IMDEA show, a new way to present student's projects in collaboration with companies and universities

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IMDEA SHOW, A NEW WAY TO PRESENT STUDENT'S PROJECTS IN COLLABORATION WITH COMPANIES AND UNIVERSITIES

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ABSTRACT

In the frame of the Institute of Acoustics Graduated School (IA-GS) at Le Mans University (France), different master's programs dealing with acoustics are offered to students. One of these programs is the International Master's Degree in Electroacoustics (IMDEA). It enables students to learn how to design, model, and measure audio systems (loudspeakers, microphones, ...) in order to work in Research and Development departments in the industry, in private or public organizations. The IMDEA program is supported by a foundation, the courses are provided in collaboration with a private engineering school, and the whole program is in English. In this program, students have to do two projects, one during semester 2, and one during semester 3. In this paper, we will focus on the first-year project (semester 2) and on the project defense, called IMDEA show, which enables students to synthesize and strengthen knowledge gathered during the lectures and to create networking with companies. The different steps of the project are described, and some examples of projects done by students are given (3D-printed speaker, bistable sound effect, Radialstrahler speaker, DML system, etc.). The way students present their work during the IMDEA show is presented and assessed by comparing with traditional project defenses. The impact of the project on the future of students is also discussed.

1. INTRODUCTION

The IMDEA Master's degree trains students in electroacoustics with the aim of integrating companies or laboratories in the following fields: pro audio, hifi, consumer audio, 3D sound, signal processing in audio, etc. It was created on the basis of a rather rare partnership in France: a foundation financing 50% of the costs of a master's degree awarded by a public university in collaboration with a private school [1, 2]. Thus, it was in September 2012 that Le Mans University, [1] associated with the Ecole Supérieure d'Electronique de l'Ouest (ESEO) [2] and the EMV Foundation, [3] welcomed its first students.
A large part of the master's programme is devoted to electroacoustics and related topics: acoustics, mechanics, signal processing, electronics. [4] As far as teaching methods are concerned, project-based learning is widely used for its recognised learning outcomes [3–5]. Thus, mini projects, requiring around ten hours of work, up to long projects (several weeks) are proposed. This paper will focus on an event dedicated to the project work of first year students: the IMDEA Show. The description of this event is done in Section 2. Then, different examples of project outcomes are provided in Section 3. Finally, a discussion of the advantages and disadvantages of this project formula is conducted in the last section.

2. IMDEA SHOW

During the second semester of the first year of the Master's programme, students work on a long project (1 day per week during 3 months) in parallel with the other courses and then full-time for 4 weeks. The form of this long project has evolved considerably over time: it was first done with project topics provided by companies. However, communication between students and professionals was not always easy, and schedules did not always coincide. It was then decided to move on to a competition for the design and realisation of an electroacoustic system. All the groups of students were given the same budget and had to design a system whose characteristics had been set by their professors. Thus, the project subjects were the construction of loudspeakers from PVC pipe in 2015 [6], subwoofers with a least two directivity pre-sets in 2016 and portable loudspeakers in 2017. The teachers were won over by this new formula: the transformation of the project into a competition greatly increased the motivation of the students, and consequently the quality of the systems developed. However, having a single goal made the oral presentations a bit monotonous and some students confided that they would have preferred to develop their own ideas. This is how the idea of the IMDEA SHOW was born, its rules are explained below.

2.1 IMDEA show rules

Students can work alone or in pairs. They have a budget of 150 € to buy the necessary supplies. They can work on their own ideas or choose a system to design from a list provided by their teachers. In all cases, the deliverable is a functional prototype that students will have mod-

[1] http://www.univ-lemans.fr
[2] https://eseo.fr
[3] http://www.institut-de-france.fr/institutions/prix-fondations/fondations/fondation-emv
[4] http://imdeacoustics.univ-lemans.fr/en/courses/provisional-schedule.html

elled and measured using the knowledge acquired during the first year of the Master's programme. In order to guide the students, a three-phase schedule is proposed to them:

1. The First phase is dedicated to the bibliographic study, the drawing of a preliminary sketch and to the computing of basic simulations.

2. The second phase allows to finalise the design of the prototype. The definitive choice of components is done during this phase in order to receive them on time. Improved simulations are also performed.

3. The last phase is planned during the last 4 weeks for which the students work full-time on the project. Then, they build their prototype, measure it, listen to it and improve it based on the results and informal listening sessions.

Oral defence sessions are planned at the end of phases 1 and 2 to check whether each project is progressing normally and to identify and remove any bottlenecks.
Various equipment is made available to students to carry out their work. For simulations, computers with simulation and measurement software are available in a room dedicated to project. A fablab for the construction of the enclosures is also available. It includes basic woodworking tools (*e.g.* saw, routers, sanders), a laser cutting machine and a digital milling machine. Two 3D printers (one with filament and one with resin) enable rapid production of prototypes. A semi-anechoic chamber and a reverberation chamber can also be used by students.
The prototype should be ready by mid-June for presentation at the IMDEA SHOW that will be described in Sec. 3.6.

3. PROJECT EXAMPLES

3.1 3D-printed Loudspeaker

The aim of this project was to build a speaker unit with as many 3D printed parts as possible. The speaker design was adapted from a Peerless SDSP83065 unit. The 3D-printed parts are shown in Fig. 1. They were printed using a Fused Deposition Modelling (FDM) printer. The membrane and suspension are printed in one go with a filament change when the nozzle arrives at the membrane-suspension junction (a flexible filament was used for the suspension). The loudspeaker was then assembled by adding rectangular magnets and winding a copper wire, its datasheet is given in Fig. 2.
This project was interesting in many ways, it allowed the students to perform tasks that we usually expect: design, analytical and numerical modelling and measurement. What was less expected was the gap between the students' understanding of how a loudspeaker works (which was quite good) and the skills needed to build one from that knowledge. Anyway, they filled this gap and build a working prototype [7].

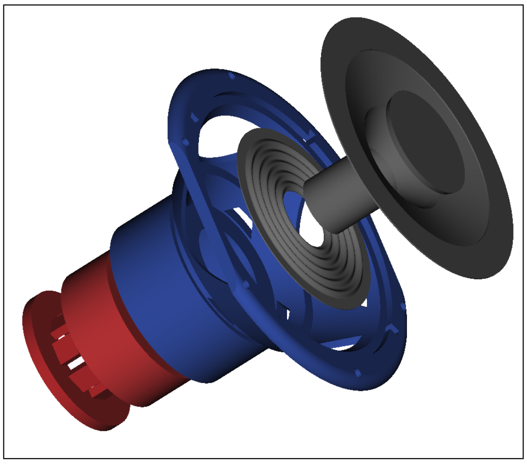

Figure 1. Exploded view of the 3D printed parts

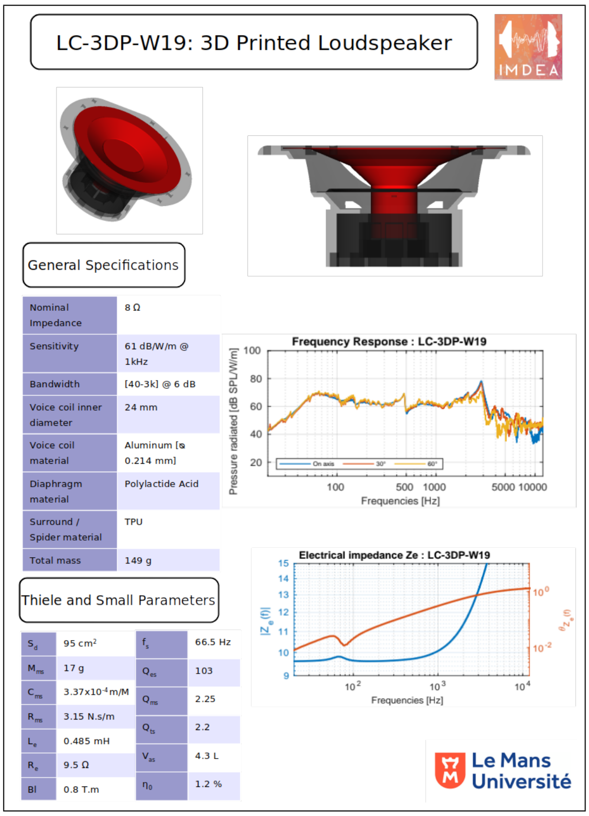

Figure 2. Exploded view of the 3D printed parts

3.2 A simplified Leslie speaker

The aim of this project was to design and build a simplified Leslie speaker. The original Leslie speaker has been released in 1940 and was very often coupled to a Hammon organ. It's an amplified speaker system that was designed to emulate theatre organs. The Leslie speaker has two rotating units: a woofer one and a treble with horns one. For their project [8], the students decided to build a simplified version with a full-range speaker. Compared to a classical loudspeaker, the construction of their prototype offered interesting challenges: the management of the rotating parts, the simulation of the sound radiated by a rotating horn in a partially open box, the time-frequency analysis of the radiated sound. They proposed a solution with a 10 cm diameter speaker equipped with a rotating horn controlled with a dedicated circuit that provides two settings: the chorale (56 RPM) and the tremolo (438 RPM). The system's response has been analytically modelled and measured, tuned and then built. The prototype is presented in Fig. 3

Figure 3. A simplified Leslie speaker

3.3 Radialstrahler Loudspeaker

For this project, the students [9] adapted a patented design [10] of an electrodynamic speaker with a polar radiation pattern. Their prototype is shown in Fig. 4. A force applied vertically by an electrodynamic motor causes the petals constituting the membrane to vibrate. An acoustic wave with a constant directivity in the horizontal plane is then radiated. This project has several challenges to take up: identifying the materials enabling the petals to have the desired mechanical behaviour, absorbing the internal modes of the cavity formed by the petals, correcting the frequency response with a DSP, etc. These challenges were very formative for students whose training focused on understanding physical phenomena and their modelling rather than on the construction of transducers. A picture of the prototype is shown in Fig. 4.

3.4 A DML speaker

For this project, the students [11] had to build and optimize a Distributed Mode Loudspeaker (DML). Here too, such a subject reinforces the knowledge acquired during the first year of the Master's programme: analytical and numerical simulation of loudspeaker systems, measurement of their characteristics and modification of their behaviour by filtering (carried out in this case with the help of a DSP).

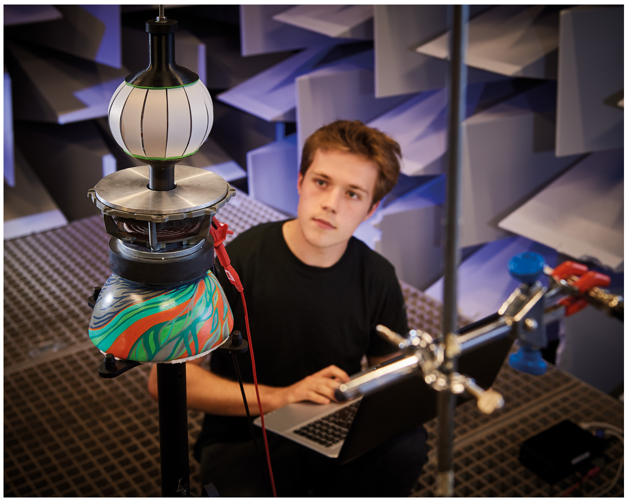

Figure 4. Radialstrahler prototype ready to be measured in the anechoic room.

For the presentation of their project, the students chose to project on the DML loudspeaker the vibratory deformations previously measured at different frequencies. A picture of the prototype installed at the IMDEA show is presented in Fig. 5.

Figure 5. DML speaker ready to be presented at the 2018 IMDEA Show.

3.5 Bistable sound effect

Here the students worked on a type of subject which is more rarely chosen by the students of the IMDEA Master: the realisation of a sound effect [12]. The aim was to design a sound effect based on the movement equation of a bistable system [13]. A bistable device has two stable equilibrium positions and an unstable one. After modelling the device using Matlab, the students developed a VST plugin using the JUCE Framework (see Fig. 6). They also developed a mechanical prototype to demonstrate the bistable system dynamics. The effect has a quite unique sound and offers a dose of unexpectedness due to its chaotic behaviour. This project has been presented at the 23rd DAFx conference [14] in 2020.

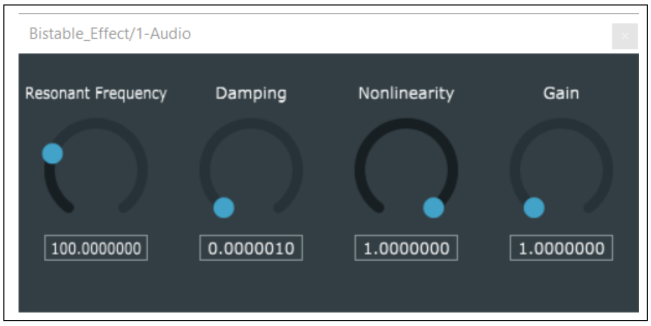

Figure 6. Bistable Plugin GUI.

3.6 IMDEA show

At the end of the project session, the IMDEA show is organised in mid-June and is open to public. We chose to relocate the event outside the university in order to take the students out of their comfort zone, so the IMDEA Show is organised in the start-up incubator in the city of Le Mans. This also allows us to offer an environment that is more oriented towards the professional world and to introduce students to a structure dedicated to support the entrepreneurship spirit. The IMDEA Show is divided into two parts: a morning where the students present a slide show to the jury (conference format) and an afternoon where the prototype is presented to the public and the jury (trade fair format, see Fig. 7). The jury is composed of teachers of the programme and engineers from companies such as Bowers & Wilkins, Focal and Orosound. The professors give a first mark for the scientific quality of the project reports. A second mark is given on the quality of oral and written scientific expression. Finally, the representatives of the companies participating in the jury give a mark on the work carried out after a demonstration by each group during the afternoon. Based on the third mark, three to four students win a prize (usually a high-end headphone) granted by companies of the jury (see Fig. 8).

Figure 7. Students presenting their modular headphone at the IMDEA Show 2018.

Figure 8. Award winners.

4. DISCUSSION

This new project formula was tested for two years in 2018 and 2019 (due to COVID, the 2020 edition could not take place). During these two years, we have been able to measure the benefits and drawbacks of this new format. In terms of advantages, the most obvious has been the increase in student involvement, which has increased considerably. This was attributed to a number of factors such as the possibility to choose one's own project topic, the active participation of renowned companies at the IMDEA show. Relocation and opening up to the public certainly had their part to play. We have thus seen a clear increase in the quality of project realisation. The companies participating in the jury also told us of their satisfaction; this event allows them to see and evaluate the work of future candidates for an internship or a job. Some students found their second year internship thanks to the contact they had with companies at IMDEA show.

For those in charge of the master's programme, the IMDEA show also has many advantages. It enables them to identify any gaps in the programme through the knowledge required to build the various prototypes. For example, the proportion of digital filtering courses and implementation on DSP has been increased since 2018. The IMDEA Show is also beneficial for external communication: (e.g. by presenting the results of student projects at student competitions during the AES conventions, or by scientific communications [14, 15]) and thus strengthens the network. The reputation of the Master's programme then makes it possible to attract highly motivated students from all over the world.

However, this level of format has a few drawbacks: it requires greater supervision of the teaching staff so that all the prototypes can be of sufficient quality. In addition, new prototypes are produced every year, thus increasing the environmental cost of the projects. We are therefore trying to recycle the different parts as much as possible and are thinking of introducing the ecological cost as a new constraint given to students.

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