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## The L-Acoustics program for vocational education in loudspeaker system and immersive audio

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### ABSTRACT

L-Acoustics has introduced several disruptive technologies in the live sound industry, like in 1992 with full-range line sources, or more recently with large-scale immersive audio. To accompany the end-users in mastering these new tools, training and education have always been a core foundation of the company.

This paper explains the educational challenges associated with the sector of live sound and how L-Acoustics has decided to overcome them. The development of a program targeted at end-users, with structured content and elaborated methodologies has allowed the evolution from traditional product training to vocational education. The different job profiles, the associated learning objectives and courses fulfil the development of live sound professionals. In addition, the program reveals itself as a good complement to initial education curriculums that will prepare their students for the multiple job opportunities in the live sound industry.

### 1 Introduction

Over the last 15 years, the L-Acoustics education program has evolved from a traditional product training approach to vocational education. It now encompasses complementary pieces of knowledge answering the learning needs of specific job profiles. It covers two main areas: loudspeaker system and immersive audio, which are nowadays intertwined in many sound reinforcement projects and technologies. The content extends simple product operation to methodologies and is supported by findings of field-application research studies.

After exposing the context and the philosophy supporting the L-Acoustics approach, this article describes the education program. The learner profiles, courses and delivery methods are presented. We also precise the ambition to close the gap between academic education and professional training.

### 2 Live sound and education

Since the advent of electro-acoustic, music and all kinds of sound performance have been embraced by what is called the audio industry. Its main actors are developers of the audio products and users of these products in their professional activity. How are they educated to perform efficiently in their jobs?

Regarding research & development careers, we could claim a shortage of formal education programs fully dedicated to professional audio. However, there are multiple degrees that indirectly offer a major part of the fundamentals for audio technology, whether they have options or specialties in acoustics, signal processing or electronics. Even with a more general curriculum, many graduated technicians, engineers, and PhDs can borrow relevant knowledge from multiple disciplines to build their own learning path and evolve in this industry.

The latter is not so easy for the end-users of the audio tools. Most of them in the early days, and many of

them nowadays, would not have a technical or scientific educational background. They would rather acquire their expertise through hands-on experience in daily operations. They could also find support in the user manuals and the product trainings proposed by some hardware or software developers. Eventually, many interdisciplinary programs, from diploma to master's degree level, have been developed to address the production aspect of the audio industry. Some combine studies in engineering and music, like Tonmeister, sound design, or music technology curricula. Other ones rather focus on communication and audio, tackling broadcasting activities [1][3]. However, the profiles of pro audio end-users are much more diverse and not all are treated equally in terms of initial education.

The sector of live sound is clearly behind, despite having a variety of disciplines involved. The useful skills are not only to be found in music, acoustics or electro-acoustic, but also in mechanics, electricity, electronics, architectural drawing, signal processing, IT network or even building project management. A limited number of initial education programs approach this diversity and complexity [3]. Some live production companies, such as Clair Global [4] and Britannia Row [5], have created a curriculum in partnership with a university. This rare initiative will ease the detection and onboarding of fresh graduates for their own staff.

The educational offer is complemented by professional training organizations. Many entities, like SynAudCon [6] in the USA or INA-Sup [7] in France, propose curriculum in sound reinforcement that span from few days to several months. They cover agnostic technical knowledge on many aspects of the industry.

But the live sound technologies moves fast and the number of tools to master never stops increasing. As a result, one of the main sources of up-to-date technical information remains the trainings and the handbooks designed by some top audio brands. The live audio brands must feel concerned by the initial and ongoing education of the end-users. They need it to ensure the quality of the listening experience when using their products.

### 3 L-Acoustics program positioning

In this chapter, we expose dimensions that determines the positioning of an education program when proposed by a commercial brand. We especially highlight the L-Acoustics philosophy and what has guided its own program development.

#### 3.1 From product training to vocational education

In a company, the technical communication is addressed differently depending on the department. On one side, the marketing team produces presale assets, like technical specification sheets, quick start videos, sales and application handbooks. Created for potential buyers and sales, they highlight specific product features and its benefits over competition. On the other side, the technical writers publish post sale documentation, like owner manuals. Designed for the end-users, they explain the product functionalities and its detailed operation.

For the product training department, the target learner profile should be the end-user also, not the potential buyer. Accurate and honest information is needed. In a minimal approach, the product training can be then seen as an extension of the user manuals. Indeed, it has the same objectives but just uses alternative delivery methods and formats.

Transitioning from product training to vocational education requires primarily to define learning objectives according to professional roles. The manufacturer has a privileged position, having the ability to anticipate technological evolutions and their impact on the workflow and positioning of end-users.

L-Acoustics has designed and organized its courses according to the learning needs of specific job profiles. The mutual objective of both L-Acoustics and the learner is to optimize the use of the system and get the best results in field applications. The instructional designer team is closely connected to field practitioners and the R&D teams, often involved into the product development projects.

The focus on the end-user leads to the proposal of efficient workflows which are transferable or adaptable to various real-life scenario, and on many occasions to other brands although the illustrated products and tools are L-Acoustics.

#### 3.2 From field practice to usable knowledge

An almost traditional axis in the audio community opposes the transmission of popular beliefs to a passion for myth busting. Scientific studies can help transforming an assumption into a fact or into a false belief. Beyond the facts themselves, the scientific method also makes possible to correct, justify or, optimize practices that are myths in themselves, being mainly used and transmitted because of habits.

L-Acoustics set up a dedicated *field-application research* team as an integral part of the Education division. The team conducts research on technologies

and best-field practices for sound reinforcement applications. The team bases its work on close interaction with field experts and conducts scientific studies based on advanced modelling techniques, analysis of large measurement datasets and psychoacoustical studies.

The two main axes of the team concern the interaction of the loudspeaker system with the audience and with the environment: qualification of live sound experience, audience exposure, effect of the audience on sound, atmospheric conditions, room acoustics. It leads to open access scientific articles, white papers, but also to exclusive content for the training courses. The L-Acoustics team investigates these problematics from the end-user perspective. Recent studies spanned a broad range of topics that have practical outcome for the professionals: measurement microphone locations for loudspeaker system measurements in venues [8], perception of interferences in high-frequencies [9], performance of flown subwoofers [12], impact of loudspeaker system design on noise pollution. Science is used to investigate the know-why knowledge associated with specific technical decisions. In this industry, it is important to be able to explain and motivate important design and optimization choices to various stakeholders. It is as important to anticipate the outcome of the compromises that inevitably occur in most projects.

## 4 Offering for professional education

### 4.1 Learner profiles

As of 2023, L-Acoustics has defined four profiles of end-users. They are connected to the tools and equipment the company designs. Therefore, these profiles do not pretend to cover all the jobs in the live sound industry.

Three of them fall under the category of loudspeaker system end-users, with different degrees of responsibilities and different levels of expertise: *system technician*, *system engineer* and *system expert*. The last one, *immersive mixing engineer*, addresses the widening of L-Acoustics end-user base with the introduction of live sound immersive technology. For each profile, the main responsibility and required abilities, driving the associated learning objectives, have been defined.

#### 4.1.1 System Technician profile

The main responsibility of a system technician is to implement a loudspeaker system so that it is safe,

functional, and ready for calibration. The required abilities are:

- Identify the elements of a loudspeaker system and understand how they complement one with another.
- Interpret the technical design documentation to properly plan the system implementation.
- Apply the official rigging procedures when mounting a loudspeaker system.
- Install the hardware elements of the drive system and perform its electronic configuration.

#### 4.1.2 System Engineer profile

The main responsibility of a system engineer is to manage a loudspeaker system project from design to operation. The required abilities are:

- Ensure coherency of a project all along its project workflow by interacting with all its stakeholders
- Design an optimized loudspeaker system, producing relevant software project files
- Master advanced calibration techniques and tools, for verification, tuning and handover of the system onsite
- Work along the mixing engineer for project specifications, show preparation and live operation

#### 4.1.3 System Expert profile

The main responsibility of a system expert is to understand the foundations of system behaviors and methodologies. The required abilities are:

- Explain optimization choices and compromises
- Understand the results of field-application research studies

#### 4.1.4 Immersive mixing engineer profile

The main responsibility of an immersive mixing engineer is to produce an object-based mix in live conditions and in different venue scales. The required abilities are:

- Master the spatial and dynamic features of object-based mixing
- Adapt a mix in relation to a specific loudspeaker system layout
- Manage the scalability of a mix between headphones, studio and venues of different scales
- Support visiting mixing engineers in venues with installed immersive systems

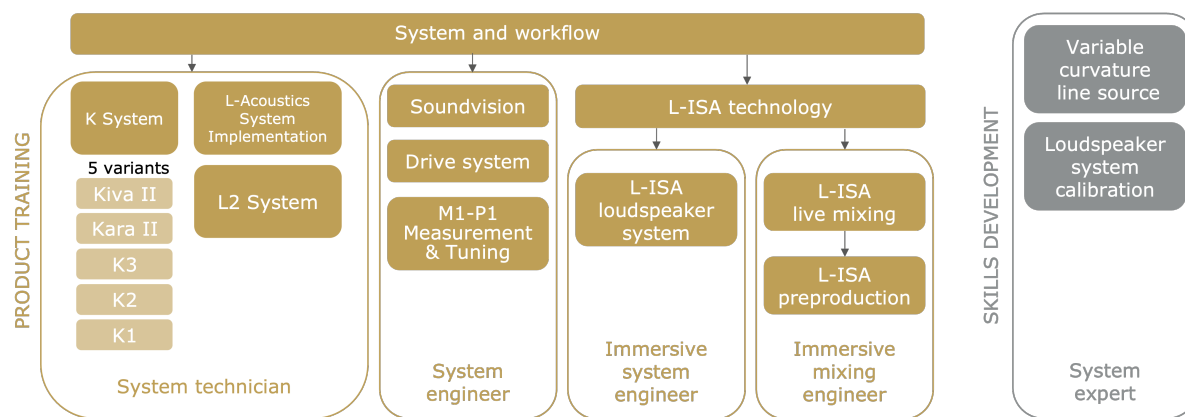


Figure 1: Program structure & courses

#### 4.2 Profile-related courses

L-Acoustics courses are engineered by a dedicated team of learning designers. Course material include presentations, learning quizzes, demonstration scripts, tutorial handouts, content for practical workshops and a trainer guide to support the delivery. As of 2023, the full L-Acoustics curriculum proposes 17 courses with 7 contact hours and a certification test for each.

##### 4.2.1 Foundational courses

*System and Workflow* course is the only prerequisite to all the other ones. It is a structuring course that provides a 360 view of the loudspeaker system (loudspeaker, electronics, mechanics, software) and the associated project workflow (design, implementation, calibration, operation). It allows bringing all learner profiles and levels together so that they can orient themselves while starting a learning journey with L-Acoustics.

*L-ISA technology* is the prerequisite to the immersive live sound courses. It defines the specifics of spatial sound technology for large-scale live sound venues and present the associated project workflow from pre-production to live show.

All other courses are associated to a specific learner profile.

##### 4.2.2 System Technician courses

Seven courses target the System Technician. One generic course addresses the full implementation workflow based on the technical design documentation. It covers 3 critical aspects: mount & rig, cable & connect, run & test.

Six courses are dedicated to each of the L-Acoustics line source systems. These courses teach the best mechanical and electronic deployments. They

especially focus on transmitting efficient & safe rigging procedures for line arrays. They also comprise practical rigging workshops and listening tests.

##### 4.2.3 System Engineer courses

Three courses target the System Engineer and cover the technical aspects of a project workflow. They specifically provide the best use of the software tools that assist the user along complementary steps: venue modelling & system simulation, drive system configuration & optimization, acoustic measurement & tuning. An extension course focuses on specific guidelines, recommendations, and tools for immersive loudspeaker systems.

##### 4.2.4 System Expert courses

Two courses so far provide detailed information about two generic the topics that are highly relevant to expert system engineers:

- Behavior and optimization of variable curvature line sources,
- Optimized and rationalized workflow for loudspeaker system calibration.

Both courses focus on know-why information that is directly transferable to other loudspeaker systems or brands.

##### 4.2.5 Immersive Mixing Engineer courses

Two courses are dedicated to mixing engineers, focusing on the transition from LR channel-based stereo or dual-mono mixing to object-based immersive audio techniques at all venue scales, from studio to theatre to arena.

The courses aim at providing efficient methodologies to support productions willing to embark into

immersive audio from the early stage, through to pre-production, touring and post-production. The courses also consider the support of visiting engineers on an immersive audio system, providing guidelines on how to adapt quickly a LR mix into an object-based compatible mix that can benefit from the use of the immersive audio system.

### 4.3 Program delivery

Courses can be delivered independently but also constitutes a logical set of courses for profile-related seminars of 2 to 4 days. This flexibility allows production companies and freelancers to keep the end of the week for the preparation of shows over the weekend.

#### 4.3.1 Instructor-led sessions

Courses are delivered by a network of 100 certified trainers worldwide that are trained, briefed, and supported by a team of 4 regional L-Acoustics trainer network managers. This includes:

- 30 L-Acoustics internal trainers from Application Project and Education & Scientific Outreach divisions,
- 35 instructors working for authorized training centres, a worldwide network of L-Acoustics

partners entitled to organise official L-Acoustics training seminars,

- 35 consultants, who are high profile sound professionals and can be missioned by L-Acoustics for the duration of a training seminar.

The trainer certification is granted according to the learner profile categories. It should fit trainers' experience, training history and ability to deliver enough sessions within a year.

#### 4.3.2 Modality

Courses are proposed preferably in a face-to-face onsite format. This allows best interaction between instructor and learners, tends to guarantee a better attention level of learners, enable manipulation of hardware and audio demonstrations with specific hardware requirements.

Selected courses may also be offered in a specific online format consisting of two virtual classrooms spaced one week apart, with eLearning activities in between. These activities, consist in the same quizzes and software tutorials as for the onsite format, with the difference that they are to be done autonomously. The learners still need to upload the completed exercises for the instructor to check them out and provide feedback.



Figure 2: Typical organization of a course for an onsite or online delivery

Interactivity and engagement of learners are a topic of concern in distance learning that came up with the forced experiment of the COVID crisis [12]. The exchanges cannot be as rich and direct as in face-to-face, but it allows a worldwide reach of the program and limits travelling requirements.

#### 4.3.3 Post-training engagement

The online education platform allows L-Acoustics to propose a blended learning approach that complements the instructor-led sessions, but also creates learner engagement on the long-term [13]. Indeed, one of the major challenges in the audio community, and maybe more generally for product training, is that professionals are reluctant to come back twice to a manufacturer training. However, as already stated, the audio technologies, along with its associated tools and methodologies, are constantly evolving. Ongoing education is needed. To address this problematic, the L-Acoustics platform is configured to extend its educational reach after the completion of an in-person classroom.

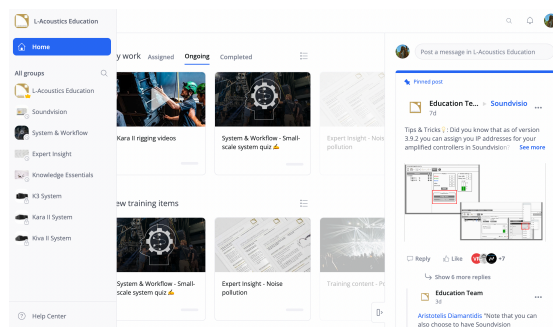


Figure 3: The L-Acoustics education platform

On the L-Acoustics education platform, access is granted to a specific group for each course the learner is certified for. These course groups host always up-to-date learning material and exclusive complementary resources such as:

- Short rigging videos for L-Acoustics line sources, illustrating the recommended procedures detailed in the manuals,
- Immersive audio mixing tutorials, including high quality multitrack audio.

In addition, on-demand learning material is accessible to everyone with an active account on the platform, such as:

- Knowledge essentials series, approaching fundamental topics with a focus on their relevance to the live sound or immersive audio.

- Expert insight series, providing expert views on advanced topics with results from scientific papers and related guidelines for field practice.

Finally, the community of roughly ten thousand certified trainees can comment the learning materials, ask question to the instructors and to L-Acoustics experts or interact between themselves.

## 5 Complementarity with formal education

To extend the observations of section 2, let's look at the workforce situation in live sound and simplify it for the sake of a diagnostic. It will allow to understand the mutual interest that school and industry certainly have in closing the gap between formal and professional education.

### 5.1 Diagnosis

Many professionals are highly efficient. They can exploit knowledge from their field experience, even though they may lack solid foundations on theoretical concepts. Some have leadership or mentorship character that allows them to efficiently onboard new live sound technicians. However, many experts do not transmit. Some of them want to keep their "self-acquired" field knowledge as a precious personal asset, especially freelancers who are in competition to get jobs. Some others just don't have the didactic skills needed to express their knowledge and transmit their valuable experience. More recently, the transmission chain has also been partially affected by the COVID crisis with many industry veterans having left the industry.

Students from audio schools are more prone to absorb academic concepts and new technologies. However, a very large majority study studio or broadcast production and are not entirely ready for the reality and specificities of live sound jobs. Employment opportunities in the live sector are high, even more since the COVID crisis, and many students will eventually end up working in this sector.

Manufacturers have a responsibility and a role to play in a triparty partnership with schools and production companies. A manufacturer can surely benefit from the early exposure of students to its technologies. But every party involved gets benefit out of it: student gains in employability, and production company finds skilled staff.

## 5.2 L-Acoustics approach

L-Acoustics considers 3 levels of engagement towards academic institutions, already in place with numerous academic partners<sup>1</sup>.

The first is proposed to any audio school. It consists in two courses specifically designed for this purpose: Introduction to live sound and Introduction to Immersive audio. The objectives are to:

- Motivate students to embrace a career in live sound and/or in immersive audio,
- Open minds about latest pro audio technologies.

The second level is adapted to schools with a live sound curriculum or with a strong focus on immersive audio. It consists in delivering to the students the official L-Acoustics courses before they graduate and enter the professional world. This one needs the support of a local production company or L-Acoustics partner to give students an early access to a professional environment. The objectives are to:

- Elevate the students with tools used by professionals in high-end shows
- Increase student employability with recognized certification and internship possibilities

The third level is reserved to selected institutions and adds a full partnership in building audio curriculum. The objectives are to:

- Improve or enrich the learning material of both partners
- Conduct research studies and projects as a collaboration between students, teachers and L-Acoustics

At any level, the additional benefit for the student is an access to the L-Acoustics Education platform. And when the operational conditions are met, the teachers can also become certified trainers and access to the L-Acoustics seminars for educational briefing or technical updates.

## 6 Discussion

Such an education program, targeted at end-users creates value for the company on the long-term. It serves the quality of the experienced sound, the image of the brand is reinforced, and it eventually reduces supporting cost for the manufacturer.

It must be acknowledged that the positioning described in section 3 is not always easy to maintain. It is especially the case when launching a new product or technology. The profile of the end-user itself may

be unclear, making difficult the development of vocational content. But there is also a higher risk of permeability between marketing and scientific arguments.

L-Acoustics has encountered these types of dilemmas already, like when introducing the V-DOSC line source (1995) or the L-ISA immersive audio technology (2019).

Indeed, when innovative products are just out on the market, the learning objectives may be difficult to define. We can showcase features and anticipate many potentials, but part of the actual usage is still to be discovered. For example, the job of system engineer was not fully established before the introduction of line sources. It took time to mature the methodologies pertaining to this role and to construct a set of coherent courses for it. Today, work still needs to be done and L-Acoustics will publish new courses to complete the profile needs. Regarding live immersive audio, the specific tasks and jobs are still under definition. New tasks involving the programming of the interaction environment and the spatial programming have appeared and their association with a traditional system or mixing engineer is still debatable. Maybe new job profiles will emerge. Maybe these tasks will become part of either profile depending on the specific competence of individuals. Therefore, the associated L-ISA training courses will evolve to follow this organic construction process.

When trying to explain new technologies with scientific facts, the usefulness or even relevance of the arguments can sometimes be challenged. For example, L-Acoustics involuntarily contributed to the myths associated to line source arrays. In the early trainings or technical publications about line sources, the company exposed concepts or formulas which were important for the development of the DOSC waveguide. Some of them relied on the physics of straight line sources, overlooking the critical effect of curvature. This approach was an obstacle for understanding the behaviour of line source arrays as actually used on the field. It led to many misconceptions and misuses, both internally at L-Acoustics and in the audio community in general. Since then, L-Acoustics has demystified most of it with the “Variable Curvature Line Source” course that was created in 2015, and also presented in a condensed lecture at various AES events [14].

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<sup>1</sup> <https://www.l-acoustics.com/education/vision/>

Eventually, having the ambition to work with academic institutions is an accelerator for a manufacturer to complete the transition to vocational training while assuring the expected functions of product training. And when its courses are included as part of a school curriculum, it is a recognition of its genuine educational value and its effort in creating a program that has value beyond the single use of L-Acoustics products.

## 7 Conclusion

The ambition of the L-Acoustics education program is to go beyond a simple extension of user manuals of L-Acoustics products.

The courses are developed by the L-Acoustics Education team to enable end-users to position themselves into the live sound ecosystem and develop as audio professionals throughout their career. The purpose is also to consolidate the knowledge of field experts, to enrich it with scientific findings and to structure it in rational methodologies.

L-Acoustics products, that end-users are expected to master on the field, remain at the centre for most courses. These courses are constantly updated to keep up with the upgrades or the evolution of technologies and practices.

The program can be followed by sound professionals as continuous education throughout the course of their career. It can also be offered as initial education, in collaboration with academic sound programs.

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