

Unit 12: Digital Audio

Level: **3**

Unit type: **Internal**

Guided learning hours: **60**

Unit in brief

Learners study the principles and processes used to convert, store and manipulate audio signals and data. They will use techniques to process digital audio to meet identified requirements.

Unit introduction

Audio is used extensively in the digital arts, including web, gaming, music, film and television. The computing principles that underpin the use of digital audio have remained unchanged for many years and form a body of knowledge that, as an audio engineer, you will be able to draw on to achieve the highest quality creative results.

In this unit, you will learn about the computing principles relevant to digital audio representation, transfer and storage. You will develop your practical skills to produce suitable audio for a range of applications, including the use of processes to enhance and augment audio. You will investigate, design, create, test and evaluate digital audio to meet a range of identified requirements.

Through studying this unit, you will apply skills and knowledge that can prepare you for a range of apprenticeships or higher education courses, including sound recording, broadcast production and broadcast technology, eventually entering the workplace as a professional in the creative computing field, such as an audio digital signal processing engineer.

Learning aims

In this unit you will:

- A** Examine the principles that underpin digital audio
- B** Design digital audio to meet client requirements
- C** Develop digital audio to meet client requirements.

Summary of unit

Learning aim	Key content areas	Recommended assessment approach
A Examine the principles that underpin digital audio	A1 Digital representation of audio A2 Storing and using audio in digital form	A report on the techniques used to record, store and represent audio in digital format, the relationship between analogue sound and digital data and the implications of using digital formats to store and reproduce sound.
B Design digital audio to meet client requirements	B1 Digital audio planning and design B2 Planning and design documentation B3 Sourcing digital audio assets B4 Reviewing and refining designs	<p>A design specification showing the planning, sourcing and processing of a range of sounds in readiness for an identified digital product.</p> <p>A selection of digital audio files which fulfil the design specification, accompanied by supporting development and testing documentation.</p>
C Develop digital audio to meet client requirements	C1 Digital audio processing methods C2 Testing digital audio C3 Reviewing digital audio C4 Quality characteristics C5 Skills, knowledge and behaviours	<p>A report evaluating the digital audio files against the design specification.</p>

Content

Learning aim A: Examine the principles that underpin digital audio

A1 Digital representation of audio

Characteristics, application and implications of using digital data to represent audio.

- Binary representation of sound, including:
 - binary numbers
 - pulse-code modulation (PCM).
- Sampling, analogue to digital conversion (ADC), using the Nyquist-Shannon sampling theorem. Features of sampling, including:
 - sample rate/frequency
 - frequency response
 - bit rates
 - digital clocking
 - synchronisation
 - quantization (including approximation, quantizing error)
 - dither
 - aliasing
 - oversampling.
- Error detection and correction.
- Digital to analogue conversion.

A2 Storing and using audio in digital form

Characteristics and implications of using and storing audio data in digital form.

- Audio file formats, including the characteristics of different audio file formats, selection and use of audio file formats, codecs.
- Compression, including:
 - compression types, e.g. lossy, lossless
 - compression methods used with digital audio.
- Impact of compression on digital audio.
- Musical instrument digital interface (MIDI).

Learning aim B: Design digital audio to meet client requirements

B1 Digital audio planning and design

Techniques and processes to consider when planning and designing digital audio for use in digital products.

- Digital processing and editing techniques.
- Sourcing digital audio assets.
- Compression formats and techniques.
- Quality characteristics, e.g. compatibility, user experience, usability, timing and length, file types, codecs.

B2 Planning and design documentation

- Requirements of the brief, including audience, purpose and client requirements.
- Organisation/company research.
- Legal and ethical considerations applicable to the equivalent legislation in England, Wales and Northern Ireland, e.g. copyright, royalties, digital rights management (DRM).
- Storyboards (where appropriate).
- Intended platform/media for delivery.
- Timeline, e.g. outlining which different assets are included and when different assets will be combined.

- Processing schedule, e.g. timeline of digital audio processing.
- Hardware, software and other resources required.
- Test plans to check accuracy, audio presentation, compatibility and other quality characteristics.
- Technical constraints, e.g. file types, software licensing.

B3 Sourcing digital audio assets

- Recording analogue audio, e.g. speech, music, sound effects.
- Creating unique digital audio, e.g. music, sound effects.
- Third party audio files.

B4 Reviewing and refining designs

Working with clients and others to improve the quality, effectiveness and appropriateness of designs.

- Gathering feedback from client(s) and potential users.
- Communicating with clients, e.g. email, verbal communication.
- Scheduling and documenting meetings.
- Agreeing and adjusting timescales.
- Refining ideas and solutions.
- Updating design specification documentation based on review and feedback.

Learning aim C: Develop digital audio to meet client requirements

C1 Digital audio processing methods

- Audio processing techniques, including:
 - simulating acoustic environments
 - delay-based processing
 - reverberation
 - pitch-based processing
 - room modelling
 - equalisation
 - dynamics.
- Storing and using digital audio, including:
 - file formats
 - compression
 - target device/platform
 - quality characteristics.
- Hardware and software requirements.
- Error detection and correction.

C2 Testing digital audio

- Testing digital audio for use in digital products, including compatibility, stability and acceptance.
- Obtaining feedback from others, e.g. effectiveness, presentation, audio performance and purpose.
- Making improvements to digital audio in response to testing and feedback from others.

C3 Reviewing digital audio

- Quality of digital audio.
- Fitness for audience and purpose.
- Suitability against the original requirements.
- Legal and ethical constraints.
- Technology constraints.
- Strengths and potential improvements.
- Optimising digital audio, e.g. resampling and different sampling rates, applying different tools or effects, using different compression methods, based on review and feedback.

C4 Quality characteristics

Quality characteristics of digital audio which can be measured against client requirements.

- Sound quality.
- Sound effects.
- Accuracy.
- Compatibility.
- Usability.
- Costs.

C5 Skills, knowledge and behaviours

- Planning and recording, including the setting of relevant targets with timescales, how and when feedback from others will be gathered.
- Reviewing and responding to outcomes, including the use of feedback from others, e.g. IT professionals and users who can provide feedback on the quality of the digital audio and its suitability against the original requirements.
- Demonstrating behaviour and its impact on outcomes, including professionalism, etiquette, being supportive of others, timely and appropriate leadership, accountability and individual responsibility.
- Evaluating outcomes to help inform high-quality, justified recommendations and decisions.
- Evaluating targets to obtain insights into own performance.
- Media and communication skills, including:
 - conveying intended meaning, e.g. written (email, design documentation, recording documentation, reports, visual aids for presentation use), verbal communication requirements (one-to-one and group, informal and formal situations)
 - use of tone and language for verbal and written communications to convey intended meaning and make a positive and constructive impact on audience, e.g. positive and engaging tone, technical/vocational language suitable for intended audience, avoidance of jargon
 - responding constructively to the contributions of others, e.g. supportive, managing contributions so all have the opportunity to contribute, responding to objections, managing expectation, resolving conflict.

Assessment criteria

Pass	Merit	Distinction
Learning aim A: Examine the principles that underpin digital audio		A.D1 Evaluate how the application of digital audio principles within digital audio signals and digital audio data affects the accuracy with which they reproduce the original audio or instrument.
A.P1 Explain the characteristics of digital audio and methods of processing sound in digital format. A.P2 Explain the impact of representing and storing audio in digital format.	A.M1 Analyse how digital audio principles impact on the accuracy and usability of sound files, and techniques that can be used to enhance the accuracy and usability of the digital audio signal.	
Learning aim B: Design digital audio to meet client requirements		BC.D2 Evaluate the design and optimised digital audio files included in a digital product against client requirements. BC.D3 Demonstrate individual responsibility, creativity, and effective self-management in the design, development and review of digital audio files.
B.P3 Produce designs for digital audio files for inclusion into a digital product which meets client requirements. B.P4 Review the designs with others to identify and inform refinements.	B.M2 Justify decisions made, showing how the design will fulfil its purpose and meet client requirements.	
Learning aim C: Develop digital audio to meet client requirements		
C.P5 Develop digital audio files to meet client requirements for inclusion into a digital product. C.P6 Test digital audio files for correctness, audio presentation and compatibility. C.P7 Review the extent to which the digital audio files meet the client requirements.	C.M3 Optimise digital audio files to meet client requirements for inclusion into a digital product.	

Essential information for assignments

The recommended structure of assessment is shown in the unit summary along with suitable forms of evidence. *Section 6* gives information on setting assignments and there is further information on our website.

There is a maximum number of two summative assignments for this unit. The relationship of the learning aims and criteria is:

Learning aim: A (A.P1, A.P2, A.M1, A.D1)

Learning aims: B and C (B.P3, B.P4, C.P5, C.P6, C.P7, B.M2, C.M3, BC.D2, BC.D3)

Further information for teachers and assessors

Resource requirements

For this unit, learners must have access to hardware and software resources that will allow them to use the tools and techniques, as given in the unit content, to record and manipulate audio files.

Essential information for assessment decisions

Learning aim A

The evidence must include characteristics of digital audio techniques used for processing sound in a digital format. This must be supported by examples of how these are used. The evidence will include an analysis of how the different techniques could be used and the effect they would have on audio files and, where appropriate, the user.

For distinction standard, learners will provide a clear and balanced evaluation of how the characteristics of digital audio impact on how accurately analogue sound is represented when processed using digital data. The evidence must provide clear examples of how storing and processing data affects the way they could be used in a range of contexts, for example as a soundtrack for a video or a sound effect on a website. Learners must make comparisons between different techniques of processing and storing audio and the impact they would have on the audio files, target product and, where appropriate, the user. The report will demonstrate high-quality written/oral communication, through use of accurate and fluent technical vocabulary to support a well-structured and considered response that clearly connects chains of reasoning.

For merit standard, learners will show a clear understanding of how processing and storing digital audio impacts on the accuracy and usability of audio files. The report must provide a balanced discussion, supported by clear examples, of how at least five types of sampling (other than analogue to digital converter) impact on how accurately the digital data can represent the original sound, and techniques that can be used to detect errors and improve accuracy. The evidence will be technically accurate and demonstrate good-quality written or oral communication.

For pass standard, learners will explain the characteristics of digital audio. The explanations must be supported by examples of how audio data is stored (binary representation of sound) and processed in digital format. The evidence will demonstrate an understanding of the process of conversion from analogue to digital and the resource requirements of converting and storing audio. Learners must discuss how different features of sampling impact on audio data. The evidence must discuss how audio file formats and compression impact on how the audio data can be used. The evidence may have some inaccuracies and the review of the impact may be unbalanced.

Learning aims B and C

Learners must provide evidence that contains the raw (original) sounds, the audio files and appropriate planning and development evidence detailing the use of processing and testing techniques. Learners must provide evidence of evaluating the effectiveness and appropriateness of the digital audio files.

Learners must provide evidence of planning and developing a number of different digital audio files for at least two different uses. For example, the client may require sound effects, soundtracks and voiceovers to be produced for inclusion in an e-learning package or a computer game. Learners are not required to present the files in a larger digital product but must provide evidence that the produced files are appropriate and ready for use in the ways specified in the project brief.

At least two of the sounds they process for inclusion in the audio files will be recorded by learners, one of which must contain spoken voice and one must contain music that has been performed live or music that has been created by learners using digital techniques.

For distinction standard, learners will draw on, and show synthesis of, knowledge across the learning aims to evaluate how the decisions and processes applied throughout the planning, design, development and testing stages impacted on the effectiveness of the digital audio files. Learners will make suitable and reasoned justifications of decisions made in comparison to alternative solutions.

Learners must provide a thorough evaluation of the effectiveness of the digital audio files against design and client requirements. The evaluation will be supported by evidence from all stages of the development and review process to reach valid conclusions as to how the chosen processing techniques provided more accurate and usable digital audio in comparison to alternatives. Learners will provide well-considered, justifiable suggestions for future improvements to the digital audio files.

The evaluation will contain a systematic and accurate review of learners' own skills and performance and the impact that this had on the effectiveness of the digital audio files. Evaluation of behaviours will consider learners' use of 'soft skills' in relation to the vocational context of the project, such as managing and liaising with other members of the team or clients and time management. Learners will evaluate their own behaviours throughout the project and the impact they have on the outcomes. Learners will take individual responsibility for their own work, for example identifying potential issues and resolving these, reviewing their work and making improvements, keeping their work safe and secure and showing responsible use of quoted materials. Creativity will be shown, for example, through taking innovative approaches to problem-solving and through the originality of their solution. Learners will refer to tangible evidence to support their evaluation such as meeting notes, correspondence and time plans.

For merit standard, learners will apply their knowledge through selection and application of appropriate tools and techniques to plan, design, develop, test and optimise digital audio files that effectively meet client requirements. Learners will produce comprehensive designs, including alternative solutions. When developing their audio files, learners should produce an optimal solution in order to meet client requirements as closely as possible. Learners should also gather and analyse feedback on their audio files in order to make improvements.

The sourcing, development and testing stages must be well-documented with clear justification of decisions and selections made throughout. Learners will record the changes that are made and produce subsequent versions of the audio files as appropriate. Learners will make clear reference to the client's requirements, target product and platform, and consider legal and ethical issues as appropriate.

Learners must provide a clear, accurate and robust justification of how the chosen processing techniques will ensure the digital audio representation is accurate and usable and fully meets client requirements.

Learners will source a wide range of raw sounds in readiness for processing with appropriate, dedicated audio editing software.

Learners must optimise their audio files by making use of testing and feedback throughout development to improve and refine the audio files to fully meet client requirements, such as resampling sound at different sample rates, applying different tools and effects and using different compression methods.

Learners will provide a clear and balanced analysis of the success of their outcomes against the design and client requirements and the quality of the audio files. Learners will refer to how the audio files and their content suit the intended audience, purpose and platform of delivery. Learners must also provide an analysis of how any associated legal and ethical issues were considered and met. They will make accurate and reasoned suggestions as to how the digital audio files could be improved and will discuss alternative processing techniques that could be used if the task were to be repeated.

For pass standard, learners will apply their understanding through the planning, sourcing and processing of digital audio files to meet identified requirements. Learners will provide an explanation of the digital audio, and related computing, requirements of an identified client and identify the success/acceptance criteria that will ensure the client's requirements are met.

Learners will produce detailed designs for their audio files, including user requirements and technical documentation. The documentation will clearly outline how audio is required for at least two different uses. Learners must explain how digital audio processing methods could be used to produce the required audio files. Learners must consider the appropriateness of different possible techniques and formats and the impact these would have on user experience. Learners will source a range of raw sounds in readiness for processing with appropriate, dedicated audio editing software. Learners can identify and source more sounds than they will finally use and explain the reasons for choosing the sounds that were ultimately used. Learners must provide a clear record of the sources used and demonstrate an understanding of the implications of relevant legal and ethical issues in their selection and use of particular sounds. Learners must produce a number of sounds that meet the requirements of the client as outlined in their project brief. Learners should carry out and document a number of tests and reviews of their files (including use of test users and appropriate test plans, schedules and test data) to ensure that the solution works and meets the identified criteria. Learners must review their designs with others to identify improvements and refinements. They should provide evidence that different types of testing have been carried out.

Learners must show some awareness of the legal and ethical considerations related to sourcing and producing digital audio files.

Learners must provide documentation for the planning, design, development, production and quality assurance of their audio files, explaining the decisions they made during the project to ensure they met the project brief. Learners will produce a solution that meets the requirements of the client, however, some small issues of optimisation may persist.

Learners must provide a review of whether their work meets the client requirements, considering both positive and negative aspects of the outcomes, although their review may be unbalanced and/or superficial. Learners will use relevant feedback, such as client feedback, to make suggestions regarding possible alternative solutions that could be implemented.

Links to other units

This unit links to:

- Unit 10: Human-computer Interaction
- Unit 11: Digital Graphics and Animation
- Unit 13: Digital Video
- Unit 14: Computer Games Development
- Unit 15: Website Development
- Unit 16: Object-oriented Programming
- Unit 17: Mobile Apps Development
- Unit 24: Software Development
- Unit 25: Web Application Development.

Employer involvement

This unit would benefit from employer involvement in the form of:

- guest speakers
- technical workshops involving staff from local organisations/businesses
- contribution of design/ideas to unit assignment/scenario/case study/project materials, including own organisation/business materials as exemplars where appropriate
- feedback from staff from local organisations/businesses on plans/designs/items developed
- opportunities for observation of organisational/business application during work experience
- support from local organisation/business staff as mentors.