Fausto "Tito" Poza (Poza Consulting Systems) has worked as an expert in the field of forensic audio for over 30 years. He is a nationally-recognized expert in the area of voice identification and elimination. He served as the technical consultant to the National Academy of Sciences committee that reported on voice ID in 1979, which included such luminaries as Richard Bolt, David Green, Franklin Cooper, and Jay McKnight. He has also co-authored two encyclopedic articles that provide attorneys with valuable information and insights in the areas of voice identification and tape authentication in particular and more generally in the broader areas of forensic communications and forensic acoustics. Tito received his BS and MA degrees from MIT in 1959, and has been a forensic consultant since 1971; he was formerly a research engineer at Hughes Aircraft and a senior research engineer in the Speech Research Group at Stanford Research Institute.

### Thursday, June 5

**1:00 pm**

**History of Audio Enhancement and Authenticity: From Edison to the Present**—Tom Owen

Speech enhancement has come a long way in the digital era, but it is not the "magic wand" depicted on TV and in Hollywood movies. Adaptive filters have traditionally been the basis of forensic audio work, but a combination of techniques—including broadband noise reduction, buzz reduction, equalization, and background noise suppression—can provide superior results when compared with any single approach. This session, illustrated using examples processed in real-time on a CEDAR Cambridge Forensic system, aims to shed light on this, demonstrating how signal processing can aid investigators in areas including criminal investigation, terrorism counter-measures, and air-accident investigation.

The volume of surveillance material now being collected means that it may not always be possible to treat each recording individually. In this case, background- and/or pre-processing facilities may be beneficial, and the tutorial will demonstrate how these can help investigators to handle larger amounts of audio than would otherwise be possible. The possibilities suggested by combining batch processing with speech recognition and speaker identification systems will also be discussed.

**2:30 pm**

**Basics of Audio Enhancement**—Gordon Reid

Eddy Bri xen and Durand Begault will conduct an informative interview with Fausto Poza on the important technical and historical issues of voice identification and elimination. He served as the technical consultant to the National Academy of Sciences committee that reported on voice ID in 1979, which included such luminaries as Richard Bolt, David Green, Franklin Cooper, and Jay McKnight. He has also co-authored two encyclopedic articles that provide attorneys with valuable information and insights in the areas of voice identification and tape authentication in particular and more generally in the broader areas of forensic communications and forensic acoustics. Tito received his BS and MA degrees from MIT in 1959, and has been a forensic consultant since 1971; he was formerly a research engineer at Hughes Aircraft and a senior research engineer in the Speech Research Group at Stanford Research Institute.

### Friday, June 6

**9:30 am**

**PAPER SESSION 1**

**1-1 ENF: Quantification of the Magnetic Field**—Eddy B. Bri xen, EBIR-consult, Simonum, Denmark

Authentication of digital recordings by tracing the electric network (the ENF criterion) has shown promising results. This methodology is possible due to the presence of electromagnetic fields radiated from all kinds of electric equipment and connected power lines. In the ENF range—around the 50/60 Hz—the magnetic component is dominating. In this paper the results of magnetic field strength measurements carried out in different relevant environments are presented. Also presented are the results of an experiment performed in order to quantify the thresholds by which the magnetic fields leave traceable ENF in various battery powered digital audio/video recording equipment. In this experiment no battery pow-
The following exhibitors will hold demonstrations throughout the convention:

1-3 Digital Audio Authenticity Using the Electric Network—Richard W. Sanders, National Center for Audio/Video Forensics, College of Arts & Media, University of Colorado Denver, Denver CO, USA

The advent of personal computers, hand-held electronic devices, and the rise of digital media have all contributed to the increasing importance of Digital Audio Authenticity (DAA). This is becoming an increasingly important issue. With digital audio it is easy for anyone with a computer to alter or otherwise change the recording, and it is usually difficult to detect such changes. Therefore, if the recording is altered or otherwise changed, it is not always clear when the recording was made, altered or recorded over. This paper is largely a test report on the Electric Network (EN) variations in the three United States power grids. It will also show how using the ENF in digital audio can help in verifying the authenticity of a recording. If it is a copy, time stamp the original and a copy, and possibly determine when the recording was made. This research is partially funded by the Department of Justice.

**Friday, June 6**

**PAPER SESSION 3**


Audio gunshot recordings can be helpful for crime scene reconstruction, estimation of the shooter’s location and orientation, and verification of evidence. This paper presents a new workflow that can be used for forensic investigations. The workflow involves the use of Adobe Audition, a popular audio editing software, to perform various editing operations such as time alignment, frequency equalization, and spectral restoration. The workflow is demonstrated using several real-world forensic cases.

**2- Deciphering Gunshot Recordings—Robert C. Maher, Steven R. Shaw, Digital Audio Signal Processing Laboratory, Department of Electrical and Computer Engineering, Morehead State University, Morehead, KY, USA.**

Gunshot recordings are critical for crime scene reconstruction, estimation of the shooter’s location and orientation, and verification of evidence. This paper presents a new workflow that can be used for forensic investigations. The workflow involves the use of Adobe Audition, a popular audio editing software, to perform various editing operations such as time alignment, frequency equalization, and spectral restoration. The workflow is demonstrated using several real-world forensic cases.

**3- Forensic Analysis of the Audibility of Female Screams—Durand R. Begauf, Audio Forensic Center, Center for Audio/Video Forensics, College of Arts & Media, University of Colorado Denver, Denver CO, USA.**

The use of such transcripts, whether produced by stenography or machine, is becoming more common in many jurisdictions. It is notable that there has been some concern over the long-term implications of this practice. The purpose of this research is to examine the viability of text-to-speech systems and their potential applications in the field of forensic voice identification. The research will involve the analysis of a variety of text-to-speech systems and the development of new methods for evaluating their accuracy and effectiveness.

**Saturday, June 7**

**PAPER SESSION 4**

**1-4 Identifying Voice Characteristics Among Various Ethnicities through Spectrographic Analysis—Adam W. Bennett, Tira Neal, Chris Ochsner, College of Arts and Media, University of Colorado Denver, Denver, Colorado, USA.**

It has been found that the nature of forensic information provided by the human voice can yield evidence to identify a person by a previously recorded voice. In the past, the presence of an analog audio signal was required. However, current digital audio technology makes it possible to analyze voice recordings in real-time. The purpose of this research is to explore the use of forensic voice identification as a means of identifying and locating potential suspects. The research involves the collection of voice recordings from a variety of sources and the analysis of those recordings to identify voice characteristics that can be used to identify a suspect.

**5-2 Identifying Voice Characteristics Among Various Ethnicities through Spectrographic Analysis—Richard W. Sanders, National Center for Audio/Video Forensics, College of Arts & Media, University of Colorado Denver, Denver, Colorado, USA.**

The characteristics of the human voice identify its unique personality traits and can be used to identify a person. In addition, the voice can provide information about a person’s health and medical conditions. In some cases, the voice can even be used to determine a person’s age, gender, and ethnicity. This paper will present the results of a study that explores the use of spectrographic analysis to identify voice characteristics for forensic purposes. The study involved the analysis of voice recordings from a variety of ethnic groups and the identification of specific characteristics that are unique to each group.
1-2 The Electric Network Frequency (ENF) as an Aid to Authenticating Forensic Digital Audio Recordings—An Automated Approach

Douglas M. Cooper, Metropolitan Police Service, London, UK

A recent forensic technique developed to establish the authenticity of recordings on Digital Audio Tape (DAT) is based on a new Electric Network Frequency (ENF) Criterion. This paper confirms the applicability of the new ENF criterion for DAT recordings in the UK and introduces an automated approach to matching ENF estimates taken from a recorded signal to that of a reference signal. The procedures described have been successfully used by the Metropolitan Police Forensic Audio Laboratory in London to extract and match ENF data from evidential recordings.

Friday, June 6 11:00 am

EXHIBITOR INTRODUCTIONS

The following exhibitors will hold demonstrations throughout the conference.

Acoustica—Robert Van Zandt, Houston Police Department, Houston, TX, USA
Cedar Audio Ltd., Great Britain; Digital Audio Corp., Durham, North Carolina; IAS Forensics, Colorado; Speech Technology Center, Russia; University of Colorado Denver, Denver, Colorado—Masters Degree in Audio/Video Forensics.

Friday, June 6 1:30 pm

PAPER SESSION 2

2-1 Quantifying the Auditory—Further Investigation into Speaker Identification by a Simple Code-Matching Technique—Jeff M. Smith, Richard W. Sanders, National Center for Audio/Video Forensics, College of Arts & Media, University of Colorado Denver, Denver, CO, USA

This paper reports on the techniques refined for a method of speaker identification through the automated comparison of spectral, timbral, and temporal features unique to an individual's speech acoustics. This method was first described in Convention Paper 7274 presented by the co-author of this paper, Richard Sanders, at the 123rd Convention of the Audio Engineering Society in 2011. Current methods of authentication use the Electric Network Frequency (ENF). The ENF signal, present with varying fluctuations in all three U.S. power grids, is embedded in just about any recording made. For authentication purposes, it is necessary to extract it from the recording and verify its existence. Many time-saving procedures and legalities; chain of custody; assessment and plan; enhance; delivery and documentation; court testimony.

Saturday, June 7 5:00 pm

PAPER SESSION 4

4-1 Diamond Cut Live 6 and Digital Media Authenticity—John Dick, Randy Kuykendall, University of Colorado, Denver, Colorado, USA

In the field of audio forensics, Digital Media Authenticity (DMA) continues to be a challenging endeavor. Current methods of authentication use the Electric Network Frequency (ENF). The ENF signal, present with varying fluctuations in all three U.S. power grids, is embedded in just about any recording made. For authentication purposes, it is necessary to extract it from the recording and verify its existence. Many time-saving procedures and legalities; chain of custody; assessment and plan; enhance; delivery and documentation; court testimony.

Saturday, June 7 11:00 am

PAPER SESSION 5

5-1 Using Spectrographic Analysis to Identify Acoustical Sources from Gunshot—Adam P. Pappas, Tira Neal, Chris Ochse, College of Arts and Media, University of Colorado Denver, Denver, Colorado, USA

It has been found that the nature of photographic information provided by the human voice can yield evidence to identify a person whose recorded voice has been electronically altered. Digital environments display similar spectrographic distinctions to sound that is recorded in the analog domain in which a specific audio recording was captured? This paper will provide data gathered from various audio recordings of specific locations in order to determine possible and essential identification. The purpose of this research is to prove or disprove that acoustic characteristics can be used to verify where an audio recording has been made.

Saturday, June 7 1:30 pm

PANEL DISCUSSION

Running a Forensic Operation—Richard W. Sanders, Tom Owen, Michael Pippenger, Alan Cooper, Eddy B. Brien...