



## LECTURE INVITATION

研討會邀請

# SOUND QUALITY OF AUDIO SYSTEMS – MODELLING, MEASUREMENT AND CONTROL

## 揚聲器系統的品質控制

- PRESENTED BY 主講: Prof. Dr. Wolfgang Klippel 科力普博士  
Institute of Acoustics and Speech Communication,  
Dresden University of Technology, Germany
- DATE 日期: 4<sup>th</sup> - 6<sup>th</sup> November, 2019  
9:00 a.m. - 5:00 p.m.
- LOCATION 地點: Feng Chia Univ. (Central Taiwan Science Park Campus)  
逢甲大學創新育成中心中科校區  
No. 951, Sec. 1, Dongda Rd, Taichung, Taiwan  
台中市西屯區東大路一段 951 號
- LANGUAGE 語言: English
- REGISTRATION FEE 費用: NTD 6,000 (Students 進修生或在學生 NTD1,000)
- PARTICIPANTS 對象: Engineers of the audio industry active in research & development,  
manufacturing and quality control students in the graduate  
program of the Electro-Acoustics  
電聲系統工程設計開發、品質管理工程設計相關、機械電聲工程相關  
學系學生
- ORGANIZER 主辦: Soma Acoustic Co., Ltd. 尚馬電聲科技有限公司  
EATD 電聲產學技術發展與驗證聯盟
- CO-ORGANIZER 協辦: Master's Program of Electro-acoustics, Feng Chia Univ.  
逢甲碩士學位大學電聲學程
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Due Date: 25<sup>th</sup> October, 2019

## **ABSTRACT 摘要**

The lecture addresses the evaluation of sound reproduction systems using physical and perceptive measurement techniques. The generation of signal distortion is modelled by linear, nonlinear and time-variant systems with lumped and distributed parameters.

New measurement techniques based on those models are presented using test signals and music. The relationship between symptoms and physical causes of the distortion is made more transparent, and the impact on the perceived sound quality by combining listening tests, auralization techniques with physical methods is discussed.

This knowledge is important for designing and manufacturing small, light and cost-effective transducers that reproduce the sound at high efficiency and sufficient sound quality and for using new control techniques (smart amplifiers).

Klippel 分析儀是一個功能強大的工具，可針對電聲音頻設備做有效的評估及改善，以最佳的成本效益設計生產出高效率及高品質的揚聲器。

本次課程主要著重於如何利用硬體量測設備與感知方式來評估揚聲器系統，由淺入深探討電聲量測技術，另外新增實務上最新主題，並以理論搭配實務操作。

## **NEW TOPICS ADDRESSED THIS YEAR IN THE LECTURE 本次研討會新議題**

Higher-Modal Analysis applied to headphones diaphragms  
高階模態分析用於耳機振膜

- What are the root cause analysis of the rocking modes (mass, stiffness or BI imbalances)?  
找尋分裂運動的根本原因 (質量、剛性、BI不平衡...)
- Why generates the diaphragm significant intermodulation distortion?  
為什麼會產生音膜上明顯的互調失真
- How to use FEA to find the optimum shape of the diaphragm  
如何利用FEA找到音膜的最佳形狀

Comprehensive evaluation of audio systems with arbitrary signals  
具有隨機訊號之音頻系統完整分析

- How to separate the distortion in reproduced music signals  
如何分離與重現音樂訊號中的失真
- How to assess the audibility of the distortion  
如何評估失真的可聽性
- How to assess impact on the reproduced sound quality  
如何評估對重現音質的影響

Fast loudspeaker measurement in a non-anechoic environment  
在非消聲環境中對揚聲器進行快速量測

- Limitations of traditional techniques (windowing of the impulse response)  
傳統技術的侷限性 (脈衝響應的區間)
- Complete compensation of the room influence by inverse filtering  
完全補償環境受到之反向濾波影響

- How to provide accurate reference data  
如何提供準確的參考資料
- Generation of a room correction curve valid for multiple speakers  
適用於多個揚聲器對環境的校正曲線

## **CONTENT 課程內容**

### Electro-Acoustical Modelling 電聲模型

- Fundamentals - transduction, vibration, radiation  
基礎 – 換能、振動、輻射
- Abstraction - models with lumped and distributed parameters  
摘要 – 集中和分佈參數模型
- Small Signal Performance - linear approximation and transfer function  
小信號特性 – 線性的近似及轉換函數
- Large Signal Performance - thermal dynamics and nonlinearities  
大信號特性 – 熱力學和非線性
- Time-varying properties - influence of climate and aging  
隨時間變化的特性 – 氣候及衰減的影響

### Measurements and Analysis 測量與分析

- Persistent excitation - artificial and natural stimuli  
連續激發型態 – 人為和自然激發訊號
- Monitored signals - electrical, mechanical and acoustical sensors  
監控訊號 – 電子、機械和聲學感測器
- Complex structures - digital and analogue components  
複雜的結構 – 數位和類比元件
- Sound field - measurements in the near and far field  
聲場 – 近場與遠場的測量
- Interaction with the room - direct and diffuse sound part  
空間內的相互作用 – 直接音與散射音
- Measurement time - ultra-fast and long-term (power) testing  
測量時間 – 超快速的測量與長時間(功率)測試
- Distortion analysis - linear and nonlinear components  
失真分析 – 線性和非線性元件
- System identification - optimal fitting and parameter estimation  
系統識別 – 最佳化近似及參數預測
- Transformations - Fourier, wavelet and perceptual modelling  
轉換 – 傅立葉、小波和聽感模擬
- Data compression - separation of unique and redundant information  
資料壓縮 – 分離有效及無效的資料

## Interpretation and Diagnostics 分析與判斷

- Interpretation - measured symptoms and physical causes  
解析 - 量測獲得的徵兆與相對的物理成因
- Perception - audibility and impact on perceived sound quality  
感知 - 在感知聲音品質的清晰度與影響
- Evaluation - selection of optimal drive units for system design  
評價 - 對於系統設計來說最佳驅動裝置的選擇
- Specification - minimal but comprehensive set of data  
規格 - 少量但具有代表性的資料
- Tolerances - variation of parameters and influences  
公差 - 參數和影響的變化

Prof. Klippel will address other topics in his lecture which are important for your work. Please send your wish list or detailed question to [henry.liou@somaacoustic.com.tw](mailto:henry.liou@somaacoustic.com.tw)  
若有任何測試相關問題欲探討，歡迎提前告知，以利安排加入課程討論中；請將您的問題傳至：[henry.liou@somaacoustic.com.tw](mailto:henry.liou@somaacoustic.com.tw)

## **MORE on Loudspeakers, Smart Amplifiers and DSP:**

**有關揚聲器，智慧放大器和 DSP 的更多資訊：**

### **Attend the Master-class on “Software Complements Hardware in Active Loudspeakers” on November 8<sup>th</sup> 2019 in Shenzhen / China!**

The three-day lecture at the Feng-Chia University covers the basic terms, fundamental and theoretical concepts and practical diagnostic methods that are required for the design and evaluation of modern audio systems. Most of the new techniques are illustrated on woofers and other common cone loudspeakers to simplify the interpretation of the measurement results.

This knowledge is used for the development of active loudspeaker systems using adaptive, nonlinear control, which can be implemented in DSP and smart amplifiers at low cost. This new technology, opportunities and practical applications in modern audio products are discussed in a separate Master-class on “Software Complements Hardware in Active Loudspeakers” that will be presented on 8<sup>th</sup> of November 2019 in Shenzhen (main land China) just before the 7<sup>th</sup> International Symposium on Electro Acoustic Technologies (ISEAT 2019). It is strongly recommended to use the three-day lecture as a warm up for the following Master-class.

逢甲大學為期三天的研討會涵蓋了現代音頻系統設計和評估所需的基本術語、基本和理論概念以及實用診斷方法。大多數新技術都在低音揚聲器和其他常見的錐形揚聲器上進行了說明，以簡化測量結果的解釋。

該知識用於非線性控制的主動揚聲器系統開發，其以低成本在DSP和智慧放大器中實現。現代電聲產品的這項新技術和實際應用將在2019年11月8日於深圳（中國大陸）舉辦之電聲技術研討會（ISEAT 2019）中討論，建議以逢甲大學為期三天的講座作為後端使用的基礎。