Good morning and welcome to my 3rd year project viva. Today I will be describing the motivations behind my 3rd year project, and the process I have undertaken to undertake it.

This project is borne from the fundamental shortcoming of loudspeaker operation – they are all run uncompensated. This means that low-cost systems are prone to multiple non-linearities and distortions that makes the sound they produce unacceptably poor, and that good sound quality costs an unreasonable amount of money in most cases.

Using electronic open- and closed-loop circuits, these non-linearities and distortions can be reduced, and, unique to subwoofers, the bass response can be extended without changing the physical design and build of the system. Making both the enthusiast and mainstream audio markets aware that these techniques exist will have the net result of improving the average quality of an average audio system, and consumers can pay less money for good quality audio.

The process of the project is as follows. Building a subwoofer system from scratch is beneficial as it keeps project costs down, facilitates learning about the fundamentals of acoustical engineering, and ensures that the uncompensated system will provide a better benchmark than a pre-manufactured system, assuming that the processes and methodology used are sound. It also yields complete control of the system from start to finish, which means that more accurate and granular data can be obtained about the system’s performance at various stages of the project easier.

This project is borne from the fundamental shortcoming of loudspeaker operation – they are all quite prone to distortions and non-linear behaviour. This forces manufacturers to design and manufacture ‘perfect’ enclosures and drivers, which shuts most consumers out from experiencing decent audio quality.

The suspension of a loudspeaker driver will never be perfect, which means that it will exhibit non-linear mechanical behaviour, especially at the lowest frequencies of sound reproduction, as shown by an analysis from [state the right paper]. Distortions will exist everywhere in the signal chain, but good closed-loop compensation techniques are very commonplace at nearly every other stage except for loudspeakers. Therefore, it makes sense to try and implement closed-loop compensation at this stage too.

It is obvious that the subwoofer’s main job is to produce as much bass as possible, so an open-loop compensator can also be designed to push the driver to achieve performance that otherwise wouldn’t be possible, using careful signal processing.

The benefit of engineering such solutions is that the average price of a loudspeaker system, both to the manufacturer and consumer, is reduced. Analogue electronic circuits are always cheaper to design and make than different enclosures, or better drivers are. Such solutions can be marketed and sold as ‘add-ons’ that improve existing systems and that are easy to introduce into the signal chain. Overall, the average quality of sound reproduction systems would increase, letting consumers experience better audio and not having to settle for underperforming, and potentially even dangerous, audio systems.

The

The Linkwitz Transform is an analogue filter that improves the overall response of a subwoofer in an enclosure by ingenious cancellation and reintroduction of poles and zeroes in the untransformed system’s frequency response. The result of this process is that the driver is pushed to produce deeper bass, further than it normally operates, whilst also reducing the group delay of the system. Reducing the group delay means the system responds faster to an input signal, and also settles to a nominal value faster. Simply by using this transform some element of distortion would be eliminated. You see here the general layout of the transform with some designer’s equations, all introduced to the public in various issues from 1980 of the Speaker Builder magazines.

A novel method of designing and implementing all required open- and closed-loop circuitry could be by using a field-programmable analogue array, such as those designed by Anadigm. Limits physical size and complexity of solutions, allows for patches from manufacturers to users, could even make a GUI to allow users to tune their own devices (although probably not possible because you need to program them through MATLAB).