

# ABSTRACTS WITHOUT SUMMARY PAPERS

## Bioacoustics

### **How deep do you call? Depth localization in Southern Resident killer whales using passive acoustics**

Jason Wood, Scott Veirs, Val Veirs & Dominic Tollit

The Snohomish Public Utility District of Washington State is applying for permits to install up to two in stream tidal turbines in Admiralty Inlet, Washington State, as part of a pilot project to determine the feasibility of marine tidal energy generation. To inform the permitting process, acoustic recordings from a vertical hydrophone array were made in Admiralty Inlet as Southern Resident killer whales transited through the study site to determine depth of whales in this area. The vertical array consisted of four hydrophones at ten meter offsets with the shallowest at a depth of 10 meters. A total of 682 calls and echolocation clicks were localized using hyperbolic localization techniques. The Time Of Arrival Difference (TOAD) was calculated using cross-correlation techniques for all calls and click trains. TOAD values were calculated for individual clicks by hand picking the times of arrival. Where present, surface reflections were also incorporated into the localizations of single clicks. We validated our techniques by generating signals at known depths (10 to 60 meters) and distances (100 to 500 meters). Measurement errors were calculated for each localization. Results of the validation study, error estimates, and depth measurements will be presented.

### **Fine-scale 3-D tracking of fish behavior in Central California using acoustic tags**

Samuel Johnston, Tracey Steig & David Ouellette

Micro-acoustic tags have been used to monitor the fine-scale three-dimensional behavior and survival of fish and other aquatic life in the Pacific Northwest and Central California for years. Three-dimensional tracks are obtained at dams, lakes, open rivers, estuaries, and in marine environments. Resolution of three-dimensional positions are sub-meter with some resolutions as fine as 20 cm. In addition to juvenile and adult salmonids, other species tracked include eel, lamprey, sturgeon, shad, crab and shrimp. Salmonid smolts as small as 92 mm have been tagged and tracked with acoustic tags, which weigh as little as 0.5 g. Today's acoustic tag technology allows researchers to view fish behavior and passage in real-time. Tags operated at 307 kHz with a user-specified pulse width of 0.5-5 msec. Recent innovations include the development of smaller tags weighing 0.5 g in air, longer life tags, remote access via smart-phone, as well as various data display options. A number of advances in the analysis methods, techniques and software have been made over the past several years. Some of these improvements include the development of various fish density algorithms and advances of three-dimensional animation programs. Three-dimensional tracks of fish approaching various structures will be presented. Examples of fish tracks and fish densities will be superimposed over bathymetry, water velocities and structures. Recent Sacramento-San Joaquin River examples will be featured.

## Ocean Acoustic Inversion

### **Bayesian model selection using evidence computations**

Jan Dettmer & Stan Dosso

This paper considers approaches to computing the evidence ( $Z$ ) in Bayesian inference problems for model selection in geoacoustic inversion. Bayes' theorem combines the likelihood function, model prior, and  $Z$  to form the posterior probability density (PPD).  $Z$  is difficult to compute for general problems and a common approach is to avoid its computation entirely by calculating an unnormalized estimate of the PPD which is sufficient for moment estimates. However, estimating the normalized PPD, including  $Z$ , allows for moment estimates as well as quantifying the likelihood of the model parameterization. This is commonly referred to as model selection and poses a natural way to quantifying the most appropriate model parameterization for a given data set (Bayesian razor). Several approaches for computing  $Z$  have been developed in the statistics community. Here, annealed importance sampling is applied to the geoacoustic inference problem. Annealed importance sampling follows an annealing approach and computes weighted averages along cooling trajectories. Both methods also give parameter estimates which are compared to Metropolis-Hastings results. [Work supported by the Office of Naval Research]

### **Transdimensional geoacoustic inversion**

Jan Dettmer, Stan Dosso & Charles Holland

This paper applies a general trans-dimensional Bayesian approach to geoacoustic inversion. Trans-dimensional inverse problems are a generalization of fixed dimension inversion and include the number of model parameters as an unknown in the problem. A model is considered to be any particular choice of physical theory, its appropriate parameterization, and statistical representation for the data errors that are used to explain the physical system under examination. By including the dimension of the search space in the inversion, a joint posterior distribution is obtained that characterizes the state of knowledge about

parameters, including effects due to limited knowledge about the parametrization of the underlying environment and error processes. The inversion is implemented using a reversible-jump Markov chain Monte Carlo algorithm and the environment is parametrized with a partition modeling approach. Data errors are assumed as unknown and addressed by including a data-error model in the inversion. Jumps between dimensions are addressed with a birth-death methodology that allows the algorithm to wander dimensions by adding or removing interfaces from the seabed partition while maintaining detailed balance of the Markov chain. The approach presented can generally be applied to geoacoustic inverse problems. Here, seabed reflection-coefficient data as function of frequency and angle are considered. [Work supported by the Office of Naval Research]

## **Underwater Acoustics**

### **Underwater Acoustic Levels of Southeast Alaska Cruise Ships**

Blair Kipple & Chris Gabriele

Radiated acoustic levels for ten cruise ships that frequently travel Southeast Alaska waters were measured at the U.S. Navy's Southeast Alaska Acoustic Measurement Facility near Ketchikan, Alaska to quantify their underwater acoustic levels. This group of ships included diesel-electric, diesel-electric/gas turbine-electric, direct-diesel, and steam turbine propulsion plant ships ranging in size from 90 to 294 meters in length. Peak one-third octave levels for 10-knot ship speeds ranged from 158 to 172 decibels relative to 1 microPascal at 1 yard. Propulsion system type and cavitation performance were important factors in cruise ship acoustic level and spectral character. Diesel-electric ship acoustics were dominated by noise energy from diesel generators and from electric propulsion motors in combination with frequency converters and diesel generators. Propulsion diesel and reduction gear noise were important contributors in the direct diesel ships' underwater acoustic characteristics. Turbine generator, propulsion turbine, and reduction gear noise were the most significant noise items for the steam plant ship. Each ship was tested at two speeds. The sound levels of some ships were strongly speed dependent while others exhibited less speed dependence. Differences in acoustic levels between speeds were typically dependent on propulsion system and propeller cavitation noise contributions.

### **Acoustic propagation sensitivity to variability and uncertainty of the ocean environment: a comparison of modeled and measured data**

Sean Pecknold, Cristina Tollefsen & John Osler

Sonar performance prediction models are a key tool for planning and carrying out sonar operations in littoral environments. Less well understood are the impacts that variability and uncertainty in the environment may have on propagation predictions. A sensitivity model was previously developed [Dosso et al, J. Acoust. Soc. Am. 121 (1), 2007] to determine the effects of limited sampling of, and uncertainty or variability in, oceanographic and geo-acoustic information on acoustic propagation modeling. Here, the model is applied to the conditions found during two field trials off the coast of Nova Scotia, using environmental data collected both initially from historical databases and then in-situ. The effects of the improved in-situ environmental sampling are demonstrated using the results of the sensitivity analysis. The sensitivity of the propagation and uncertainties in modeled propagation loss are then compared to the propagation loss data collected during the field trials.

### **Characterization of scattered acoustic intensity fields in the resonance region of a motionless rigid sphere**

Robert Barton & Kevin Smith

In this study, the properties of the scattered acoustic vector fields generated by simple rigid spheroids are investigated. Analytical solutions are derived from general acoustic pressure scattering models, and analyzed for wave numbers in the resonance region. Of particular interest is the understanding of the characteristics of energy flow of the scattered acoustic vector field in the near to far-field transition region. The separable active and reactive components of the acoustic intensity are used to investigate the structural features of the scattered field components. Numerical results are presented for the near and transition region for a rigid sphere. The ability to extract scattered field features is illustrated with measurements obtained from a recent in-air experiment using an anechoic chamber and acoustic vector sensor probes to measure the scattered acoustic vector field from rigid spheroids.

## **Advanced Audio Applications**

### **Transmission characteristics of two tactical communication headsets with hearing protection capabilities**

Christian Giguère, Chantal Laroche & Véronique Vaillancourt

Communication headsets are increasingly used in the workplace. In some of the most challenging environments (e.g. military, law-enforcement tactical operations), the device must protect hearing against hazardous continuous and/or impulse noise while maintaining good situational awareness (e.g. sound localization, speech communication) within the immediate surrounding and

during radio communications with remote locations. These objectives must be met despite the presence of noise-induced and other types of hearing losses among users. Several analog and digital headsets are commercially available with adaptive level-dependent passive/active noise reduction, user-adjustable talk-through or surround volume, in addition to radio capabilities. Unfortunately, the technical specifications supplied by manufacturers are very limited, even for high-end products, and do not readily allow for a systematic analysis of the best devices or parameters to use in specific communication scenarios given the noise characteristics, task demands and hearing status of the user. This is in contrast to the hearing aid industry, where product testing and specification sheets are very extensive and highly standardized, and where systematic fitting procedures exist to optimize communication. In the paper, the characteristics of two high-end tactical communication devices are reported. The devices are the Peltor Powercom Plus (circumaural) and the Nacre QUIETPRO (intraaural). The test battery included measurements of (1) the passive sound attenuation, (2) the insertion gain and compression parameters at various control settings of the talk-through/surround modes, and (3) the speech intelligibility in two military noises with subjects covering a wide range of hearing profiles. [Work supported by DRDC Toronto].

### **DST a novel approach for noise dependent hearing protectors**

Engbert Wilmink & Pieter van 't Hof

A novel concept for dynamic hearing protection has been developed based on an automatically opening and closing gate. Using miniaturized electronics this solution can be worn in the ear with a very low energy consumption meeting international standards for hearing protectors. The underlying physics of dampening sound through a varying orifice will be discussed in relation to attenuation data obtained in the lab and with test persons. Current CE certification methods of dynamic hearing protectors pose an issue to test the devices compared typical usage conditions. A lab based test method is proposed to ensure quality and performance.

### **Measurements of noise exposure during wildfire air firefighting operations**

Hugues Nelisse, Jerome Boutin, Martine Gendron & Tony Leroux

The use of air attack on wildfire causes fixed-wing aircraft and helicopters to operate in close proximity within a designated airspace. The Bird Dog crew members are charged with the responsibility to co-ordinate the direction of air traffic over and in the immediate vicinity of wildfire alongside the ground firefighting. The crew of the Bird Dog consists of a pilot and a specially trained forest fire fighting person. These workers wear communication headsets during their entire mission, can receive transmissions through as much as 9 to 10 channels and can fly over long period of time ranging from 3-4 hours to 8-9 hours. There are thus great concerns regarding the noise exposure for such activities. This paper presents the comparison of two techniques for measuring the exposed levels (noise under the headset) for different workers in real flight conditions. The first technique, based on the F-MIRE technique, uses dual miniature microphones inserted into the ear muff to measure the noise outside and inside the ear muff. The second technique uses a probe-tube microphone placed close to the tympanic membrane to measure the exposed signal. A communication headset was instrumented with the necessary equipment for both techniques and simultaneous time recordings are performed during entire flights missions to allow systematic comparisons of the two approaches. Results for different workers and different flight conditions are presented and discussed.

### **Temporal metaphors in auditory strategies of environmental monitoring**

Joachim Gossmann

The organisation of sound for auditory monitoring is often considered from a perspective of superimposed simultaneous layers of sound: The grouping of auditory elements into streams, or the deconstruction of auditory scenes into different sound sources. A temporal perspective of sound is highlighted in Murray Schafer's investigation into soundscapes - in which the elements are regarded in their spatio-temporal relationship as part of an environmental ecology. In this paper, we would like to highlight the perspective of the human perceiver on the temporality of sound - our own contribution to the way sound occurs to us and how we can enable us as listening beings to derive more meaning from what we hear. Here, we would like to focus specifically on the temporal aspects. Marshal McLuhan highlights the nature of media as "Extensions of Man", while George Lakoff emphasises the importance of metaphorical structures to the way the world occurs to us. Temporal metaphors we could apply in this bi-directional information exchange between our approach to the world and the way the world occurs to us can come from a variety of origins (the time of music, familiar temporalities in our environment and everyday experience, temporal structures of communication and our own body, among many others). As concrete implementations scientific sonifications and audifications of seismological data are presented and evaluated: - A perceptual analysis of audified seismograms. - sonification of earthquake event catalogues under the application of different temporal metaphors This will guide us through an investigation of sound generation, how temporal structuring of sounds can target our specific perceptual abilities better, and finally, the potentials of our own openness of listening "for". This will provide us with concrete handles to make auditory applications in the field of discovery-oriented science more relevant to a human listener.



## **Soundscapes**

### **The Toronto Sound Map Project**

Frank Russo

Although humanistic and artistic approaches to soundscapes have flourished over the last half-century and particularly in Canada, there is very little that is known about the psychology of urban soundscapes. To this end, we have recently captured over 200 soundscapes from the metropolitan Toronto area. Each soundscape consists of a 2-minute binaural recording with accompanying sound-level measurements. The recordings will serve as stimuli for a new program of research that aims to generate knowledge about the psychology of the urban soundscape. Progress on three of the initial studies in this program will be described. Study 1 is a multidimensional scaling study in which participants will be asked to rate the similarity of soundscapes presented in pairs. The scaling solution will provide insight into the underlying cognitive representation of urban soundscapes. Study 2 combines electrophysiological and behavioral methods to examine stress response and recovery to/from commonly experienced soundscapes that have been described as aversive. Study 3 examines the influence of soundscapes on the useful field of view. In all studies, soundscapes will be presented over headphones in a double-walled IAC chamber at levels that are calibrated with the accompanying SPL measurements. We expect that physical and psychophysical dimensions that are independent of sound intensity will influence the various questions under investigation. In addition to the planned experimental work, we will report on the development of a website ([torontosoundmap.com](http://torontosoundmap.com)) that provides map-based navigation of the soundscapes and public dissemination of the research findings.

## **Speech Communication**

### **Acoustic diagnostics of prosodic phrasing in SENĆOTEN**

Janet Leonard

Acoustic Diagnostics of Prosodic Phrasing in SENĆOTEN (Saanich, North Straits Salish). It is widely accepted that languages organize grammatical information into prosodic units (e.g. Selkirk 1986,) and that evidence for prosodic structure should be reflected in the acoustic signal (e.g. Shattuck-Hufnagel and Turk 1995). Building from previous work investigating the acoustic correlates associated with Salish prosodic structure, this paper seeks to examine the relationship between the acoustic signal and prosodic structure in SENĆOTEN. In particular, a set of acoustic correlates associated with the phonological phrase are determined (see Beck 1999, Koch 2008) by examining the acoustic properties of a corpus of SENĆOTEN sentences elicited during fieldwork sessions with two fluent speakers. The results of this study illustrate that 1) pauses in pitch, along with variations in F<sub>0</sub>, coincide with the predicted boundaries between phonological phrases, 2) high F<sub>0</sub> coincides with the predicted head of a phonological phrase and 3) longer vowel duration coincides with the end of a phonological phrase. This paper contributes to the growing body of literature investigating the nature of the relationship between phonology and phonetics in SENĆOTEN. Beck, D. (1999). Words and Prosodic Phrasing in Lushootseed. In T. Alan Hall & Ursula Kleinhenz, (eds.), *Studies on the Phonological Word* (pp 23-46). Amsterdam: Benjamins. Koch, K. (2008). *Intonation and Focus in Nl̓he7kepmxcin* (Thompson River Salish). UBC PhD Thesis. Selkirk, E. (1986). On derived domains in sentence phonology. *Phonology Yearbook*, 3 371-405. Shattuck-Hufnagel, S., and Turk, A. E. (1996). A prosody tutorial for investigators of sentence processing. *Journal of Psycholinguistic Research*, 25(2): 193-247.

### **Perception of stress on accented and unaccented words: A comparison between native and nonnative English speakers**

Qian Wang

Native English speakers rely on F<sub>0</sub>, duration, and intensity in the perception of lexical stress. Second Language Acquisition studies have examined the use of these acoustic cues by non-native speakers in the perception of English lexical stress. A problem common to these SLA experiments was that words used for the perception tests were either in citation forms or excised from focused position in a sentence. The lexical stress on these words was, thus, confounded by phrasal accent, also cued by F<sub>0</sub>. Little is known about how well non-native speakers would discriminate lexical stress on words that bear no phrasal accent and how their performance would differ from native English speakers. In this experiment, Mandarin Chinese learners of English (CE) and native English speakers (NE) were compared in the perception of lexical stress on words excised from both ACCENTED and UNACCENTED conditions in an oddity test. Participants listened to a triad with three accented tokens or with three unaccented tokens, and decided whether the tokens in a triad all have the same stress pattern or not. An analysis of error rates showed no significant difference between CE and NE in the accented context but CE made significantly more mistakes than NE in the unaccented condition. CE's comparable performance with NE in perceiving lexical stress in accented contexts may be ascribed to their tonal background and sensitivity to F<sub>0</sub>, whereas their difficulty with unaccented words may be due to their insensitivity to duration and intensity.

## **The long-term retention of fine-grained phonetic details: Evidence from a second language voice identification training task**

Stephen Winters

This study investigated the extent to which listeners store in memory the acoustic cues to non-native phonetic contrasts. Native English listeners were trained to identify the voices of Thai speakers, from a series of individual words, in three separate training conditions. In one training condition, the words produced by each voice consistently bore one of Thai's five distinctive lexical tones. In a second training condition, each voice was consistently associated with one of Thai's three distinctive VOT categories. After three days of training, listeners were then presented with words in a generalization test, in which the previous associations between words and phonetic properties no longer held. In a third, control condition, the voices were not consistently associated with any particular phonetic property. Evidence from both training and generalization indicated that listeners used both tone and VOT properties to learn to identify voices, including particular VOT values and tone contours that are not meaningfully contrastive in English. Talker identification accuracy in both the tone and VOT training conditions was significantly better than in the control condition; talker identification accuracy also decreased significantly in generalization testing for the tone and VOT listeners, but not for listeners in the control condition. Since listeners showed greater perceptual dependence on tone-talker associations than on VOT-talker associations, listeners may be more sensitive to longer, prosodic cues than to shorter timing cues in speech. Overall, these results indicate that listeners do store in memory low-level phonetic details, including acoustic distinctions they might normally perceive categorically.

## **Imagery-induced context effects**

Mark Scott

This experiment examines whether context effects can be induced by auditory imagery. How a sound is perceived often depends on what was heard immediately prior – the ‘context’ of the sound. One well-known context effect was reported by Mann (1980) who found that a sound which is ambiguous between /da/ and /ga/ tends to be categorized as /da/ if immediately preceded by /ar/, but as /ga/ if immediately preceded by /al/. The reason for this effect is believed to be that the low F3 of /ar/ makes the F3 of the following ambiguous sound seem higher (so more /d/-like) by comparison. The high F3 of /al/ has the opposite effect, making the following F3 seem lower and so more /g/-like. The current experiment tests whether auditory imagery of the context sound can induce the same effect; if so, it would suggest that auditory imagery has detailed phonetic content (including formant structure). The experiment compares the strength of the effect across 2 conditions: normal speech and imaged speech. In both conditions subjects produce (externally or internally) one of the context sounds (/ar/ or /al/) in a rhythm, and after several repetitions, a /da/~ga/ ambiguous target sound is played which they must categorize. The experiment is currently being run (8 participants so far) and initial results suggest that imagery does indeed induce the context effect. As not all subjects experience this context-effect, it is interesting to note that susceptibility to the effect seems to be strongly correlated across the two conditions.

## **A perceptual study of [liquid + stop] sequences**

Terrance Nearey & Benjamin Tucker

Lotto and Kluender (1998), following Mann(1980) studied the perception of stops in the four syllables like /arga, alga, arda, alga/. These experiments and several others used a /-ga/ to /-da/ varying along an F3-transition continuum. All experiments reported finding more /d/ responses following /ar-/ than /al-/ precursor syllables. We replicated part of Lotto and Kluender's Experiment 2 in preparation for more elaborate experiments manipulating /r/ and /l/ as well as /d/ and /g/. Preliminary findings with 16 listeners (native speakers of English) show effects broadly similar to those previously reported, with /al-/ precursors leading to more /d/ responses. However, mixed-effects logistic regression analysis (Laplace approximation) suggests that more than simple boundary shifts are involved. For stimuli in the /al-/ context, the estimated /g-d/ response curve shows a steeper slope than that in the /ar-/ context. The nature of this interaction may have consequences for evaluating competing perceptual accounts (auditory contrasts vs. compensation for coarticulation) of this phenomenon. Simple logistic regression analysis of individual listeners data revealed that only eight of 16 showed significant ( $p < .05$ ) effects of /ar-/ context in the expected direction, while three showed significant effects in the wrong direction and 5 showed non significant effects. (All but one listener showed significant main effects in the expected direction for the d to g continuum.) Further analysis of these results and results from listeners who are non-native speakers of English will be reported.

## **Architectural Acoustics**

### **Providing “good”, “better” or “best” acoustical plumbing system proposals to cost sensitive clients**

Chip O'Neil

Providing “Good”, “Better”, or “Best” proposals for acoustical noise and vibration isolation of piping systems to cost sensitive

clients When it comes to the costs associated with effective acoustical isolation of a plumbing or piping system there are a variety of choices available. Though effective isolation materials and methods are available for very modest costs, there is still often the challenge of “Value Engineering” to face. As in most facets of building construction, there are a variety of quality levels available when it comes to plumbing and piping system acoustic isolation options. Become familiar with “Good”, “Better” and “Best” materials and methods, in order to assist you during the planning and budgeting stages of a building project. Learn to provide valuable input during the Cost–Benefit analysis phase of a building project. Base your input to your client upon solid laboratory test data arranged by specific plumbing or piping system applications, such as through-stud isolation, riser clamp isolation, shower head attachments, etc. This paper will provide fundamental presentation points and cost analysis templates easily customized to any plumbing or piping system. These analytical tools take into account both labor and material factors, in order to generate a true “Installed Cost Analysis”, while assisting you to specify a proven engineered system for your client.

### **Subjective ranking of low-frequency impact and footstep sounds on lightweight floor-ceiling assemblies**

Bradford Gover, John Bradley, Trevor Nightingale, Berndt Zeitler & Stefan Schoenwald

To rate the acoustical performance of floor-ceiling assemblies excited by impact sources (e.g., footsteps), an objective metric must correlate well with the subjective judgments of listeners hearing the radiated sounds. For each of a series of full-scale lightweight floor-ceiling assemblies, physical measurements and sound recordings were made of the sounds generated by standard impact sources (tapping machine, rubber impact ball, bang machine), and by adult walkers (with and without shoes). The physical measurements were used to calculate standard and non-standard metrics. The recordings were played back for listening test participants, who subjectively rated the radiated sounds. The correlations among the objective and subjective ratings were calculated. Results indicate that some standardized sources and metrics are not optimal for rating subjective performance.

### **Noise Control**

#### **Analysis and control of bridge expansion joint “croaking” noise**

Clair Wakefield

Large bridges require expansion joints to accommodate thermal expansion and contraction and seismic events. Different styles and sizes of expansion joints are employed depending on bridge type, length and other factors. Virtually all expansion joints create some additional noise over and above normal that due to normal tire-pavement interaction. Many joints create “banging” or “booming” noises due to the impact of tires on leading edges of the joint, which often feature some vertical misalignment and/or mechanical looseness. These impulsive noises can be annoying to nearby residents. It is often possible to control this noise by reducing or eliminating such misalignment and/or looseness or by installing overlapping “finger joints” which reduce tire impact forces on the joints by essentially eliminating transverse leading edges. Wakefield Acoustics Ltd. has recently been involved in assessing and controlling noise from two types of expansion joints which produce a totally different sort of noise - one that results from the excitation of resonances inside the cavities temporarily created between the rolling tires and the gaps between transverse joint elements. The two bridges employ quite different types of expansion joint. The first utilizes a modular expansion joint consisting of series of transverse “lamella” beams (I-beams) with v-shaped rubber seals between them, while the joints on the second bridge featured corrugated, “saw-tooth” like surfaces (expansion mats) constructed from rubber-encased steel strips. In both cases a similar noise is produced which has been variously described as sounding like a “croaking frog” or a “zipper”. The characteristic frequency of this croaking sound was not found to be directly related to vehicle speed as would be expected if the noise was caused simply by the sequential impact of tires on the transverse joint elements. In both situation cases, these unfamiliar intermittent noises have resulted in ongoing complaints. A series of field tests have been carried out to explore the mechanisms behind these noises and to evaluate potential control measures. The outcomes of these field trials will be discussed as will the Helmholtz resonator analogy believed to explain how these noises are created and may be controlled.

#### **Noise survey within patient care wards at the Royal Jubilee Hospital, Victoria BC**

Andrew Williamson

Hospital noise levels around the world have increased steadily over the past 50 years. High noise levels are among the top complaints of both patients and hospital staff members. High noise levels disturb patients and staff members, hinder speech intelligibility and raise the risk of medical errors. Noise levels often remain high during night and can interfere with patients sleep. Wakefield Acoustics Ltd. has recently conducted a survey of the noise environment within the West and Royal Blocks of Royal Jubilee Hospital in Victoria, B.C. The noise monitoring was conducted continuously over an eight day period at four locations within each of the patient care wards. To identify the sources of noise within the hospital, one of the four sound level meters employed within each patient ward also recorded a digital audio file and several hours of attended monitoring was conducted in each ward. The results of the noise monitoring were used to identify the most significant sources of noise and their



respective noise levels. At a later date, this noise survey will be replicated within the new Patient Care Center at the Jubilee Hospital to see if noise control measures implemented within the new facility have been effective.

## **Vibration and Transport Vehicle Noise**

### **Effect of helicopter noise and vibration on healthcare facilities**

Rob Jozwiak

At an increasing rate, new hospitals and renovations to existing hospitals are incorporating helicopter pads (helipad's) into the design of their facility. Hospitals contain many sound and vibration sensitive spaces, which the operation of a helicopter may affect. The vibration generated from a helicopter landing has potential to impede on the operation of sensitive diagnostic equipment in the hospital and the noise generated by the helicopter turbines and propellers can disturb patients. This paper presents sound and vibration measurements of a Sikorsky S-76 medivac helicopter landing and taking off from St. Michael's Hospital in Toronto Ontario and provides an analysis of architectural and structural design considerations to minimize the affect of helicopter operation at medical health centres.

### **Methods for measuring Off-Highway Vehicle (OHV) sound emissions and their correlation with "near-to-track" and "off-track" sound levels**

Ian Matthew, John Emeljanow & Mark Levkoe

With the impact of noise from recreational activity being an ever increasing concern, the accurate measurement/classification of sound emissions from off-highway vehicles (OHVs) for the purposes of controlling sound levels at noise-sensitive off-track locations is becoming more and more critical. Conventionally, sound emission testing for this purpose is conducted according to SAE J1287 (or equivalent) which uses a stationary vehicle in neutral gear with the engine at approximately half-throttle. However, the poor correlation between results using this test method and measured sound levels at "near-track" and "off-track" locations is well documented. A new method has been proposed by the Fédération Internationale de Motocyclisme (FIM) which purports to provide improved correlation between the stationary vehicle sound emission level and "near-track"/"off-track" sound levels, and as such would be expected to be an improved method for qualifying or disqualifying a vehicle from operation in a given locale. A direct comparison of the measured sound emission levels as determined using the SAE method and the proposed FIM method are presented, along with comparisons with "near-track" and "off-track" measurements in order to assess the potential for improved correlation and thus, improved control of environmental noise levels.

### **Application of automatic data processing at the systems of condition monitoring of industrial equipment**

Alexander Serov

The report is devoted to the development problems of the monitoring and diagnosis system of the industrial equipment. Modern systems of stationary type ordinary use some different autonomous subsystems of the equipment monitoring running in the synchronous mode. The structure and the set of these subsystems depend upon the functional purposes of the monitoring and diagnosis system' using. Each of these subsystems use their own set of physical methods for the detection of the equipment characteristics. It leads to arising of the development problem of multi-parametrical monitoring and diagnosis methods. Using of the simultaneous monitoring of the same technical object by the different physical methods leads to the possibility of the essential generalization of the monitoring and diagnosis problems and to the formulation of the interesting set of general scientific problems. One of the main problems of this set is the problem of the non-uniform information processing. Data acquiring by the acquisition and saving subsystem is a non-uniform one both at the problem of the detection of the current state of the monitoring object and at the problem of the prediction for the dynamics of object characteristics. The approach to the processing of data based on the methodology of Group Methods of Data Handling (GMDH) and statistical data processing is proposed at this report. It makes possible to apply the methods of self-organization of the mathematical models to the problems of the monitoring of complex technical systems. Proposed method was realized as software and applied for the problems of monitoring of turbine engines.

## **Musical Acoustics**

### **The complementary roles of temporal and spectral processing in tonal perception of low-frequency tones**

Frank Russo, Lola Cuddy & Alexander Galembo

We assessed tonal perception in low-frequency harmonic tones that varied the extent of interaction between partials within critical bands. Hol(e)y tones minimize the likelihood of interaction by incorporating holes (missing harmonics) in the spectrum (Mathews, 1999). Unhol(e)y tones have fewer holes, leading to more interaction. Tonal perception was assessed by the probe-tone method. A listener is presented with a key-defining context followed by a probe tone drawn from the 12-tone chromatic scale. For each probe tone, the listener rates the goodness-of-fit with the preceding context. The correlation between the set of

12 ratings, called the probe-tone profile, and a standardized profile (Krumhansl & Shepard, 1979) is referred to as the “recovery score” (Russo, Cuddy, Galembo & Thompson, 2007). Our previous work (e.g., Cuddy, Russo & Galembo, 2007) examined recovery for synthesized harmonic and nonharmonic piano tones throughout the tessitura and identified critical roles for both temporal and spectral processes. Based on this work, we made three predictions for the current experiment:

(1) recovery scores should be superior for unholy tones due to interaction between components; (2) consistent with temporal models, recovery scores for unholy tones should decrease with increasing frequency due to components falling beyond the upper limit of phase locking; and (3) consistent with spectral models, recovery scores for holy tones should increase with increasing frequency due to the increased spacing between harmonics. Results fully supported these predictions and will be discussed in the context of pitch processing models.

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**Submissions:** The original manuscript and two copies should be sent to the Editor-in-Chief.

**General Presentation:** Papers should be submitted in camera-ready format. Paper size 8.5" x 11". If you have access to a word processor, copy as closely as possible the format of the articles in Canadian Acoustics 18(4) 1990. All text in Times-Roman 10 pt font, with single (12 pt) spacing. Main body of text in two columns separated by 0.25". One line space between paragraphs.

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