array of projects ranging from small acoustic assessments to larger multi-disciplinary environmental assessment projects.

Nicholas Shinbin is the technical noise and vibration lead at IEC, with over 13 years of experience based in the fields of acoustic, vibration and air quality assessment. Specializing in environmental noise and vibration impact assessment, he has worked with a wide range of clientele to provide services including compliance permitting, supporting Environmental Assessment projects through the provision of detailed noise and vibration studies, completing feasibility studies and land use compatibility assessments, and developing noise and vibration control strategies. His skills include source characterization (through direct measurement and numerical methods), long-term data acquisition programs and predictive modelling.

Mr. Shinbin has provided comprehensive noise and vibration assessment services for over 150 projects within Ontario, as well as throughout Canada and internationally. He has a thorough knowledge of the regulatory framework in Ontario and throughout Canada for the assessment of noise and vibration from industrial sources, construction and transportation projects, as well as occupational noise exposure in the workplace. He has successfully completed projects in accordance with the strict requirements of the Ontario Ministry of the Environment and Climate Change, Ontario Ministry of Transportation, Health Canada, the International Finance Corporation (IFC) as well as for environmental regulators within Canada and abroad.

Mr. Shinbin has been trained and certified as an expert user of the internationally recognized acoustic modelling software Cadna-A. He has applied his knowledge in the development of complex acoustic modelling for existing facilities, proposed expansions and proposed future facilities for a broad range of project types. Examples of acoustic modelling assessments projects he has completed include: mining complexes (incl. air traffic for remote facilities), manufacturing facilities, roads and highway projects, railways, public transportation projects, energy facilities (e.g., nuclear power plants, natural gas power plants, solar farms, wind turbines) and large-scale construction/ remediation projects.

In addition to Cadna-A, Mr. Shinbin also has extensive experience with modelling noise from transportation sources (road and rail) using the MOECC traffic noise model, STAMSON, as well as the U.S. FHWA Traffic Noise Model (TNM). He has also applied methodology provided by the U.S. Federal Rail Administration (FRA) in the prediction of noise and vibration impacts from rail traffic. He has completed modelling of indoor environments for prediction of potential occupational noise exposure issues.

In addition to consulting, Mr. Shinbin spent 20 months working as a Research Assistant to Professor Ramani Ramakrishnan at Ryerson University, completing a project for an industrial business partner in the field of noise control. This project involved developing an approach to modelling the insertion loss of lined ducts in 3D using COMSOL Multiphysics, and validating the results against laboratory data for existing designs and examples from literature. The validated approach was then applied to test the viability of innovative new silencer designs developed by their business partner, such that they could avoid the high costs associated with building prototypes and completing testing during the feasibility stage. Using this modelling approach, Dr. Ramakrishnan and Mr. Shinbin were also able to provide their business partner with normalized design curves for various models of elbow silencers, which allows them to approximate how the insertion loss would change if parameters such as the liner width and/or material were changed.

4 Conclusion

The highly qualified and experienced professionals that comprise the Noise and Vibration team at IEC are able to provide a wide range of assessment and consulting services for projects around the globe. Our staff are knowledgeable, dedicated, conscientious, and thorough, and committed to completing projects accurately and in a timely and unbiased manner.

AERCOUSTICS - ACOUSTIC, NOISE, AND VIBRATION DESIGN CONSULTANTS

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Résumé

Aercoustics Engineering Limited est la plus grande purement acoustique firme d'ingénieurs-conseils en Amérique du Nord avec une expertise en acoustique, bruit et vibrations. Situé à Toronto, en Ontario, le Aercoustics a été fondée en 1974 et a participé à de nombreux projets de profil haut dans le monde entier. Provenant des fosses d'orchestre à gravières, nous sommes les aller-à ingénieurs acoustiques qui résoudre problèmes acoustiques, de bruit et de vibration à l'intérieur ou à l'extérieur, aériennes ou souterraines. C'est notre unique profondeur de compréhension de la science de l'acoustique qui nous permet d'aborder les projets les plus difficiles.

Mots clés : Ingénierie acoustique, bruit dans l'environnement et les vibrations, le vent bruit de turbine, de conception de transit, de bruit et de surveillance des vibrations, construction isolation vibratoire, TMD.

Abstract

Aercoustics Engineering Limited is the largest purely acoustical consulting engineering firm in North America with expertise in acoustics, noise, and vibration. Located in Toronto, ON, Aercoustics was founded in 1974 and has been involved in many high profile projects over the years, all around the world. From orchestra pits to gravel pits, Aercoustics is the go-to acoustic engineering firm to solve acoustic, noise and vibration problems indoors or outdoors, overhead or underground. It's Aercoustics' unique depth of understanding of the science of acoustics that allows us to tackle the most challenging projects.

Keywords: acoustic engineering, environmental noise and vibration, wind turbine noise, transit design, noise and vibration monitoring, building vibration isolation, TMD

1. Introduction

Aercoustics is a knowledge-based company, with engineering and technical resources that enable us to respond to shifting regulatory environments, industrial landscapes, and the ever evolving needs of our clients in the area of acoustics, noise, and vibration.

Our services range from planning to post-construction across multiple industries including energy, transportation, planning, architecture, tunnelling, and more. A sample of this experience follows.

2. Transit Operations & Maintenance / Transit Design

Aercoustics has been the Toronto Transit Commission's primary noise and vibration consultant through contracts it has held with the Subway Infrastructure department since the early 1990s. Over the past 20+ years, Aercoustics has gained extensive experience in the measurement and analysis of vibration and sound generated from the TTC subway and streetcar transit systems. Our work with the TTC includes executing community noise evaluation campaigns, evaluating how different rail components and streetcar models affect the noise and vibration levels experienced in the community, and developing noise and vibration controls.

Aercoustics has provided these services, and more, to support transit systems across North America.

- Long term noise and vibration monitoring
- Wheel condition detection
- Complaint investigation
- Public meetings and presentations
- Maintenance evaluation services
- Best practice management
- Track design
- Station design
- Environmental compliance
- Noise and vibration prediction for sensitive uses
- Fastener selection
- Speech intelligibility
- FTA transfer mobility
- Building isolation
- Component evaluation

3. IEC 61400-11 Standard – Wind Turbine Noise Measurements

Aercoustics is an ISO 17025:2005 accredited lab; and is also accredited to conduct wind turbine noise testing as per IEC 61400-11 test procedures.

Aercoustics has been involved in the wind industry since its commercial inception in Ontario over 10 years ago. Aercoustics has pioneered various methods and procedures used in the industry today and have worked with government agencies, developers, manufacturers, operators and residents.

Having completed acoustic assessment and sound modelling studies for over 1GW of wind energy, and having

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logged more than 15,000 hours of post construction noise measurements from wind turbine facilities, Aercoustics is the most experienced company in Canada in the area of Renewable Wind Energy.

Payam Ashtiani, a principal with the company, is a Canadian representative on the working group MT 11 of IEC Standards Technical Committee 88. The Technical Committee reviews and sets electrical standards for wind turbines and MT 11 focuses on wind turbine noise measurement techniques.

Figure 1 On site noise measurement system

Aercoustics carried out a three phase project in order to develop a new protocol for measuring and quantifying noise from wind turbines in a way that was applicable to the sound level limits already in place. The process involved a jurisdiction scan and scientific literature review; a draft protocol development, which included public consultation sessions; and a field verification protocol which involved measurements on candidate wind farms to validate and fine tune the protocol. The final protocol was also peer reviewed as part of the contract. The new protocol was issued by Ontario Ministry of the Environment and Climate Change in mid-2011 and has been carried out as a part of the post construction monitoring requirements since that time.

4. Noise and Vibration Monitoring

Our firm has unique instrumentation capabilities for conducting multi-channel sound and vibration measurements, including four (4) multichannel vibration measurement systems, including a state-of-the-art LMS data acquisition and real-time analyzer allowing for recording capability with simultaneous analysis including real time octave filtering, frequency spectrums, coherence, transfer function processing among many others processing techniques for up to 44 channels and further expandable for specific project requirements.

Aercoustics has developed a fully remote, purpose built noise and vibration monitoring system, with customizable metrics. The monitoring system can be scaled to support a single monitor or multiple locations and is a fully managed service that includes real-time monitoring, as well as reporting services.

Aercoustics' monitoring system was employed to support the OHL/FCC JV Team for the delivery of the construction monitoring program required by the **TTC York Spadina Subway Extension (TYSSE)** Contract. As part of the services provided, Aercoustics developed a noise and vibration monitoring plan for each of the four identified sites as specified by the TYSSE Contract to record noise and vibration levels during the progression of the four (4) year construction period. Aercoustics developed the appropriate protocols and equipment requirements for monitors, the applicable noise/vibration limits, and exceedance event and complaint protocols. At its peak, Aercoustics installed, maintained and operated fourteen (14) noise and vibration monitors that had automated upload capabilities to an in house server with ease of data viewing, logging and reporting.

Figure 2 Rail vibration measurements

Aercoustics has provided similar services tailored to the needs of the following projects:

- Ryerson Student Learning Centre
- Ryerson Church Street Development
- 500 Lakeshore West Development
- 2131 Yonge Street
- Highway 50 Construction Monitoring

ADVANCED BIOMEDICAL ULTRASOUND IMAGING AND THERAPY LABORATORY

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Résumé

Laboratoire avancée de l'imagerie et de thérapie biomédicale à ultrasons (ABUITL) est un laboratoire de recherche 1600 pieds carrés affilié conjointement à l'Université Ryerson et l'Hôpital St. Michael. Il est l'un des principaux laboratoires de recherche dans le domaine d'ultrasons biomédicale au Canada. Le laboratoire a été créé en 2007 dans le Département de physique de l'Université Ryerson et a été transféré à iBEST (institut de génie biomédical, sciences et technologie) dans l'Hôpital St. Michael en Septembre 2015. Le laboratoire accueille un éventail d'équipements de recherche d'ultrasons biomédicale dans les domaines diagnostic et thérapeutique, et a été actif dans la conduite de projets et la formation de personnel hautement qualifié (PHQ). Champ d'application des projets de recherche dans le laboratoire étend de la compréhension de la science fondamentale et l'investigation des mécanismes biophysiques à de nouvelles applications cliniques dans tous les principaux domaines d'ultrasons biomédicale.

Mots clefs: ultrasons biomédicale; l'imagerie, la thérapie et la simulation par ultrasons; imagerie photoacoustique; l'administration de médicaments par ultrasons.

Abstract

The Advanced Biomedical Ultrasound Imaging and Therapy Laboratory (ABUITL), a 1600 square-foot research laboratory jointly affiliated to Ryerson University and St. Michael's Hospital, is one of the leading research laboratories in the field of biomedical ultrasound in Canada. The laboratory was established in 2007 in the Dept. of Physics, Ryerson University and was relocated to iBEST (Institute for Biomedical Engineering, Science and Technology) in St. Michael's Hospital in September 2015. The laboratory hosts an array of research equipment in diagnostic and therapeutic biomedical ultrasound and has been active in conducting research and development and the training of highly qualified personnel (HQP) in the field. The scope of the research projects in the laboratory spans from ultrasound basic science and the investigation of biophysical mechanisms of the interactions of ultrasound with cells and tissues to novel clinical applications in all main areas of biomedical ultrasound.

Keywords: biomedical ultrasound; ultrasound imaging, therapy, and simulation; photoacoustic imaging; ultrasound drug delivery.

1 Introduction

The Advanced Biomedical Ultrasound Imaging and Therapy Laboratory (ABUITL) was established in 2007 through multiple investments from the Canada Foundation for Innovation (CFI), and a strategic investment by Ryerson University that was leveraged by an Ontario Research Fund-Research Excellence (ORF-RE) grant from the Ontario Ministry of Research and Innovation. Since its establishment, the laboratory has been receiving equipment funding support from several external funding agencies and Ryerson internal funding sources (see Acknowledgments section for details). The laboratory hosts an array of state-of-the-art biomedical ultrasound research and development resources to be used for various research projects, spanning a wide range of topics in both therapeutic and diagnostic ultrasound. The laboratory is currently co-directed by the authors of this paper.

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2 iBEST in St. Michael's Hospital

In 2013, Ryerson University and St. Michael's Hospital agreed on a long-term partnership to launch iBEST (Institute for Biomedical Engineering, Science and Technology). The leadership from both institutions, who believe that innovation in healthcare is borne from multidisciplinary collaboration, supported this partnership. Both institutions have a history of strong research collaborations, joint commercialization projects, and education and training opportunities dating back nearly two decades. Connected to St. Michael's Keenan Research Centre for Biomedical Science, iBEST's access to biomedical, technological and clinical expertise allows its members and partners to identify challenges and rapidly pilot, modify and introduce biomedical discoveries and inventions to improve health. In September 2015, the laboratory was relocated to iBEST in St. Michael's Hospital's Keenan Research Centre leading to further expansion based upon the institute's foundation of excellence that combines researchers' expertise with state-of-the-art research labs and infrastructure.

3 Mission and Areas of Research Focus

Ultrasound is a non-ionizing wave-based energy modality with a wide range of applications in medicine and biology. The mission of ABUITL is to advance the scientific understanding and applications of biomedical ultrasound in Canada and worldwide. To this end, the laboratory has been active in securing research funding, in conducting a wide range of R&D projects in biomedical ultrasound, and in the training of highly qualified personnel (HQP) in various levels from undergraduate and graduate students to post-doctoral fellows and visiting researchers. The laboratory collaborates actively with a number of higher education, clinical research, and private-sector industrial institutions within Canada and abroad. Research and development projects in all areas of biomedical ultrasound diagnostics and therapeutics and the interaction of ultrasound with other energy modalities are being undertaken in the lab. The scope of the research projects spans from basic science and the investigation of biophysical mechanisms to novel clinical applications.

4 Main Research Themes in the Laboratory

- Ultrasound imaging (high-frequency ultrasound imaging, ultrasound tissue characterization and cancer detection, and acoustic microscopy and cell imaging)
- Photoacoustic imaging and optical coherence tomography for diagnostic and therapeutic monitoring applications
- Ultrasound in combination with microbubbles in medical imaging and therapeutics
- Ultrasound-mediated targeted drug delivery
- Ultrasound-enhanced radiotherapy and chemotherapy in oncology
- Modeling and simulations of ultrasound propagation and interactions in tissues in linear and nonlinear regimes
- Image-guided ultrasound therapy including high intensity focused ultrasound (HIFU), histotripsy, and low intensity pulsed ultrasound (LIPUS)
- Ultrasound therapy in neurology and neurosurgery
- Biomedical ultrasound signal and image processing

5 Main Research Equipment in the Laboratory

- High-frequency ultrasound scanners (up to 100 MHz) and an acoustic microscope (up to 2 GHz)
- Several ultrasound scanners and imaging probes
- A high frame rate optical camera (2 million frames/sec) integrated with a high magnification microscope
- Ultrasound transducers for diagnostic and therapeutic applications and associated electronics
- HIFU, histotripsy and LIPUS systems and electronics
- RF power amplifiers, digital oscilloscopes, impedance meters, pulser/receivers, acoustic power meters, and calibrated hydrophones
- 3D micro-positioning systems and water tanks for acoustic field measurements
- A water conditioner system (degasser and deionizer)
- Various ultrasound simulation software tools
- Thermometry systems with calibrated thermocouples
- A high-resolution thermal camera
- Several optoacoustic imaging systems
- An optical parametric oscillator with double integrating spheres for measuring materials' optical properties
- Compact spectrometers operating over the visible and near infrared (NIR) range of the spectrum
- Solid state laser interferometry setups
- A 4-channel laser delivery system for therapy
- A nerve electrophysiology system

Figure 1: Advanced Biomedical Ultrasound Imaging and Therapy Laboratory (ABUITL) at iBEST in St. Michael's Hospital's Keenan Research Center.

6 Conclusion

ABUITL, a research laboratory jointly affiliated to Dept. of Physics, Ryerson University, and iBEST, St. Michael's Hospital, is one of the leading research laboratories in the field of biomedical ultrasound in Canada. The laboratory will continue pushing the boundaries of knowledge and filling the gap between basic science research and clinical applications in the field of biomedical ultrasound and related areas.

Acknowledgments

Research support and grants to establish and expand the laboratory were provided from several external funding agencies and Ryerson internal funding sources including the Canada Foundation for Innovation (CFI), Ontario Ministry of Research and Innovation, Ontario Premier's Early Researcher Award, Canada Research Chairs Program, Ontario Research Fund- Research Excellence (ORF-RE), NSERC- Research Tools and Instruments Grants Program (NSERC- RTI), Terry Fox Foundation, Canadian Cancer Society Research Institute (CCSRI), CIHR, and several Ryerson Dean's Research Funds. We would also like to acknowledge technical help from Arthur Worthington, Elizabeth Berndl, Christopher Smeenk, Lauren Wirtzfeld, and the many students and alumni from our graduate programs in setting up and operating various research equipment in the laboratory.

SOUND AND VIBRATION IN BUILDINGS AND THE ENVIRONMENT: RWDI

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Abstract

RWDI is a specialty provider of consulting engineering and science. In addition to offices in Guelph, Toronto and Hamilton it has offices across Canada and globally. The company is recognized internationally for its work to push the boundaries of engineering and practical scientific knowledge. Sound and vibration at RWDI spans the company's subject areas of environment, buildings, wind load and its effects. This article illustrates some types of sound and vibration work conducted at RWDI.

Keywords: acoustics, noise, vibration, aeroacoustics, footfall, mitigation, monitoring, ECA, NAAP, tuned-mass damper

Résumé

RWDI est un fournisseur de services spécialisés et expert-conseil en ingénierie et autres sciences, ayant un siège social situé à Guelph et possédant plusieurs bureaux satellites partout au Canada et dans le monde. RWDI est mondialement reconnu comme étant une entreprise qui pousse les limites d'ingénierie et des sciences. Chez RWDI, l'expertise en bruit et vibrations se retrouve dans plusieurs de nos domaines de services, soit par exemple, l'environnement, les bâtiments et les effets de charges dues aux vents. Cet article illustre les différents types d'études sur le bruit et les vibrations menées par RWDI.

Mots clefs : acoustique, bruit, vibrations, aéroacoustique, bruit de pas, moniteur de bruit, l'amortisseur de masse à l'écoute

1 Introduction

The consulting firm RWDI, also known as Rowan Williams Davies & Irwin, began in Guelph Ontario and has grown to a staff of more than 400 people located in offices and testing facilities nationally and internationally. The principal Canadian locations are in Guelph, Toronto, Calgary, Vancouver, Hamilton, Windsor, Ottawa, and Thunder Bay.

Sound and vibration services are integral to the company's specialty consulting services relating to the environment, buildings, and the interaction between them. RWDI's international reputation for work that pushes the boundaries of engineering and practical scientific knowledge is regularly called upon to deal with new or unique problems. The development and testing of innovative ideas is supported by a substantial capability for computational and physical modelling.

2 Architectural and Building Acoustics

Design of an acoustic environment involves integration of the structural, mechanical and architectural aspects. Residential projects typically focus on noise control, structure-borne noise and sound flanking paths. Design of performance spaces develops a match of acoustic atmosphere to the type of space through a balance between room volume and shape, ceiling and wall orientations, and surface finishes in order to control reflections and reverberation. Optimization of the materials and speakers is supported by computational acoustic techniques and ray tracing models like the one shown in Figure 1. Existing spaces can be better understood using specialized tools and in-situ testing.

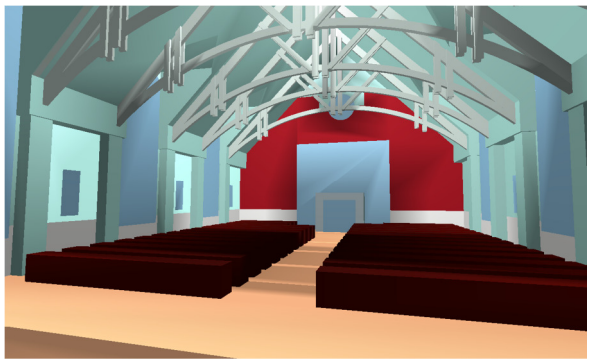

Figure 1: Acoustical Model of a Chapel.

3 Vibration

Mechanical and anthropogenic sources of vibration influence the function and use of our living and working spaces. This is of particular interest for human comfort or operation of MRI, CAT and PET scanners or microscopes. Activity such as walking or recreation in a building can induce vibration that is experienced in other spaces. Interior

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vibration can also propagate from poorly isolated mechanical equipment in the building or from adjacent sources such as roadways, railways or subways. Similarly, vibration can have negative impact on wildlife habitat. RWDI's team quantifies the effect by measurements or modelling and provides mitigation strategies where needed.

4 Structural Motion

The prediction, evaluation and control of structural motion is an important factor in the design of tall buildings and long-span bridges. Modern structures are built for controlled flexibility in response to wind and seismic forces. Determining how a specific structure's design interacts with the wind is the specialty of several teams at RWDI. Testing in wind tunnels, using scale models, can be used to inform the design. Management of the vibration can then be designed into the structure.

In some situations it is desirable to introduce vibration damping systems to buildings or bridges. These use a moving mass as a counterbalance. Examples would be tuned-mass dampers or tuned water-sloshing dampers. The resulting reduction in motion increases human comfort. In the case of the Taipei Financial Center, the damper (shown in Figure 3) is also a tourist attraction surrounded by a restaurant.

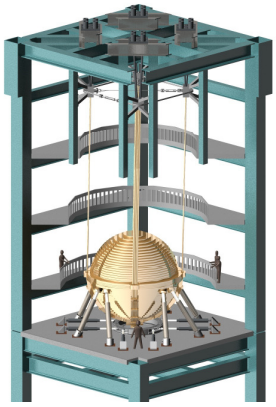

Figure 3: Schematic of a Tuned Mass Damper.

5 Environmental Noise

Outdoor sound is assessed for human annoyance or impact on wildlife in the course of environmental compliance approval, environmental assessment, compliance audit, land-use planning and public consultation projects. RWDI goes beyond the standard measurement and modelling techniques where a better description of the situation needed. This has included areas of complex meteorological influence, or the use of an acoustic camera for convoluted noise sources.

Where noise mitigation is needed, RWDI works interactively with clients to develop strategies and noise abatement action plans using our experience with large and complex mitigation projects. In a recent example, very large sound level reductions requirements were achieved for high plume exhaust fans in cooperation with a specialized mitigation supplier.

6 Aeroacoustics

With the recent proliferation of increasingly novel architectural building designs, aeroacoustic noise and wind-induced vibration in architecture occurs more frequently. Wind flowing across or around external building features such as sunshades, rain screens, mullions and other decorative building elements cause component vibration and intense acoustic tones or whistles (as shown in Figure 2). A number of high-profile incidents have occurred over the past few years. The resulting noise can be audible hundreds of meters from the source, causing complaints and significant disruption to both building occupants and neighbors. Wind-induced vibration may result in concerns with fatigue or component failure. Issues related to wind-induced noise and vibration are often difficult to mitigate, requiring costly retrofits, if addressed after construction is completed.

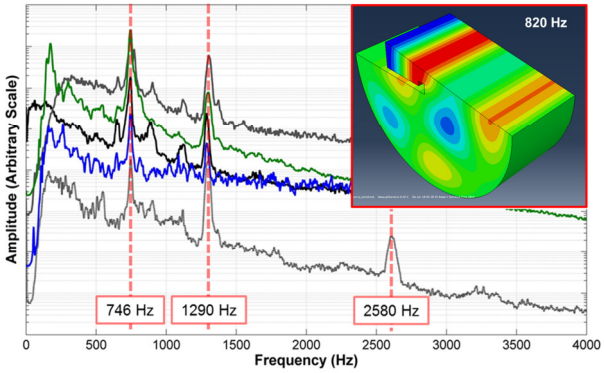

Figure 2: Measured Aeroacoustic Cavity Noise with FEA Prediction.

7 Monitoring

Long term permanent or semi-permanent monitoring is used to show the ongoing achievement of specific criteria in the face of dynamic circumstances. The system provides a record of the operation, or warnings where the criteria are exceeded. Automated monitoring can therefore facilitate complex construction or demolition activity close to sensitive locations. Operators of high performance structures and buildings use monitoring systems to ensure that their buildings continue to perform as intended. Wind farm compliance audits also use automated monitors. RWDI has developed custom systems to address needs across all of its sound and vibration services.

Figure 4: Automated Construction Monitoring System.

AIOLOS ENGINEERING – AERO-ACOUSTIC CAPABILITIES FOR TEST FACILITY DESIGN

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Résumé

Aiolos Engineering est un fournisseur d'installations d'essais aérodynamiques, climatiques, et acoustiques spécialisées desservant des clients à travers le monde. La majorité des installations d'essais conçu par Aiolos sont des souffleries. La plupart des souffleries ont des exigences relatives au contrôle de bruit, pour lesquels l'analyse et la conception est réalisée en interne. Aiolos conçoit aussi des installations uniques qui ne sont pas des souffleries, par exemple des chambres de bruit de forte intensité pour des essais sur des satellites.

Mots-clés: bruit, soufflerie, acoustique, résonateur, générateur de bruit

Abstract

Aiolos Engineering is a supplier of aerodynamic, climatic, and specialized acoustic test facilities for clients around the world. Most of these test facilities are wind tunnels though there are also unique non-wind tunnel facilities. Many of the wind tunnels have requirements for noise control, for which the analysis and design is performed in-house. Some unique non-wind tunnel facilities supplied by Aiolos include high-intensity noise chambers for satellite testing.

Keywords: Noise, wind tunnel, acoustic, resonator, noise generator

1 Introduction

Aiolos Engineering provides engineering design services, construction management, final testing verification, and turnkey supply of aerodynamic, climatic, and specialized acoustic test facilities for clients around the world. Most of these test facilities have their form as wind tunnels. Some non-wind tunnel configurations include large high-intensity noise chambers. [1]

2 Aeroacoustic Noise Control

Many of the wind tunnels designed by Aiolos incorporate some degree of acoustic control. The balancing of many competing influences usually requires low pressure loss noise attenuation methods such as acoustic turning vanes and treated duct sections upstream and downstream of the main fan. In addition, the impact of flow induced self-noise further restricts the options available. Aiolos performs the acoustic design to ensure proper integration with the aerodynamic circuit as well as to ensure suitability of the acoustic materials with the air temperature and moisture content range of the wind tunnel. An example is the University of Ontario Institute of Technology ACE Climatic Wind Tunnel located in Oshawa, in which the test section wind speed reaches 250 km/h, the air temperature is controlled from -40°C to +60°C, and the dew point varies from -40°C to saturated [2].

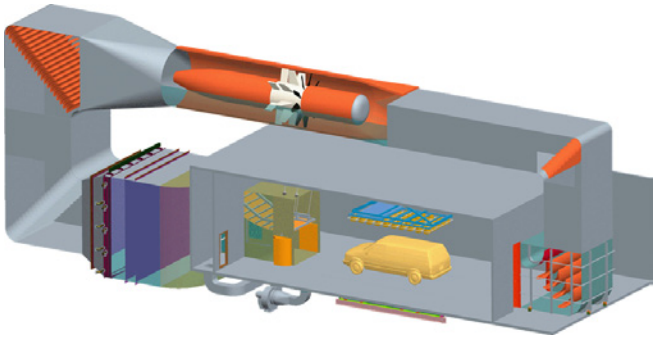

Figure 1: The University of Ontario Institute of Technology ACE Climatic Wind Tunnel
Acoustically Treated Turning Vanes and Fan Shown in Orange

Low-noise aerodynamic wind tunnels have driven additional design techniques. For the S2A automotive aeroacoustic wind tunnel [3] located outside of Paris, Aiolos used the following design features to meet the demanding aerodynamic and acoustic requirements:

- Double-sided foam-lined turning vanes, where the foam incorporates a thin smooth skin to provide a non-porous aerodynamic surface with near-transparent acoustic properties.
- A vented internal vane structure to avoid deformation and possible blow-out of the material due to pressure variations during wind speed ramping.
- A unique micro-pore floor surface to minimize the self-noise at the surface of the floor boundary layer suction system. This detail was in addition to the standard silencers applied both sides of the suction fan.

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– A membrane-absorber panel system for the plenum that surrounds the test section to provide the hemi-anechoic conditions for the test vehicle.

Additional low-noise facilities produced by Aiolos include a combined aerospace-acoustic research wind tunnel for the Agency for Defense Development in Taejon, Korea [1], the Hyundai Aero-Acoustic Wind Tunnel near Seoul, Korea [4], and an acoustic upgrade to the GM Aerodynamics Laboratory in Michigan.

Aiolos is also involved in the specification and integration of the acoustic instrumentation. In the case of the S2A, Aiolos oversaw the specification and procurement of the complete acoustic instrumentation package which included an in-vehicle acoustic holography set and an external Beamforming unit.

Besides the audible frequencies, Aiolos has developed extensive capabilities in the control of low-frequency pressure fluctuations [5]. Shear layers produced at open jet test sections induce pressure fluctuations that can couple with different resonant modes in the air circuit, primarily the closed-loop return air path but also the relatively large plenum. The frequencies are of the order of several Hertz to about 10 Hz. Resonator absorbers connected to the circuit have been developed at Aiolos to provide passive and broadband control of these low-frequency pressure fluctuations. They have been used on several recent climatic wind tunnels, including a set of 3 climatic wind tunnels for BMW [6] and two climatic wind tunnels for Daimler [7].

3 High-Intensity Noise Generation

Aiolos also designs test facilities that provide simulation of very high noise levels. An example of this is the very large Reverberant Acoustic Test Facility (RATF) at the Space Power Facility of NASA Glen Research Center's Plum Brook Station in Sandusky, Ohio. This test facility is used to simulate the acoustic environment that satellites and space vehicles experience on launch. Overall sound pressure levels of up to 163 dB are generated by a bank of noise generators in one wall of the test chamber (Figure 2).

The noise is produced by electrodynamic or hydraulically driven gaseous nitrogen modulators coupled to an acoustic horn with a suitable cut-off frequency. During the design phase of the RATF project Aiolos performed extensive testing to characterize the modulators in a reverberant chamber at the National Research Council of Canada [8]. Aiolos considered using supersonic jets for producing part of the noise spectrum required for the RATF. This idea was tested at the NRC [9].

Figure 2 : NASA Reverberant Acoustic Test Facility

Aiolos has also upgraded an existing high noise test facility. Changing test requirements for the Large European Acoustic Facility (LEAF) resulted in a design and supply contract for Aiolos to modify LEAF's noise generators to produce more high frequency noise [10]. LEAF is similar to RATF (but smaller) and is used for high noise tests on space vehicles.

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Canadian Acoustical Association

Minutes of the Board of Directors Meeting
Held by video conference
1 April 2016

Present: Frank Russo (chair), Alberto Behar, Bryan Gick, Dalila Giusti, Michael Kiefte, Hugues Nélisse, Kathy Pichora-Fuller, Roberto Racca, Mehrzad Salkhordeh, Jérémie Voix

Minutes taken by Roberto Racca

Video conference started at 15:30 EDT
Meeting called to order (all participants on-line) at 15:45 EDT

Frank Russo opened the meeting by noting that only an unofficial telephone discussion among Board members had taken place since the previous formal Board meeting in October, and the October minutes had been effectively approved through e-mail exchanges; there was therefore no requirement for formal approval at the present meeting.

President's report (Frank Russo)

Frank did not submit a formal report but provided instead a verbal overview of activities. His update touched primarily on a rekindled communications strategy for the Association. Over the past months he had built up the use of social media as a means of disseminating information of relevance to members of the Association. The CAA-ACA's LinkedIn account had been lying dormant but still had some 450 legacy connections; since its reactivation 60 more connection requests have been approved; newly created accounts on Twitter and Facebook attracted that far 66 and a dozen contacts respectively. Frank indicated that he had been posting almost daily news and updates on acoustics matters. As he had only committed to carry out the social media communications role until the end of April, a way forward had to be determined. The role of communications director could be filled by either a Board member or an external person, assisted by student volunteers gathering and providing feeds of information. Kathy suggested that messages should focus on interesting news about acoustics and the acoustics community, more than just internal business of the Association; Frank saw a mix of the two as optimal content. Conventional e-mail blasts would still be used in very controlled situations where their value outweighed the potential annoyance, an example being an announcement about the upcoming CAA conference. After some discussion, Frank suggested that the role of communications director could be defined as an additional dedicated position on the Board. Before taking that step, however, it was proposed that current Board member Joana Rocha be offered the role with Huiwen Goy (a current grad student of Kathy) as deputy / coordinator.

Treasurer's report (Dalila Giusti)

Dalila reported good success in bringing up revenue levels from advertising fees and actually collecting on receivables in a timely manner. A substantial HST refund and a number of recent membership renewals also boosted the finances. The Association currently has $281,000 in investments in various GIC's, none of them at maturity yet. Dalila noted that interest rates were not very high but as good as could be expected for low risk investments. The 2015 CAA-ACA conference held in Halifax posted a final profit of $4854.29.

In discussion, Frank brought up the matter of travel subsidies for students presenting a paper at the annual conference. In e-mail exchanges that had taken place since the October meeting

it had been proposed to provide subsidies of $500 per student (increased from the $250 originally discussed by the Board) up to a maximum of $10,000 yearly. The larger contribution per individual was thought by the proponents to be more realistic both in terms of what the subsidy could cover and of the usual number of student participants. Some debate arose around whether the variable levels of conference sponsorship should affect the approach, and the need to retain consistency from year to year. Dalila commented that the e-mail discussions of the increased subsidy level had not included everyone on the Board and therefore it was not possible to reach agreement on the matter at that point. Kathy moved that a yearly amount of $10,000 be allocated for the travel subsidy without yet including specifics on its apportioning. Mehrzad seconded. The motion was carried with only Dalila opposed, but the Board agreed that the approach would have to be revisited in future years.

Roberto moved to approve Treasurer's report; Mehrzad seconded. Approved unanimously.

Incidental business

Jérémie and Kathy had to excuse themselves from the meeting around 17:10 EDT, about halfway through the Secretary's report (below). Before signing off, Jérémie brought up an action item calling for due recognition of the graphic artist in charge of the journal cover, who had first submitted a logo design that likely had inspired the one that the CAA eventually adopted. A $250 remuneration was proposed to be given to Simon for the logo design; there were no objections to approving the request and Jeremie is to check if this proposal is accepted.

Secretary's report (Roberto Racca)

Roberto provided and reviewed the current tally of Association members and Canadian Acoustics subscribers as summarized in the table below, which shows by comparison the numbers for 2015 reported at the October meeting.

Category	**Paid-up 2016** **As of 1 April 2016)**	**Paid-up 2015** **As of 5 Oct 2015)**
Regular member	133	165
Emeritus	1	1
Student	18	22
Sustaining subscriber	26	28
Indirect subscribers		
- Canada	5	3
- USA	4	6
- International	3	5
Direct subscribers	3	4
Total	**193**	**234**

Roberto noted that the substantial drop in numbers especially in the regular membership was cause for concern and would require follow-up as it was unclear whether members had chosen not to renew or were encountering problems with the online renewal and payment system which might have caused them to abandon the attempt. Over the past year 9 members had contacted the Association indicating that they would not be renewing due to changes in their professional situations, such as retirement. On the other hand, Roberto had received and acted upon a number of requests for assistance with the on-line payment process; in most cases the problem appeared to be related to PayPal declining credit cards without cause. A few members had resorted to manual renewal and payment by cheque, but others might simply have given up and not renewed. Jérémie pointed out that PayPal had been having significant issues of late with declining of cards for no apparent reason, as documented by online forums. Roberto indicated that he would follow up one on one via e-mail with recently lapsed members to determine what had caused them not to renew, and would comb further through the membership database and cross correlate with Dalila's PayPal remittance summaries to better understand the dynamics of the decline in membership. On a related matter, he noted that the process of manually renewing institutional subscriptions managed by agencies (which still rely on purchase orders and mailed cheques) had been streamlined somewhat but still entailed lags because of the decentralized paperwork; in some cases, this had resulted in missed mailings of issues.

Roberto reported briefly on other communications to the Secretary that included notifications of congresses and other events, requests for endorsement and/or support of particular initiatives, and some suggestions for changes within the organization primarily related to membership fee structure. He would forward these to the Board and the executive officers for direct action or consideration at the formal meetings. Specifically, Roberto brought up a recent request by Michel Stinson to be nominated for a further term as representative of the Association on the ICA Board for 2016-2019; this was approved by the Board members remaining in the meeting.

Frank moved to approve Secretary's report; Dalila seconded. Approved unanimously.

Editor's report (Jérémie Voix, in absentia)

The members of the Board still in attendance reviewed the report submitted by Jérémie, which included some updates on matters raised at previous meetings: indexing of the Journal by SCOBUS, indirect subscriptions renewal glitches already noted by the Secretary, migration of Journal and Conference web sites to a Virtual Private Server, and a budget requirement of $275 per year to support Digital Object Identifier for instant electronic referral of JCAA articles. Items of new business included the execution of a publishing agreement with EBSCO, fixing of bugs in the database script that generates the Members' Directory, updating of contact information for the CAA-ACA domain, and acquisition of a security certificate for the web sites at a cost of $150 per year. The report also noted the upcoming or planned publication of two special regional interest editions of Canadian Acoustics, the June 2016 issue (curated by Umberto Berardi) covering activities in the Greater Toronto Area and the June 2017 issue (pending confirmation by Sean Pecknold) that would cover the Halifax region.

No issues or concerns were raised with the contents of the Editor's report, including budgetary requirements.

Awards coordinator's report (Hugues Nélisse)

Hugues provided an update on the status of the general Prizes of the Association, all of which had been awarded for 2015; the applications deadline for 2016 would fall on 30 April. The Canada Wide Science Fair Award in Acoustics was to be issued at this year's event at McGill University on 15-20 May, and judges were being sought. Hugues alerted Board members that the candidate papers for the Directors' Award were being checked for eligibility and would soon be circulated for evaluation. There was some discussion on the matter of the newly instituted award in honour of John Bradley, that John lately requested be focused on work in architectural acoustics whereas the original understanding was that it should recognize work of a multidisciplinary nature. This would create a duplication of emphasis with the Tom Northwood award in architectural acoustics. Hugues indicated that he would endeavour to follow up with John Bradley and present the situation so that an outcome agreeable to all parties may be reached.

On an informational level, Hugues mentioned that two young researchers recently contacted him asking for letters of recommendation from the CAA-ACA for their funding applications for travel to international conferences. In this instance he knew the applicants personally and he provided the endorsement upon Frank's approval; there was, however, no official protocol for requests of this kind. The Board members in the meeting agreed that for the time being these infrequent requests could be handled on a case per case basis. If the demand for such letters were to intensify, a vetting procedure might have to be established.

Other business: translation services

Frank pointed out that the Association needs translation of abstracts, notices etc. into French (or from French to English) for the Journal and web site, and noted that at times authors have had to pay outside agencies for such translation services. Dalila suggested that the CAA gather a panel of volunteers to provide these services free of charge within the context of the Journal requirements. All agreed on pursuing this initiative.

Meeting was adjourned at 17:40 with motion by Dalila.

ACOUSTICS WEEK IN CANADA 2016

September 21-23, 2016, Vancouver, British Columbia

Conference Co-chairs: Kathy Pichora-Fuller, University of Toronto
Clair Wakefield, Wakefield Acoustics, Victoria, BC

Welcome to Vancouver!

Vancouver looks forward to welcoming delegates to the 2016 Acoustics Week in Canada. Acoustics researchers, professionals, educators, and students from across the country are welcomed to Canada's scenic West Coast for three days of plenary lectures and technical sessions. The Canadian Acoustical Association Annual General Meeting will be held in conjunction with the conference, along with the Acoustical Standards Committee Meeting and an exhibition of acoustical equipment and services. There will be an opening reception on Wednesday September 21st, at the end of the first day of the conference, and the Awards Banquet will be held the next evening, on Thursday September 22nd. The World Congress of Audiology is an associated event that will be held only a few blocks away earlier in the same week from September 18th-21st.

The Canadian Acoustical Association conference will be held at the Sutton Place Hotel, a short walk from the Robson Street shopping area and Stanley Park with its over 1000 acres of land where you can visit the Vancouver Aquarium or enjoy walks in the forest, on the beach or along over 20 km of the Seawall. Vancouver is "spectacular by nature". It is a truly unique and world-class city. It has a mild climate, is safe, clean and friendly. You will find a blend of cosmopolitan amenities, natural splendor and cultural attractions. There are stadiums, dining, shops, art galleries, museums and entertainment within walking distance or easily accessible by a public transportation system of "Sky Trains" and buses. Or you could rent a bicycle and use the network of specialized bike lanes to get around the city like a local. It is a great city to see with your family.

There are lots of exciting options if you have time to extend your travels in conjunction with the conference. Vancouver is 1.5 hours from Whistler and 3 hours from Seattle. If you want to go further, then it is a 1.5-hour sail on BC Ferries through the Gulf Islands to visit Victoria on Vancouver Island. Or you could take a cruise to Alaska from Vancouver before the close of the season in early October.

Plenary Lectures

Each day of the conference will begin with a plenary lecture by a leading expert.

Wednesday September 21st: **Judy R. Dubno** from the Medical University of South Carolina will talk about age-related hearing loss and how interdisciplinary teams can advance research and practice in acoustics.

Thursday September 22nd: **Thais Morata** from the National Institute for Occupational Safety and Health (NIOSH) and the Center for Disease Control (CDC) will talk about hearing loss prevention in 2016 and modern ways to communicate to the public about hearing health and noise.

Friday September 23rd: **Bryan Gick and Sid Fels** from the University of British Columbia will talk about interdisciplinary approaches for advancing articulatory speech theory and synthesis by combining linguistics with electrical and computer engineering.

Technical Sessions

Technical sessions will cover all major areas of acoustic interest, including Hearing Loss Prevention, Acoustical Standards, Architectural Acoustics, Noise Control, Shock and Vibration, Hearing and Speech Sciences, Musical Acoustics, Underwater Acoustics, Marine Bioacoustics. If you would like to propose and/or organize a special session on a specific topic **please contact one of the technical co-chairs, Murray Hodgson or Bryan Gick, as soon as possible** (conference@caa-aca.ca).

Topics and Session Chairs Confirmed to date:

Session	Organizer
Acoustics and health	Hugh Davies, Population & Public Health, UBC
Acoustics and sustainable building	Maureen Connelly, Architectural Ecology, BCIT
Acoustical standards	Tim Kelsall, Consultant, Hatch
Acquisition of Speech	Henny Yeung, Linguistics, SFU
Architectural acoustics	Murray Hodgson, Mechanical Engineering, UBC
Hearing and healthy aging	Kate Dupuis, Baycrest Health Sciences, Toronto
Ocean acoustics	Stan Dosso, Earth & Ocean Sciences, U Victoria
Occupational Noise & Hearing Protection	Jérémie Voix, ETS & Hugues Nelisse, IRSST
The practice of acoustical consulting	Mark Bliss, Consultant, BKL
Sounds of Indigenous Languages	Sonya Bird, Linguistics, U Victoria
The sound of emotion	Frank Russo, Psychology, Ryerson
Speech-in-noise testing	Josée Lagacé, Health Sciences, U Ottawa
Speech Perception	Molly Babel, Linguistics, UBC
Speech Production	Bryan Gick, Linguistics, UBC
Voice	Linda Rammage, Audiology & Speech Sciences, UBC
VR and multi-sensory integration	Sin-Tung Lau & Jennifer Campos, Toronto Rehab

Paper Submissions

The abstract deadline is **June 15th, 2016**.

Two-page summaries for publication in the proceedings of Canadian Acoustics are due by August 1st, 2016. Please see the conference website for further details.

Exhibition and Sponsorship

There will be an exhibition area for acoustical equipment, products, and services on September 22nd, 2016. If you or your company is interested in exhibiting, or if you would be interested in sponsoring a conference social event, technical session, coffee breaks, or student prizes, **please contact the sub-committee co-chairs, Mehrzad Salkhordeh or Bernard Feder, as soon as possible** (conference@caa-aca.ca). The conference offers an excellent opportunity to showcase your company and products or services.

Student Participation, Scholarships and Prizes

Students are enthusiastically encouraged to attend the conference and to submit papers. Students whose papers are accepted for presentation can apply for a student conference bursary that will cover one night of accommodation at the Sutton Place Hotel and free registration. Information about applying for a student conference bursary for the conference will be posted soon on the conference website. The deadline will be June 15th, 2016.

Student presenters are also eligible to win prizes for the best paper presentations (three prizes of $500). See the website of the Canadian Acoustical Association for more details about the presentation prizes and other awards for students. Note that the deadline to apply for other CAA student awards is April 30th, 2016.

Hotel Information

The Sutton Place Hotel is located in the heart of downtown Vancouver on Burrard Street near Robson Street. It features a signature restaurant and wine merchant, and an elegance that few hotels can rival, with European charm and exceptional service.
The basic room rate for the conference is $199/night (single or double) plus taxes, including the following:

- **Complimentary Internet:** wireless/high speed internet in guestrooms and wireless internet in function rooms.
- **Health Club and Pool:** Access to the fitness facility and swimming pool complimentary to all overnight guests.
- **The Sutton Shopper Program:** The Sutton Shopper Program, exclusive to the Sutton Place Hotel, will be offered to every guest with the group. This program enables guests to receive discounts between 10% - 30% at over fifty shops and services along the Robson Street shopping corridor.
- **Pre/Post Rates:** The guestroom rates will be extended to our group 3 days prior and 3 days following the inclusive dates of your meeting, subject to availability at the time of booking.

Direct reservations must be made prior to Friday, August 18, 2016. To make reservations, please state that you are coming for the "**Canadian Acoustical Association 2016 Conference"**.
Telephone: **1-866-378-8866 (toll-free in Canada and Continental USA)**
Email: **res_vancouver@suttonplace.com**
On Line: **www.vancouver.suttonplace.com**
BOOKING GROUP CODE: VCSEP2016_CAA

Conference Registration

Details will be available shortly at the conference website.
CONFERENCE WEBSITE: http://awc.caa-aca.ca

Important Dates

Before Acoustics Week in Canada
June 15th: Deadline for submission of abstracts
June 15th: Deadline for student conference bursary applications
August 1st: Deadline for submission of two-page papers
August 18th: Cutoff date for group hotel reservations
September 18th-21st: World Congress of Audiology*
During Acoustics Week in Canada
September 21st: Plenary talk by Judy Dubno
September 21st: Opening reception
September 22nd: Plenary talk by Thais Morata
September 22nd: Exhibits
September 22nd: Annual General Meeting of CAA members
September 22nd: Awards Banquet
September 23rd: Plenary talk by Bryan Gick and Sid Fels
September 23rd: Announcement of Student Presentation Prizes at the closing lunch.

*World Congress of Audiology

For those who may be interested in attending two meetings while in Vancouver, the 33rd World Congress of Audiology (the meeting of the International Society of Audiology) will be held across the road at the Sheraton Wall Centre from September 18th to September 21st. Please see the WCA website for further information: **http://www.wca2016.ca**

Semaine canadienne d'acoustique 2016

21 au 23 septembre 2016, Vancouver, Colombie-Britannique

Coprésidents du congrès: Kathy Pichora-Fuller, University of Toronto
Clair Wakefield, Wakefield Acoustics, Victoria, BC

Bienvenue à Vancouver!

La ville de Vancouver est heureuse d'accueillir les délégués au congrès de la Semaine canadienne d'acoustique 2016. Les chercheurs et les professionnels en acoustique, de même que les éducateurs et les étudiants de partout au pays sont invités sur la côte pittoresque de l'Ouest canadien pour trois jours de séances plénières et scientifiques portant sur l'acoustique. L'assemblée générale annuelle de l'Association canadienne d'acoustique aura lieu pendant le congrès, ainsi que la rencontre du comité de normalisation en acoustique et une exposition d'équipements et de services. Il y aura une réception à l'ouverture du congrès dans la soirée du mercredi 21 septembre ainsi qu'un banquet de la remise des prix, en soirée du jeudi 22 septembre. Le Congrès mondial en audiologie prendra place dans la même semaine, soit du 18 au 21 septembre, et ce, seulement qu'à deux coins de rue du congrès de la Semaine canadienne d'acoustique

Le congrès de l' Association canadienne d'acoustique se tiendra à l'hôtel Sutton Place, situé à quelques pas des fameuses boutiques de la rue Robson, de même que du Parc Stanley où vous pouvez aussi visiter l'aquarium de Vancouver. Vous pourrez aussi aller faire de longues promenades en forêt, sur la plage ou encore sur le long des 20 km du Seawall et tout ça, à de très courtes distances de l'hôtel. En plus de sa nature mondialement reconnue, la ville de Vancouver jouit d'un climat bien tempéré. C'est une ville où l'on se sent en sécurité et entouré de gens sympathiques. Vancouver regorge d'attraits cosmopolites, tant sur le plan culturel que sur celui de ses richesses naturelles. On y trouve aussi un stade, des restaurants et cafés, des boutiques et galeries d'art, des musées de même que d'autres attraits et tous sont à des distances facilement faisables à la marche ou accessibles avec les transports publics, sans oublier le fameux «Sky Train». Il est aussi possible de louer un vélo et les multiples pistes cyclables de la ville vous permettront de vous promener en ville comme si vous étiez un résident permanent. Vancouver est aussi une ville merveilleuse à visiter en famille.

En plus des multiples attraits de Vancouver, il y aussi des endroits très intéressants à visiter à proximité de la ville. Par exemple, on peut se rendre à Whistler en 1 heure et demie, ou encore à Seattle (États-Unis) en trois heures. Il y a aussi les petites îles du golfe et même l'ile de Vancouver où l'on peut se rendre en traversier, et ce à moins d'une heure et demie de la ville, sans oublier les croisières en Alaska qui sont fonction jusqu'au début du mois d'octobre.

Séances plénières et scientifiques

Chaque jour du congrès débutera avec une séance plénière prononcée par un expert.

Mercredi 21 septembre: **Judy R. Dubno** de la *Medical University of South Carolina* viendra parler sur la perte d'audition associée au vieillissement et comment les équipes interdisciplinaires peuvent faire avancer la recherche et les pratiques en acoustique.

Jeudi 22 septembre: **Thais Morata** de la *National Institute for Occupational Safety and Health* and et du *Center for Disease Control* viendra parler de la prévention de la perte auditive en 2016 et des méthodes modernes de parler en publique de la santé auditive et du bruit.

Vendredi 23 septembre: **Bryan Gick et Sid Fels** de l'University *of British Columbia* vont venir parler des approches interdisciplinaires pour l'avancement des théories articulatoires de la parole et de leur synthèse, en combinant les modèles linguistiques, électriques et de génie informatique.

Séances techniques

Il y aura des séances techniques portant sur l'ensemble des sujets en acoustique, soit la prévention de la perte auditive, les normes d'acoustiques, l'acoustique architecturale, le contrôle de bruit, les chocs et les vibrations, les sciences de l'audition et de la parole, l'acoustique en musique, l'acoustique sous-marine et la bioacoustique marine.

Si vous êtes intéressés à organiser ou à suggérer une séance spéciale sur un sujet précis, s'il-vous-plaît communiquez le plus rapidement possible avec **Murray Hodgson ou Bryan Gick à l'adresse suivante** conference@caa-aca.ca**.**

Sessions et organisateurs confirmés à ce jour:

Session	L'organisateur
Acoustics and health	Hugh Davies, Population & Public Health, UBC
Acoustics and sustainable building	Maureen Connelly, Architectural Ecology, BCIT
Acoustical standards	Tim Kelsall, Consultant, Hatch
Acquisition of Speech	Henny Yeung, Linguistics, SFU
Architectural acoustics	Murray Hodgson, Mechanical Engineering, UBC
Hearing and healthy aging	Kate Dupuis, Baycrest Health Sciences, Toronto
Ocean acoustics	Stan Dosso, Earth & Ocean Sciences, U Victoria
Occupational Noise & Hearing Protection	Jérémie Voix, ETS & Hugues Nelisse, IRSST
The practice of acoustical consulting	Mark Bliss, Consultant, BKL
Sounds of Indigenous Languages	Sonya Bird, Linguistics, U Victoria
The sound of emotion	Frank Russo, Psychology, Ryerson
Speech-in-noise testing	Josée Lagacé, Health Sciences, U Ottawa
Speech Perception	Molly Babel, Linguistics, UBC
Speech Production	Bryan Gick, Linguistics, UBC
Voice	Linda Rammage, Audiology & Speech Sciences, UBC
VR and multi-sensory integration	Sin-Tung Lau & Jennifer Campos, Toronto Rehab

Soumissions des propositions de communication

La date limite pour la soumission d'un résumé de présentation est le **15 juin 2016**.

La date limite pour la soumission des articles résumés de 2 pages qui seront publiés dans les actes de congrès est le 1er août 2016. Pour plus de détails, prière de consulter le site internet du congrès.

Exposition et commandites

Il y aura un espace d'exposition pour les équipements, les produits et les services en acoustique le 22 septembre 2016. Si vous, ou votre entreprise, êtes intéressés à exposer ou commanditer un évènement social du congrès, une séance technique, une pause-café ou des prix d'étudiants, **prières de communiquer avec Mehrzad Salkhordeh or Bernard Feder, le plus rapidement possible** au conference@caa-aca.ca. Le congrès offre une excellente occasion de présenter votre entreprise, vous produits ou vos services.

Participation des étudiants, bourses et prix

C'est avec enthousiasme que les étudiants sont invités à participer au congrès et d'y présenter leurs travaux de recherche. Les étudiants dont la proposition de présentation sera acceptée pourront faire une demande de bourse qui couvrira les frais pour une nuitée à l'hôtel Sutton Place, de même que les frais d'inscription au congrès. Les informations au sujet de la demande de cette bourse étudiante seront bientôt affichées sur le site internet du congrès. La date limite pour soumettre une demande de bourse est le 15 juin 2016.

Les étudiants qui présenteront leurs travaux sont aussi éligibles aux prix des meilleures présentations (trois prix de $500). Pour plus de détails au sujet des prix pour les présentations et autres reconnaissances pour les étudiants, prières de consulter le site internet de l'Association. Il est à noter que la date limite pour soumettre sa candidature au Prix étudiant de l'Association canadienne d'acoustique est 30 avril 2016.

Information sur l'hôtel du congrès

L'hôtel Sutton Place est située au centre-ville de Vancouver sur la rue Burrard, tout près de la rue Robson. En plus d'un restaurant signature et d'un marchand de vin, cet hôtel au charme européen et d'une élégance inégalée offre un service exceptionnel.
Le tarif de base pour une chambre pendant le congrès est de $199/nuit (simple ou double) et les taxes sont en sus. Ce tarif inclut les services suivants:

- **Service internet gratuit:** l'internet sans fil et à haute vitesse est disponible dans toutes les chambres et les salles de réunion.
- **Centre de conditionnement et piscine:** les invités de l'hôtel bénéficient d'un accès gratuit aux équipements du centre de conditionnement de même qu'à la piscine.
- **Le programme "Sutton Shopper Program":** Ce programme, exclusif à l'hôtel, est offert à tous les délégués qui hébergent à l'hôtel et donne droit à des rabais de 10% à 30% dans plus de 50 boutiques et services offerts de la rue Robson.
- **Tarifs réduits avant et après le congrès:** Tous les délégués qui hébergent à l'hôtel pendant le congrès pourront profiter du tarif réduit trois jours avant le congrès ainsi que trois jours après, selon la disponibilité des chambres au moment de la réservation.

Pour profiter des tarifs réduits, vous pouvez directement réserver une chambre en indiquant que vous êtes un délégués au congrès de la "**L'Association canadienne d'acoustique**".
Téléphone: **1-866-378-8866 (sans frais au Canada et États-Unis)**
Adresse courriel: **res_vancouver@suttonplace.com**
En ligne: **www.vancouver.suttonplace.com**
Code de réservation pour le groupe: VCSEP2016_CAA

Inscription au congrès

Les détails seront bientôt affichés sur le site internet du congrès: **http://awc.caa-aca.ca**

Dates importantes

Avant la Semaine canadienne d'acoustique

15 juin: date limite pour la soumission des résumés de présentation
15 juin: date limite pour soumettre une demande de bourse étudiante
1er août: date limite pour soumettre l'article résumé de deux pages à paraître dans les actes de congrès.
18 août: dernier jour pour profiter du tarif réduit pour le séjour à l'hôtel du congrès
18 au 21 septembre: Congrès mondial en audiologie*

Pendant la Semaine canadienne d'acoustique

21 septembre: Séance plénière de Judy Dubno
21 septembre: Cérémonie d'ouverture
22 septembre: Séance plénière de Thais Morata
22 septembre: Exposition
22 septembre: Assemblée générale annuelle pour les membres de l'Association de l'acoustique canadienne
22 septembre: Banquet de la remise des prix
23 septembre: Séance plénière de Bryan Gick et Sid Fels
23 septembre: Annonce du prix pour la meilleure présentation des étudiants au déjeuner de fermeture.

*Congrès mondial en audiologie

Pour ceux qui souhaitent participer à deux congrès pendant leur séjour en Vancouver, sachez qu'il sera possible de le faire puisque le 33e Congrès mondial en audiologie (organisé par la Société internationale d'audiologie) aura lieu juste de l'autre côté de la rue au *Sheraton Wall Centre* du 18 au 21 septembre. Pour plus de détails, consulter le site internet du congrès: **http://www.wca2016.ca**

The Canadian Acoustical Association - L'Association canadienne d'acoustique

CANADIAN ACOUSTICS TELEGRAM ANNOUNCEMENTS - ANNONCES TÉLÉGRAPHIQUES DE L'ACOUSTIQUE CANADIENNE

Tri-Agency Open Access Policy on Publications

The good news? Publication and copyright policies of Canadian Acoustics journal are fully compliant with these new rules! That's another good reason for reseachers to publish in Canadian Acoustics!

The Canadian Institutes of Health Research (CIHR), the Natural Sciences and Engineering Research Council of Canada (NSERC) and the Social Sciences and Humanities Research Council of Canada (SSHRC) are federal granting agencies that promote and support research, research training and innovation within Canada. As publicly funded organizations, the Agencies have a fundamental interest in promoting the availability of findings that result from the research they fund, including research publications and data, to the widest possible audience, and at the earliest possible opportunity. Societal advancement is made possible through widespread and barrier-free access to cutting-edge research and knowledge, enabling researchers, scholars, clinicians, policymakers, private sector and not-for-profit organizations and the public to use and build on this knowledge.According to a new policy, all grant recipients that were funded in whole or in part by NSERC or SSHRC for grants awarded May 1, 2015 and onwar (Januray 1, 2008 for CIHR) are required to ensure that any peer-reviewed journal publications arising from Agency-supported research are freely accessible within 12 months of publication.

May 28th 2015

Looking for a job in Acoustics?

There are many job offers listed on the website of the Canadian Acoustical Association!

You can see them online, under http://www.caa-aca.ca/jobs/

August 5th 2015

CAA is now social!

Canadian Acoustical Association is moving to the social media!

Find us on social media:Twitter: CanAcousticalFacebook: facebook.com/canadianacousticalassociation

December 14th 2015

ICA Early Career Award

Congratulations to Frank Russo for receiving the ICA Early Career Award!

The winner of the 2016 ICA Early Career award is Frank Russo. Professor Russo works in the Department of Psychology at Ryerson University in Toronto, Canada, and is the current President of the Canadian Acoustical Association.

February 8th 2016

InterNOISE 2016

Internoise 2016 will be held in Hamburg, Germany, 21-24 August 2016.

Abstracts in any area of noise and vibration control are welcome. The abstract deadline is 10 March 2016, and final papers are due 17 May 2016. Abstracts can be submitted online at www.internoise2016.org.

February 16th 2016

ICA 2016 to be held in Buenos Aires, Argentina, on September 5-9, 2016.

The 22nd International Congress on Acoustics will be held in Buenos Aires, Argentina, on September 5-9, 2016. The Congress venue will be the Catholic University of Argentina in Buenos Aires (UCA).Please visit our website at www.ica2016.org.ar for updates and other relevant information.

The International Congress on Acoustics provides the opportunity once every three years for all those around the world who are working in all areas of Acoustics to meet, discuss and exchange ideas. The technical program will include plenary and keynote lectures, invited, contributed and poster papers covering all aspects of acoustics. There will be an extensive technical exhibition highlighting the latest advances in acoustical products, such as materials, systems and equipment.ICA 2016 is being organized by the FIA and the Argentinean Acousticians Association (AdAA), in cooperation with the Chilean Acoustical Society (SOCHA), under the endorsement of the International Commission for Acoustics and the sponsorship of the Acoustical Society of America (ASA).Jointly, it will also be held with the X Ibero-American Federation of Acoustics Congress, incorporating the XIV Argentinean Congress of Acoustics and the XXVI Meeting of the Brazilian Acoustical Society.ICA 2016 has the official sponsorship of the Acoustical Society of America (ASA), of the International Union of Pure and Applied Physics (IUPAP), and the National Council of Acoustical Consultants (NCAC).

March 8th 2016

Intensive Underwater Acoustics courses - July 2016, Victoria

Underwater noise in the marine environment is a topic of increasing importance. As concern has grown over its possible negative effects, regulatory requirements have become more stringent. Seiche are recognised experts in underwater acoustics. We provide solutions to industry, defence and research sectors for mitigation, monitoring and modelling.Seiche Training runs highly-respected Underwater Acoustics courses in association with University of Bath, UK, and CPD-recognised by the Institute of Marine Engineering, Science and Technology (IMarEST).

UNDERWATER ACOUSTICS IN THE MARINE ENVIRONMENT 25th – 27th July 2016 Coast Victoria Harbourside Hotel and Marina, Victoria, Canada This three day course equips delegates with a thorough knowledge of the fundamentals of underwater acoustics. It then focuses on developing clear, quantitative understanding of the issues involved in the impact of acoustics on marine wildlife. The following topics will be covered: ocean environments, noise propagation models, sound field modelling, methods of assessment, impacts of noise on marine life, mitigation, environmental regulations and Environmental Impact Assessments (EIAs), fisheries, JNCC guidelines and emerging studies and technologies across this field. Delivered by leading research professors and experts including Dr Paul Lepper and Professor Victor Humphrey. The course is intended for regulators, environmental consultants, researchers and policy/environmental professionals within industry. It will be particularly useful in providing a better understanding of reports that delegates either have to deliver or receive from clients. UNDERWATER ACOUSTICS AND SONAR SYSTEMS 25th – 27th July 2016 Coast Victoria Harbourside Hotel and Marina, Victoria, Canada

This four day intensive course in underwater acoustics is intended for engineers and scientists, particularly within industry and defence. The first part of the course covers the principles of underwater acoustics. This is followed by advanced modules on underwater sound sources with a key emphasis on sonar, seismic imaging, seismic sources and seismic data. Dr Philippe Blondel, Professor Victor Humphrey and Dr Peter Dobbins are the key lecturers for this course. Seiche Training is also running its two day Protected Species Observer (PSO) and three day Passive Acoustic Monitoring (PAM) training courses in Canada 18 – 22 Jul

April 1st 2016

EuroRegio2016 - SUMMER SCHOOL on Acoustics - Porto, Portugal

In June, from 11 to 12th, there will be in Porto, Portugal, a EAA Summer School on Acoustics, sponsored by the European Acoustics Association and organized by the Portuguese and Spanish Acoustical Societies. This Summer School will be held previously to the EuroRegio2016, at the Faculty of Engineering of the University of Porto (FEUP).

The EAA Summer School comprises several topic-focused courses, dealing with some of the most actual topics in acoustics, as follows: . APA – Approaching Acoustics (one day) . ENA - Environmental acoustics and smart cities (1.5 days) . SAVB - Sustainable acoustics and vibrations in buildings (1.5 days) . RMA – Room and Musical acoustics (one day) . 3DVA - 3D virtual acoustics (half day) . NMA - Numerical methods in acoustics (half day) . SPM - Sound propagation in special media (one day) The organizers encourage all those interested in attending the Summer School to register at http://www.spacustica.pt/EuroRegio2016/index.html, where you can also find the ”Detailed Program of the Courses: timetable; lecturers and thematic key words”.

April 1st 2016

Why publish in Canadian Acoustics?

Because, it is...

- A respected scientific journal with a 40-year history uniquely dedicated to acoustics in Canada
- A quarterly publication in both electronic and hard-copy format, reaching a large community of experts worldwide
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Pourquoi publier dans Acoustique canadienne ?

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- Une publication trimestrielle en format papier et électronique, rejoignant une large communauté d'experts à travers le monde
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- Une alternative intéressante pour une évaluation par les pairs, fournissant aux auteurs des commentaires pertinents, objectifs et constructifs

Canadian Acoustical Association
Association canadienne d'acoustique

Application for Membership

CAA membership is open to all individuals who have an interest in acoustics. Annual dues total $100.00 for individual members and $50.00 for student members. This includes a subscription to ***Canadian Acoustics***, the journal of the Association, which is published 4 times/year, and voting privileges at the Annual General Meeting.

Subscriptions to *Canadian Acoustics* or Sustaining Subscriptions

Subscriptions to ***Canadian Acoustics*** are available to companies and institutions at a cost of $100.00 per year. Many organizations choose to become benefactors of the CAA by contributing as Sustaining Subscribers, paying $475.00 per year (no voting privileges at AGM). The list of Sustaining Subscribers is published in each issue of ***Canadian Acoustics*** and on the CAA website.

Please note that online payments will be accepted at http://jcaa.caa-aca.ca

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For individuals or organizations wishing to pay by check, please register online at *http://jcaa.caa-aca.ca* and then mail your check to:

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Association Canadienne d'Acoustique
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Formulaire d'adhésion

L'adhésion à l'ACA est ouverte à tous ceux qui s'intéressent à l'acoustique. La cotisation annuelle est de 100.00$ pour les membres individuels, et de 50.00$ pour les étudiants. Tous les membres reçoivent ***l'Acoustique Canadienne***, la revue de l'association. Les nouveaux abonnements reçus avant le 31 août s'appliquent à l'année courante et incluent les anciens numéros (non-épuisés) de ***l'Acoustique Canadienne*** de cette année. Les nouveaux abonnements reçus après le 31 août s'appliquent à l'année suivante.

Abonnement pour la revue *Acoustique Canadienne* et abonnement de soutien

Les abonnements pour la revue ***Acoustique Canadienne*** sont disponibles pour les compagnies et autres établissements au coût annuel de 100.00$. Des compagnies et établissements préfèrent souvent la cotisation de membre bienfaiteur, de 475.00$ par année, pour assister financièrement l'ACA. La liste des membres bienfaiteurs est publiée dans chaque issue de la revue ***Acoustique Canadienne***. Les nouveaux abonnements reçus avant le 31 août s'appliquent à l'année courante et incluent les anciens numéros (non-épuisés) de ***l'Acoustique Canadienne*** de cette année. Les nouveaux abonnements reçus après le 31 août s'appliquent à l'année suivante.

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