

IPRO 344

Improving Energy-Efficiency &
Offering Quality Audio in
Mobile Devices & Intercoms



Problem Statement

- ▣ Lack of **standardized test data and methodology** for evaluating the audio quality of a two-way communication system performing in a high noise level environment.
- ▣ We offer a solution to **measure performance** of fast food industry intercom systems and components to **decrease order capture error**.

Previous Semesters' Progress

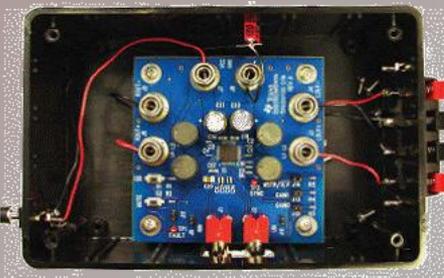
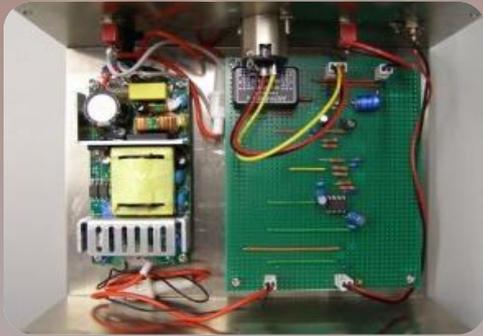


Studied and improved technologies for low-power mobile audio, evaluated amplifier technology

Improved efficiency with Class D amplifier & developed two-way communication system

Designed pre-amplifier for headset & microphone

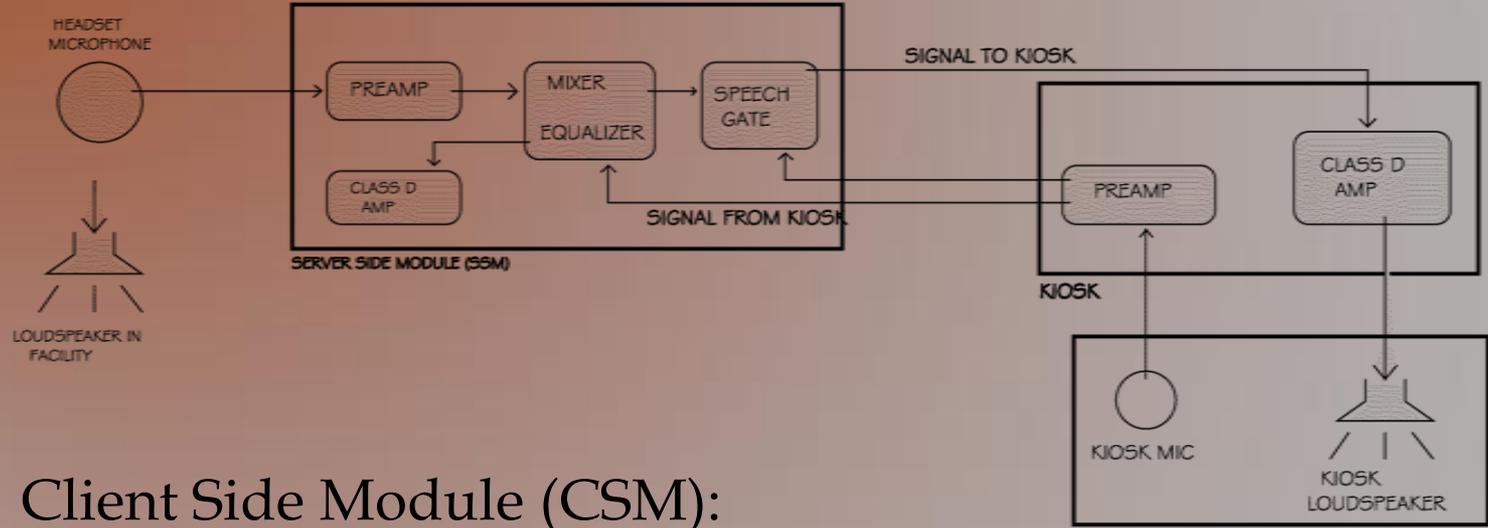
Rebuilt system, developed & implemented standardized test methodology





iFidelity

High Efficiency & Audio Quality Intercom System



- ▣ Client Side Module (CSM):
Kiosk enclosure; contains Class D amplifier, mic, foam
- ▣ Server Side Module (SSM):
Mixer, equalizer, headset and microphone pre-amplifier
- ▣ Client Priority Gate (CPG):
Ensures proper etiquette in order capture process



Objectives

- ❖ Reconstruct server side module
- ❖ Develop testing methodology
- ❖ Evaluate performance of our system
- ❖ Collect comparative real-world sample
- ❖ Conduct ambient noise tests

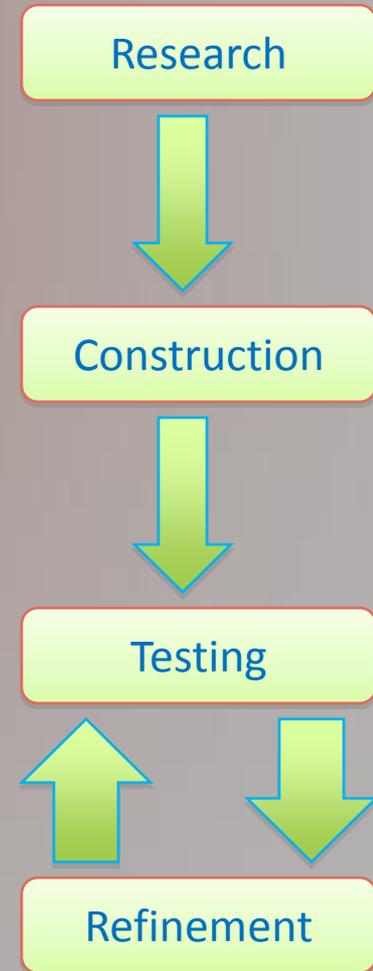


Team Organization

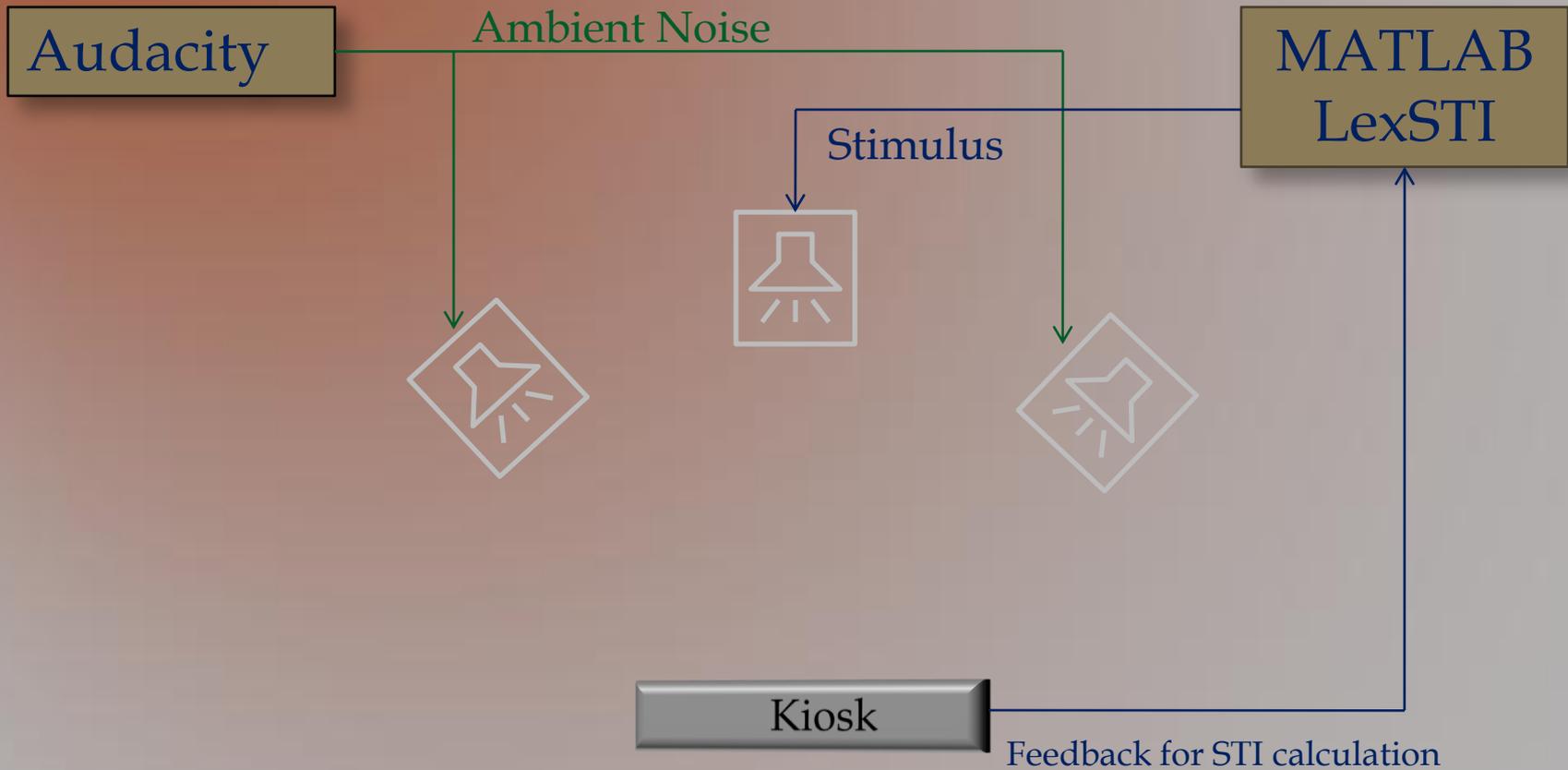


Project Approach

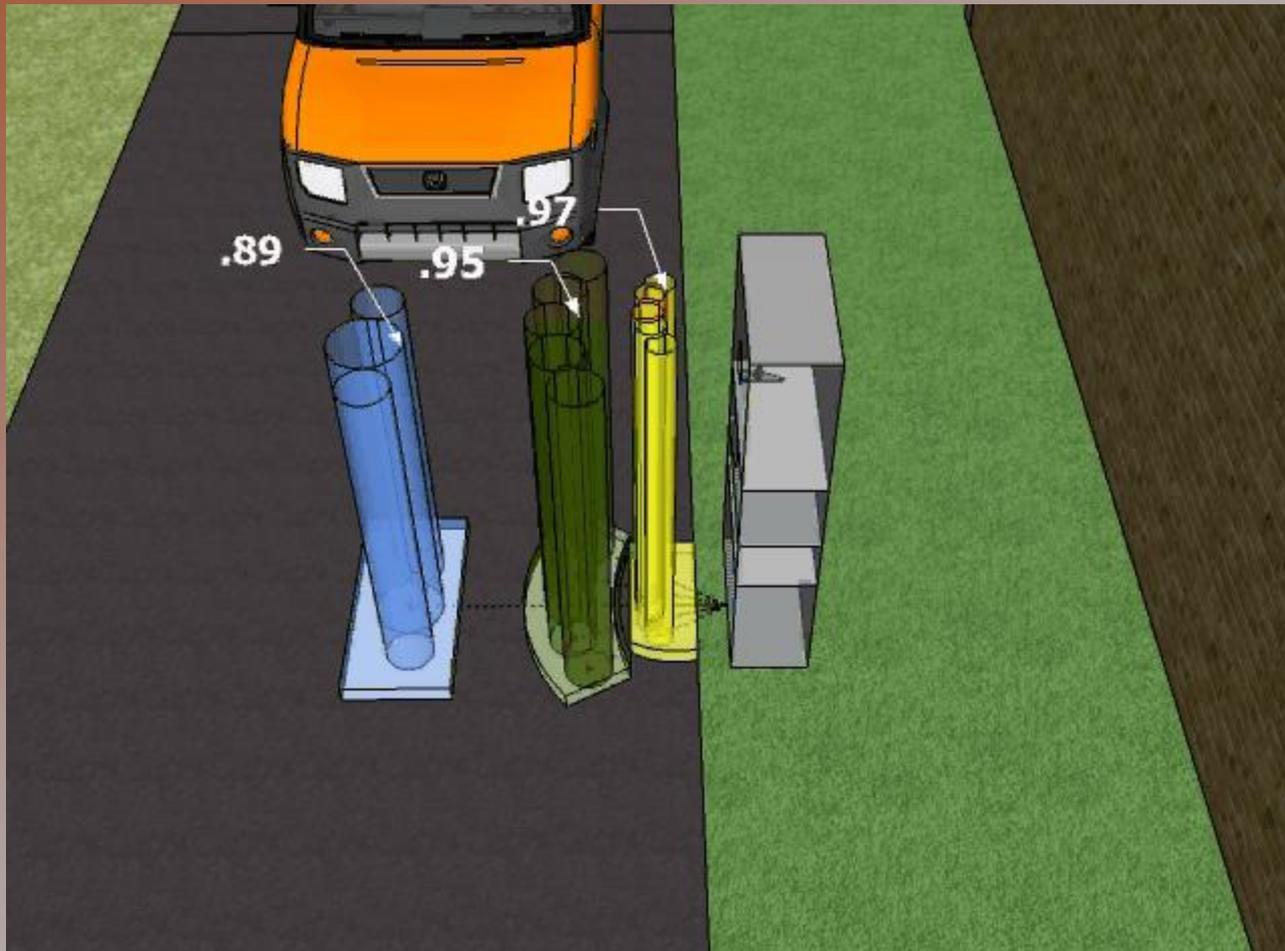
- ❖ Phase I: Research & Construction
 - Two-way communication system
 - Ambient noise interference & STI
- ❖ Phase II: Testing
 - Establish standards and evaluate
- ❖ Phase III: Refinement
 - Use results for improvement of system



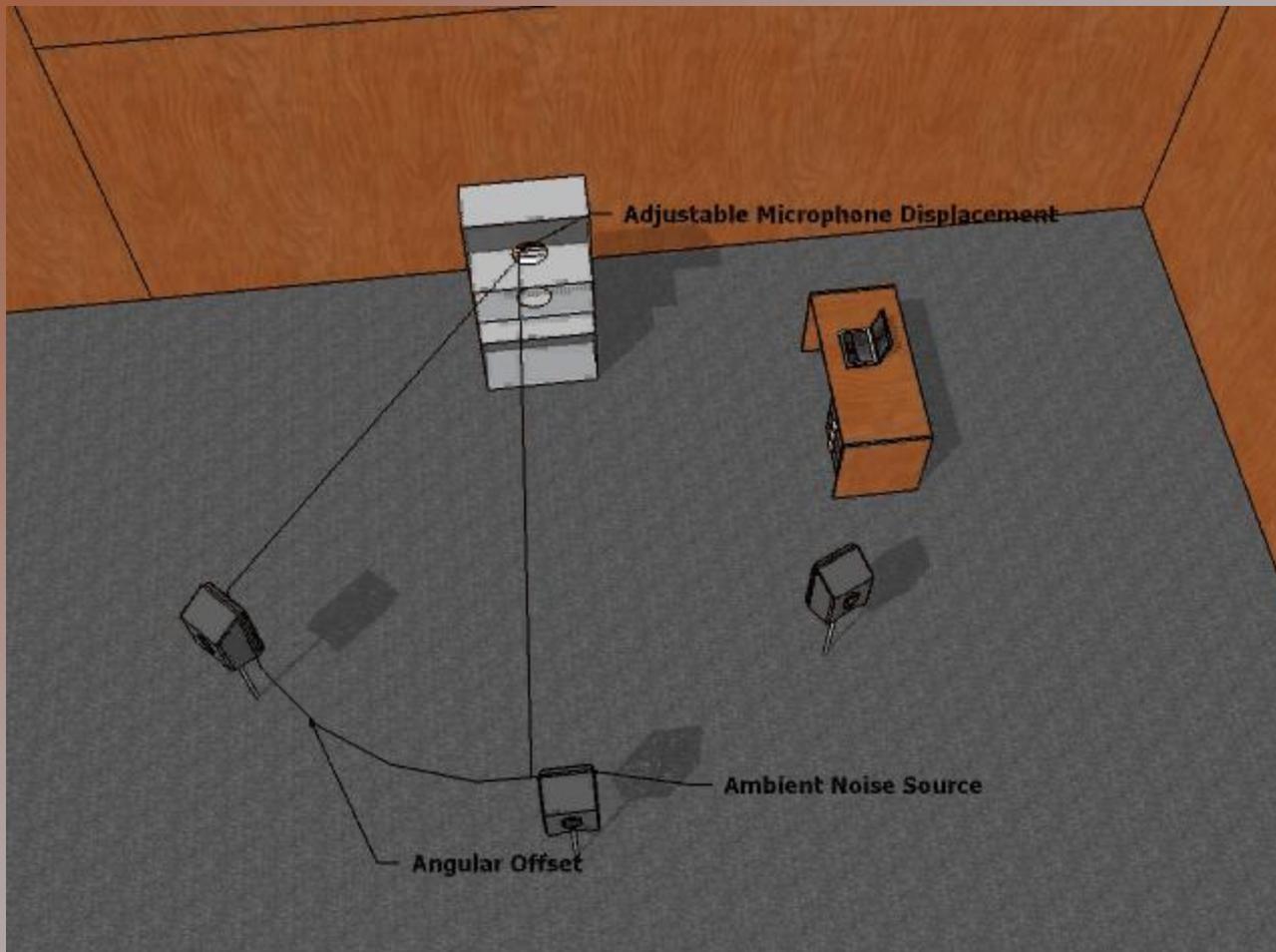
Testing



Speech Transmission Index

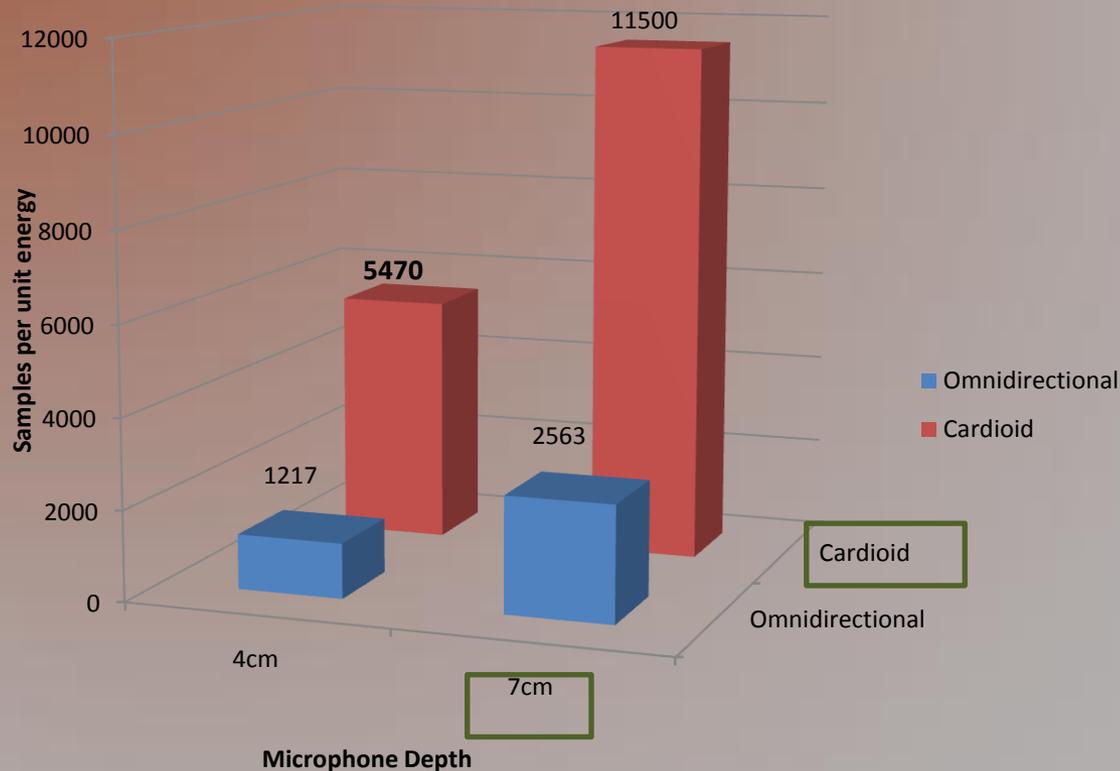


Ambient Noise Acquisition & Analysis (ANAA)



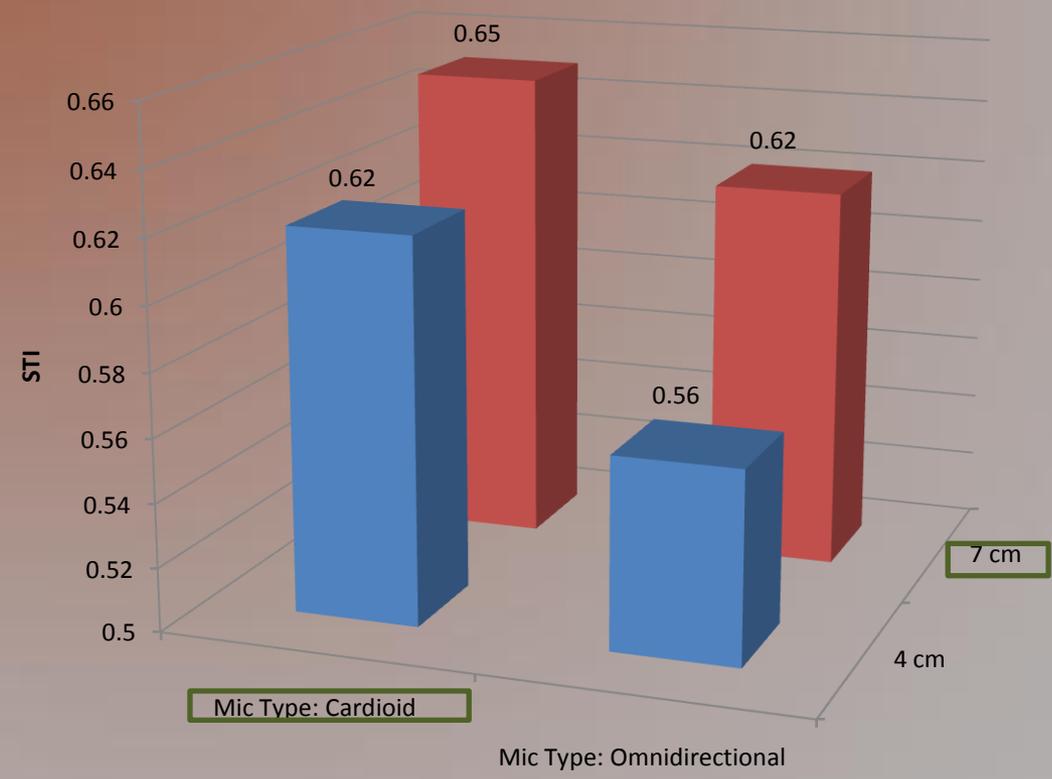
Analysis I

- ❖ Ambient Noise Rejection vs. Microphone Type and Depth



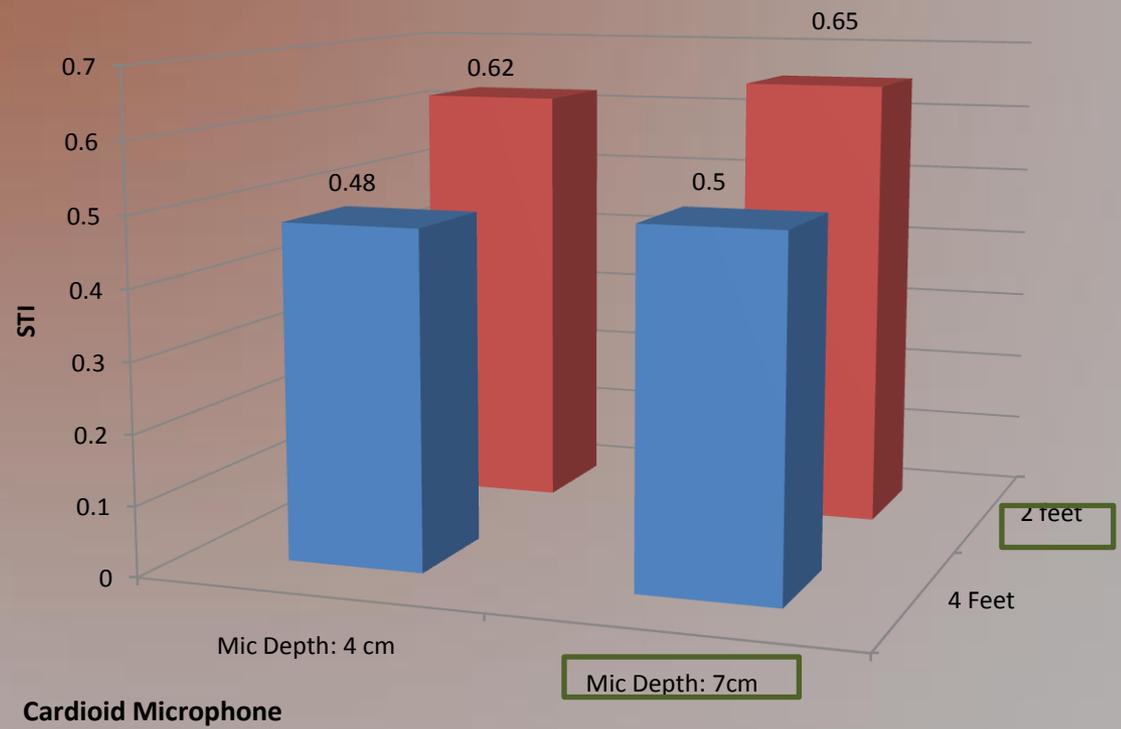
Analysis II

Microphone Type and Depth vs. STI



Analysis III

Relationship Between Distance from Stimulus Source and STI





Qualitative Conclusion

- ▣ Optimal microphone depth: 7 cm
- ▣ Optimal distance from stimulus: 1 ft
- ▣ Microphone directionality pattern: cardioid
- ▣ Acoustic foam improves ambient noise rejection

Franchise Testing

- ❖ Basis for comparison
- ❖ Industry standard drive-thru
- ❖ Order sample:



- ❖ iFidelity system sample:



Server Side Module

- ❖ Adjust desired sound signals from different input & output channels
- ❖ Mixer, equalizer, pre-amplifiers, client priority gate
- ❖ Redesigned & rebuilt
 - Clean wiring
 - Audio equipment conventions





Ethical Consideration

- ❖ Energy efficiency
 - Class D amplifiers are extremely efficient ($\geq 90\%$)
- ❖ ROHS compliance
 - Restriction of hazardous substances directive
 - Electrical equipment and components



Economics

- ▣ QSR Magazine states, “The most important factor to increase business is order accuracy.”
- ▣ U.S. fast food industry : \$120B with 200K restaurants
- ▣ System facilitates the exchange of information
- ▣ Several viable configurations of components to evaluate, replace, enhance an existing system
- ▣ Low cost and energy efficiency provide a definite advantage over other systems



Acknowledgments

- Dr. Ralph Muehleisen
- Shure, Inc.





Thank You!



Q & A