Music, Technology, Innovation

Industry and Educational Perspectives

Edited by Carol Johnson and Andrew King

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Music, Technology, Innovation: Industry and Educational Perspectives draws upon cutting-edge practice in the use of technology from both a pedagogical and industry perspective. Situated within the latest research, this edited volume explores technological innovation from a musical perspective, examines current trends within the industry, and carefully considers them from an educational perspective.

Noted throughout history, music education is responsive to industry innovations. However, emerging technologies often begin with over-hyped promises before they move through various phases of development and are then repurposed for learning and teaching. Educators can adopt an innovation and develop a framework that is pedagogically sound and learner-centred. Based on these ideas, the authors together highlight industry innovations that have potential outcomes for engaging students in music learning within research-informed practices, build upon these ideas and identify proactive mechanisms for teaching music education, and work towards developing a framework for understanding these phenomena. The chapters address key topics including the ethics of technology, AI and music, online performance and teaching, gamification, big data, teaching audio production, acoustic ecology, and more. The examination of areas in contemporary innovation can further support the potential to empower teachers and students to understand the opportunities for teaching, sustainability, and growth in music education.

Carol Johnson (PhD) is Senior Lecturer in Music (Online Learning and Educational Technologies) at the Melbourne Conservatorium of Music, The University of Melbourne (Australia), and founded The Virtual School of Music in 2004.

Andrew King (PhD) is Professor in Music and Technology and was Head of the School of Arts (2017–2023) at the University of Hull, UK. He is currently Pro Vice Chancellor at the University of Hull (UK).

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To my family.
Angela King (1963–2024).

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Contributors

Fabio Antonacci (PhD) is Associate Professor at Politecnico di Milano, Milan. His research focuses on space-time processing of audio signals for both speaker and microphone arrays (source localization, acoustic scene analysis, rendering of spatial sound) and on modelling of acoustic propagation (visibility-based beam tracing). He is the author of more than 60 articles in proceedings of international conferences and on peer-reviewed journals.

Federico Avanzini (PhD) is currently a full professor with the computer science department, University of Milan. His research interests are in Sound and Music Computing (SMC) and mainly concern algorithms for sound synthesis and processing, 3D sound rendering, non-speech sound in human-computer interfaces, with applications to assistive technologies, virtual musical instruments, digital cultural heritage, and digital learning. He is a principal investigator for EU-, national-, and industry-funded projects, has authored 200+ publications on peer-reviewed international journals and conferences, and has chaired and served in several program and editorial committees. He has been Associate Editor for the international journal Acta Acustica (2014–2021), and is currently a member of the Editorial Board of Milano University Press. He has been President of the Italian Music Informatics Association (2018–2022) and is currently Conference Coordinator of the International SMC Board.

Leah Barclay (PhD) is a sound artist, designer and researcher (Senior Lecturer in Design, University of the Sunshine Coast, Australia) who works at the intersection of art, science and technology. Leah's research and creative work over the last decade has investigated innovative approaches to recording and disseminating the soundscapes of terrestrial and aquatic ecosystems to inform conservation, scientific research and public engagement. Her work explores ways we can use creativity, new technologies and emerging science to reconnect communities to the environment and inspire climate action.

Alberto Bernardini received a Bachor of Science degree in computer engineering from the University of Bologna, Italy, in 2012, a Master of Science degree (cum laude) in computer engineering, and a PhD degree (cum laude) in information engineering from Politecnico di Milano, Italy, in 2015 and 2019, respectively. He was a postdoctoral researcher with Politecnico di Milano, from 2019 to 2021, where he is currently an assistant professor with the Dipartimento di Elettronica, Informazione e Bioingegneria (DEIB). He has authored more than 40 publications in international journals and the proceedings of international conferences. His main research interests include audio signal processing, computational acoustics, and the modelling of nonlinear systems. He is the first author of two international patents. In 2019, he was a recipient of the Dimitris N. Chorafas

Award. He serves as Associate Editor for IEEE Transactions on Circuits and Systems I: Regular Papers and EURASIP Journal on Audio, Speech, and Music Processing.

James Cook joined the Reid School of Music in 2017, having previously been a university teacher in music at the University of Sheffield, a lecturer at Bangor University, a supervision tutor at the University of Cambridge, and an adjunct lecturer at the University of Nottingham. After completing his doctorate on fifteenth-century English mass cycles, supervised by Peter Wright and Philip Weller, James held a number of short-term post-doctoral fellowships followed by a Postdoctoral Fellowship of the Society for Renaissance Studies, during which he worked on the apparent decline in interest in English music in the later fifteenth century. He works mainly on early music and is especially interested in music of the fourteenth to sixteenth centuries – the period that falls neatly between the Middle Ages and the Renaissance. James is also interested in the representation of early music on stage and screen, be that the use of 'real' early music in multimedia productions, the imaginative re-scoring of historical dramas, or even the popular medievalism of the fantasy genre. He was co-founder of the REMOSS (Representations of Early Music on Stage and Screen) study group, which organises regular roundtables and conferences in this area.

Luca Comanducci received a Bachelor of Science degree in music information science from the University of Milan, Milan, Italy, in 2014, a Master of Science in computer science and engineering, and a Ph.D. degree in information technology from Politecnico di Milano, Milan, Italy, in 2018 and 2022, respectively. He is currently working as a post-doctoral researcher at Politecnico di Milano. His research interests include application of deep learning techniques to spatial audio problems, networked music performance, and automatic music generation.

Giovanni Cospito is Professor of Electroacoustic Music Composition, Coordinator of the Department of Music and New Technologies and the School of Electronic Music at the Conservatories of Music of Como and Milano. His research interests span the design and development of technologies for music education, music composition and tools for computer music and live electronics. His artistic activities include music productions and compositions for live electronics, electroacoustic and computer music, at the CSC of Padua, LIMB of Venice, GMVL in Lyon, AGON and LASDIM in Milano, EMS of Stockholm, IRCAM in Paris, TEMPO REALE at Florence, Bourges International Electroacoustic Music Festival, Teatro alla Scala and Milano Musica, the Poket Opera Company in Nürnberg, Dusseldorf and Dresda. He authored several multimedia productions and interactive performances in collaboration with DIST center of Genova, Brera Academy of Fine Arts in Milan, Total Opera in Venice, Carlo Felice Theater of Genoa, Theaters of New Music-Terra delle Gravine, Candiani Venice Center. He is a member of the CEDIM (Center for Electroacoustics and Digital Interactions), of the San Fedele Cultural Foundation-Milan, and he is a director of METAS Association for electroacoustic music, performing arts, soundscape installations and sound design projects.

Stefano Delle Monache (PhD) received his PhD in Science of Design in 2012 from Iuav University of Venice, Italy. His research interests focus on the study and design of behaviours mediated by sound, and span practices, methods and representations for sound-driven design, evaluation of sound in interaction, and interactive sound models for computational artefacts. He has been involved in several EU-funded research projects. He was Marie Skłodowska-Curie Research Fellow at Delft University of Technology, Faculty of

Industrial Design Engineering. His funded project, Participatory Designing with Sounds (PaDS, 2020–2022), contributed to extending knowledge on sound-driven design cognition, to assist designers and other actors to collaboratively create sound-driven designs. He is a member of the Critical Alarms Lab at TU Delft, and co-chair of the DRS Special Interest Group on Sound-Driven Design. Currently, he is a researcher at KTH, Division of Media Technology and Interaction Design, where he is involved in the Sound for Energy project.

Paul Doornbusch (PhD) is an academic, composer, sonologist, researcher and occasional performer who works largely with algorithmic composition systems for traditional instruments and electronics. Currently a guest professor at EPFL Switzerland, prior to that he spent a decade as Associate Dean of the Australian College of the Arts. His work is presented internationally in concerts throughout Europe and Australasia and ranges from compositions involving instruments and electronics to media works. Active as a scholar, Doornbusch has chapters in *The Oxford Handbook of Computer Music*, and he has written articles on algorithmic composition, computer music, mapping and virtual reality for publications worldwide. Doornbusch's book *The Music of CSIRAC* reports on the successful research project to reconstruct and document the music played by Australia's first computer, CSIRAC. This charts a new history of computer music, providing an accessible and cogent overview of a now-pervasive social and technical transformation in how music is mediated.

Nicolas Gold (PhD) is an associate professor in computer science at UCL. His research interests include source code analysis, research ethics, and computing education involving music and making, with particular emphasis on design aspects. He teaches professional practice and ethics in software engineering at UCL, is co-chair of the UCL Computer Science Research Ethics Committee, and has served on the UCL REC. He has contributed to ethics guidance and policy departmentally and in the wider institution. He has also co-authored papers on research ethics in mining software repositories, on the propagation of ethics values by publishing communities, and on post-research ethical duties for research involving affective software. Gold is currently the chair of the ethics committee for the New Interfaces for Musical Expression (NIME) international conference series, a contributing author to its ethics code, and he serves on the UK Research Integrity Office register of advisors. He is also an active musician.

Aristotelis Hadjakos (PhD) is Professor of Music Informatics at the Detmold University of Music. He heads the centre for Music and Film Informatics (CeMFI). His research area is musical human-machine interaction. His specific research interests are digital humanities, digital music scores and tangible music interfaces. He received his doctorate in computer science from the Technical University of Darmstadt and holds diplomas in piano pedagogy and computer science.

Phil Harding (PhD) started in the music industry aged 16 at London's **Marquee Studios** in 1973, where he got to work as an assistant engineer under the guidance of top producers on albums for artists such as **Elton John, Kiki Dee** and **Barry Blue**. As Phil's career progressed, a long list of credits began to accumulate, with artists as diverse as **The Clash, Killing Joke, Toyah, Amii Stewart** and **Matt Bianco** all taking advantage of Phil's fast-growing reputation as a top engineer. During the last decade, Phil has worked with **Lamont Dozier** in Los Angeles mixing **Cliff Richard**'s 'Soulicious' album and published the book **'PWL From The Factory Floor'** with an accompanying '**Phil Harding Club**

Mixes of the 80s' CD. In 2017, he completed a **PhD** doctorate in Music Production at Leeds Beckett University. https://www.philhardingmusic.com/books

Evangelos Himonides (PhD) is Professor of Technology, Education, and Music at UCL, where he leads a number of courses and supervises doctoral and post-doctoral research. He co-directs the International Music Education Research Centre (iMerc) and iMerc Press. He is co-founder of the Music-Education-Technology International Conference (MET), edits the Sempre conference series, is associate editor of *Frontiers in Psychology* and the *Journal of Music, Technology and Education*), and is past associate editor of *Logopedics Phoniatrics Vocology*. Evangelos has developed the free online technologies for Sounds of Intent (2003–2023), Inspire-Music, and the Online Afghan Rubab Tutor. He is fellow of the RSA and Chartered Fellow (FBCS CITP) of the British Computer Society. When time is available, Evangelos likes to handcraft musical instruments in order to raise funds for his charitable work.

Carol Johnson (PhD) is Senior Lecturer in Music (Online Learning and Educational Technology) at the Melbourne Conservatorium of Music in Melbourne, Australia. She is interested in supporting effective practices for teaching and learning in technology-enabled learning (TEL) environments, which include online and blended learning and immersive learning environments. Her main focus in research is on developing approaches for online music pedagogy and practise-based research for the effective adoption of educational technology in higher education music learning. Carol founded The Virtual School of Music in 2004, and her publications highlight evidenced-based teaching practices for teaching music online and provide innovative approaches for teaching online and using educational technology to support students. You can explore her research and publications here: https://carolj.net/

Andrew King (PhD) is Professor of Music and Technology at the University of Hull, UK. He was Head of the School of the Arts from 2017 until 2023 and is a Principal Fellow of the Higher Education Academy. He previously led the music subject area and has led major research projects funded by AHRC, the Arts Council and the Paul Hamlyn Foundation (via PRSF, Sound and Music) in the areas of online music education, psychological well-being and evaluating the impact of composer residencies. His current work examines access and participation in music education examining sustainable models of delivery.

Robert Laidlow (PhD) is a composer and researcher at the University of Oxford. His "gigantically imaginative" (BBC Radio 3) music is concerned with discovering and developing new forms of musical expression through the relationship between advanced technology and live performance. Laidlow's music exploring the intersection of classical music, artificial intelligence, and creativity includes 'Silicon' (2022) for the BBC Philharmonic, 'Post-Singularity Songs' (2023) for Stephanie Lamprea, and 'Tui' (2024) for International Contemporary Ensemble. He is currently a Fellow in Composition at Jesus College, Oxford University. From 2018–2022, he was the PRiSM PhD Researcher in Artificial Intelligence in association with the BBC Philharmonic.

Peter Lee has worked in the field of music education and technology for over 25 years and is one of the original authors of the Auralia and Musition educational music software packages (https://www.risingsoftware.com/). He has worked extensively in the USA, UK and Australia, consulting with teachers and students to better identify appropriate technology solutions for the modern music classroom. The Auralia Ear Training and Musition Theory

Training packages are widely acknowledged as leading software training aids in music classrooms and studios.

Kenny McAlpine (PhD) joined Melbourne Conservatorium of Music in February 2019 as Melbourne Enterprise Fellow in Interactive Composition. He is an award-winning composer, writer, broadcaster, musician, and technologist who has scored for theatre, film, and video games.

Brad Merrick (PhD) is Senior Lecturer in Music and the Arts in the Faculty of Education at the University of Melbourne. He undertakes research across the areas of music education, online learning, music technology, motivation, engagement, and teacher practice. Brad completed his PhD in Music Education at the University of New South Wales, and he has contributed to the *Oxford Handbook of Music Education* and the *Routledge Companion to Music, Technology and Education*. He has published widely and sits on the international and national editorial boards of various journals. Brad is past Chair of the Music in Schools and Teacher Education commission of ISME and is a passionate advocate for music education globally. He currently serves as a member of the ISME International Board and is the current President of the Australian and New Zealand Association for Research in Music Education (ANZARME).

Matthias Nowakowski is a programmer and researcher at the Center for Music and Film Informatics (CeMFI) in Detmold, Germany. He pursued an interdisciplinary education in philosophy, musicology, and media informatics at universities in Cologne and Düsseldorf. Throughout his studies, he was drawn to exploring the complexities of digital musical workflows, aiming to understand their inner workings and potential applications. He could prove this during his time at the Fraunhofer Institute for Digital Media Technology (IDMT) in Ilmenau where he completed his thesis, focusing on deep learning strategies in automatic transcription of electroacoustic music. Currently, he concentrates his research on improving the usability and user experience of music notation software.

Pamela D. Pike (PhD) is the Herndon Spillman Professor of Piano Pedagogy and Associate Dean for Research, Creative Activity and Community Engagement in the College of Music and Dramatic Arts at Louisiana State University. A graduate of the University of Western Ontario, Southern Illinois University, and the University of Oklahoma, Pike has extensive experience teaching piano to students of all ages, both privately and in group settings. In 2002, she founded the "Third-Age Piano Program" for senior citizens to study piano and make music in a group setting. The program has become a model for successful community engagement. She won the 2019 LSU Foundation Distinguished Teaching Award and has received various honors for her teaching in Arkansas and Louisiana. Pike is dedicated to helping pedagogy students develop skills necessary to become successful piano teachers. Graduates of the LSU piano pedagogy program are working in colleges and private studios throughout the United States, Asia, central and south America. In 2020, Pike was named a Yamaha Master Educator.

Ross Purves (PhD) is an associate professor of music education at the Institute of Education, University College London's Faculty of Education and Society. Here he contributes to master's, doctoral and secondary school teacher education programmes. A Senior Fellow of the Higher Education Academy, Ross was previously Deputy Programme Leader and Employability Champion for BA Education Studies at De Montfort University. Before entering higher education, Ross was a course manager for music and music technology

in a large 16–19 college and also served as music subject coordinator for a school-led consortium for initial teacher education. Ross's research interests embrace British music education history and the intersections between music, software engineering, design and making. An Associate Fellow of the UCL Centre for Climate Change and Sustainability Education, Ross has also recently begun researching the environmental impacts of music education.

Augusto Sarti (PhD) has a BS/MS and Ph.D. in electrical and electronics engineering from the University of Padua, Italy, in 1988 and 1993, respectively, with research in nonlinear communication systems. Sarti's research interests are in the area of digital signal processing with focus on space-time audio processing, sound analysis, synthesis and processing, image analysis, and 3D vision. His research contributions are in the area of sound synthesis (nonlinear wave digital filters); of space-time audio processing (plenacoustic processing, visibility-based interactive acoustic modeling, geometry-based acoustic scene reconstruction; soundfield rendering, etc.); nonlinear system theory (Volterra system inversion, Wave Digital circuit simulation); computer vision; image analysis and processing. He is currently focusing on geometric space-time audio processing methodologies; music information processing; spatial audio processing and more. https://sarti.faculty.polimi.it/Augusto_Sarti/CV_and_publications.html

Tim Summers (PhD) teaches and researches music at Royal Holloway University of London. His work concerns music in modern popular culture with a particular focus on music in video games. His publications include *Understanding Video Game Music* (2016), *The Legend of Zelda: Ocarina of Time – A Game Score Companion* (2021) and *The Queerness of Video Game Music* (2023), as well as co-editing the *Cambridge Companion to Video Game Music* and *The Journal of Sound and Music in Games*. Both his teaching and research are informed by his experiences of secondary school music teaching. His research seeks to understand the musical experiences and educations that mass media provide for the huge audiences they address.

Chester Thompson is known as the "drummer's drummer". Playing drums in clubs by the age of 13, Thompson's first drum audition, which led to his time with Frank Zappa and the Mothers, was a foreshadow of his exceptional performance and studio career. Thompson is a Grammy award-winning performer. He has performed and/or recorded with Ben E., King (1969), Jack McDuff, Frank Zappa and the Mothers (1973–1975), Weather Report (1975), Genesis (1977 through 1992), Phil Collins (various tours across 1999 to 2007), Santana (1984), Kirk Whalum and many other Grammy award musicians. His expertise in multiple music genres (i.e., Rock, Jazz, Pop, Progressive Rock, and Gospel) position him as an integral part of music history since the 1970s – and he continues to be influential on today's drummers. Whether it is a stadium performance, or a studio recording, his remarkable drumming is second-to-none. Labelled a "drummer's drummer" from his time as drummer with Genesis, Thompson taught applied drum lessons for 20 years at Belmont University (Nashville, USA), and is also a composer and producer. Thompson's accolades include a 2018 Grammy Award for performing on TajMo and 2008 Sabian Lifetime Achievement Award and was inducted into the *Rock and Roll Hall of Fame* in 2010 as a member of the band Genesis. His most recent CD is *Wake-Up Call* (2024) with Robert "Pewee" Hill, Michiko Hill and with special guest appearance by Akil Thompson (guitar). See www.chesterthompson.com

Jason Torrens is a musician, academic, technology expert and audio engineer who works in Higher Education and various musical endeavours. Currently the Senior Program Leader of Entertainment and the Head of Audio Production at Collarts in Melbourne, Australia, Jason has been at the forefront of hybrid and remote learning amongst practical disciplines like Audio Engineering, Music and Music Production. Being a drummer and teacher for over 35 years as well as working in various recording studios and live production environments, Jason has blended this experience of creativity and technology to create ground-breaking educational techniques for inclusive and remote learning, specifically for Audio Production. With qualifications in Music, Audio Production and Higher Education, Jason is currently completing a masters in higher education degree in technology for learning at the University of Wollongong.

George Waddell (PhD) is Performance Research and Innovation Fellow at the Royal College of Music. He is also Area Leader in Performance Science for the BMus programme and an honorary Research Associate in the Faculty of Medicine at Imperial College London. His research focusses on optimising how performers learn and are evaluated, including the development of new technologies to do so. He oversees a range of BMus RCM modules ensuring that students benefit from the latest research, scientific knowledge, and technology in their training. George also works closely with experts across fields to examine parallels in performance practice and to develop and deliver bespoke performance training to a range of professionals. He is a co-author of the research methods textbook *Performing Music Research*, holds a PhD in Performance Science from the RCM, and completed his BMus and MMus in piano performance at Brandon University (Canada) while studying psychology.

Tim Wilson is a music educator, jazz saxophonist and co-author of Auralia & Musition ear training and theory programs. He has taught at Melbourne University, Victorian College of the Arts, Monash University and conducted workshops around the world. His performance credits include Ray Charles, Natalie Cole, Tony Bennett, Melbourne Symphony Orchestra, The Australian Art Orchestra, Robbie Williams, Lalah Hathaway, Michael Buble, and James Morrison. Tim was a finalist at the World Saxophone Competition (BBC Jazz Festival) and the National Jazz Awards. He has released 12 solo albums and was awarded the 2017 Australian Jazz Bell Award for 'Best Australian Instrumental Jazz Album' for his live duo album 'Consider This' with acclaimed pianist Andrea Keller.

Aaron Williamon is Professor of Performance Science at the Royal College of Music (RCM) where he directs the Centre for Performance Science (CPS), a partnership of the RCM and Imperial College London. His research focuses on skilled performance and applied scientific initiatives that inform music learning and teaching, as well as the impact of music and the arts on society. Aaron is the founder of the International Symposium on Performance Science, founding chief editor of Performance Science (a *Frontiers* journal), and the founding chair of Healthy Conservatoires, an international network constituted in 2015 to support health literacy and wellbeing among student and professional performing artists. He is a fellow of the Royal Society of Arts (FRSA) and the UK's higher education academy, AdvanceHE (FHEA), and in 2008, he was elected an Honorary Member of the Royal College of Music (HonRCM).

Introduction

Carol Johnson and Andrew King

By editors

Music, Technology, Innovation draws upon cutting-edge practice in the use of technology from both a pedagogical and industrial perspective. Situated within the latest research, this edited volume explores technological innovation from a musical perspective, examines current trends within the industry, and carefully considers them from an educational perspective.

Noted throughout history, music education can be responsive to industry innovations. However, emerging technologies often begin with over-hyped promises before they move through various phases of development and then are repurposed for learning and teaching. Educators can adopt an innovation and develop a framework that is pedagogically sound and learner-centred. Based on these ideas, the authors highlight industry innovations that have potential outcomes for engaging students in music learning within research-informed practices, build upon these ideas and identify proactive mechanisms for teaching music education, and work towards developing a framework for understanding these phenomena. The examination of areas in contemporary innovation can further support the potential to empower teachers and students to understand the opportunities for teaching, sustainability, and growth in music education.

The focus of the book is about exploring how education music, technology, and innovation in teaching, curriculum, and the creativities surround music creation and performance. There are three parts within the volume: Technology, Performance, and Context; Perspectives and Design for Teaching; and Current Issues. Each part is introduced with a prequel narrative from an industry perspective and followed by standard chapters (i.e., literature review followed by research study with discussion and implications). The themes reflect the key topics for music educators and innovators in higher education as they look to resolve known challenges when adopting new technologies into music teaching, as well as look to the potential for technology to assist in furthering music learning for our next generation of music students.

The changing landscape of pedagogical practice as a result of disruptive technologies will continue its impact upon society and go beyond discipline specificity. Consequently, there are many innovation influences that are impacting the field. Influential factors include pedagogy, audio technologies, key stakeholders, and locations. To effectively understand and surface how music education can better utilize innovation, the book has been addressed thematically. By highlighting research-informed practices and studies of *Music, Technology, Innovation*, a greater understanding of the challenges and opportunities within music education can be reached.

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In response to revealing the key considerations within the educational technology domain, the book will lead the reader through the narrative provided by industry experts as well as academic researchers. While this combination of authorship is not often presented side by side, readers are encouraged to consider the different viewpoints arising from the contexts of industry and academe.

Chapter Overviews

This volume opens with a vignette from Chester Thompson, an industry performer with many years of experience on a global stage. It was important to the volume to hear the voices of professionals in this work, since it highlights their perspectives and the ways they have adapted to technology throughout their careers. Using recording technology to learn tunes was something Jazz musicians did from the advent of the gramophone and it continued through the decades, which Green captured from an educational perspective in *How Popular Musicians Learn*. Also, the shift between live performance and studio capture and the impact technological development has on practice and the overall experience in performance venues for musicians and listeners. There are also some important recommendations put forward for young musicians, highlighting the need to balance digital know-how with musical skills – something that also came across from the producer interviews in Chapter 9 of this volume. This performer perspective is an important voice to this section as we go on to consider playing online, performance training, virtual festivals, and finally, how educators go about designing a framework for student studies.

The first chapter begins with a consideration of *technology, performance, and context* with an opening discussion of 'Synchronous Online Ensemble Performance'. This has long been the challenge of online collaboration, since issues around synchronicity can be problematic with latency related to network speeds. Monache, Comanducci, Cospito, Sarti, and Avanzini discuss what is meant by Networked Music Performances (NMP) and report on cutting-edge research from the *Intermusic* project in this area. This chapter considers the nature of ensemble music playing and how it can apply in an online context. These developments are at the forefront of online collaborative musicianship and share some of the same issues discussed by King in Chapter 9 when considering recording studio practice in online environments; several tools have emerged to facilitate online collaboration in real-time. To compliment the considerations for performers and the technical aspects in Chapter 1, we then move on to 'Performing in the Virtual Auditorium'. The recent global pandemic that started in 2020 accelerated the need for other ways for people to engage in music that was performed rather than recorded. McAlpine and Cook shine a light on virtual festivals and the shift from physical to virtual performance and what this entails for our understanding of music practice, stagecraft, and repertoire in Chapter 2. There are also issues concerning engagement with the types of technology, audience, and musician needs, as well as the commercial aspects of the approach.

Beyond the use of the technology for virtual collaboration and the potential for immersive music experiences, there are also the performer's concerns to consider. In Chapter 3, Waddell and Williamon draw attention to self-regulated learning for the development of musical skills in performance. By using technology-enhanced practice methods, learners' interactions can be measured and instant feedback given on their practice sessions. It is the view of the authors that this does not seek to replace effective teaching, merely to improve the practice habits of students and using technology to plug the gap between formal supervised lessons and self-regulated practice. The context for all learning by music students of

course needs a framework, which is provided by Johnson in Chapter 4 of this volume. This report of a substantial 12-month study for 'Developing an online music orientation using the framework for teaching music online' provides unique insights to online learning in one of the world's leading conservatoriums. Using a four-stage design process Johnson investigates digital literacy and students' self-regulation in an HE environment. The development of digital literacy is often overlooked, and educators often make assumptions about student pre-requisite skills with digital technology that are not yet embedded when arriving at a conservatorium. It is therefore necessary to consider what these are, take an overview of the design process, and determine what the potential outcomes for the curriculum could be. This first part of the volume has therefore examined some of the design and process challenges and considerations for musicians collaborating in ensembles online; it has addressed technology's potential to provide a practice aid to get the performers onto the stage while also considering the virtual aspects of immersive music festivals. How this is all framed in terms of online delivery, therefore the environment, people, process, and design of learning, is highlighted through a relevant study in an international music school.

The second part of our volume, *Perspectives for Teaching*, begins with the voices of Peter Lee and Tim Wilson working from the position of software development industry experts to support musical development. The duo has many years of experience specifically developing aural and music theory software packages. They discuss shifts in digital computing and how this enabled a different learning environment from the days when students used to listen to cassette tapes for training. What is also emphasized is the collaborative nature of the design process and the need for clear workflow in the various stages, with input from key stakeholders along the way. Their approach relates to what Waddell and Williamon discuss in Chapter 3, in that it recognizes technology as a tool to bridge the gap between more formal musical lessons and therefore act as a practice aid.

How music students engage in online learning requires in-depth study, and this is something Pike demonstrates in Chapter 5, 'Instrumental Learning Online', drawing experience from two studies that examine common findings in synchronous online education and a collective case study of three piano teachers that highlights best practice, how teachers prepare for online lessons, and key lessons for teachers wanting to engage in online music lessons. This research is important since even prior to the global pandemic, there have been issues with students gaining access to music education in remote communities (for example, see King et al., 2019a, 2019b).

Chapter 6 by Merrick provides a broader view of 'Informed Teaching and Practice in Music Education' from a global perspective. This contribution explores teaching with technology, social media, and working with young musicians in Australia. Importance is placed upon curriculum development, emerging technology, and its implications and connecting music technologies to student learning through ICT. This work also draws attention to the need to consider Johnson's approach in Chapter 4 that requires educators to consider the learning environment and structures to support students.

The delivery of traditional teaching and how this can be supported via technology has been an important cornerstone of music academic research. However, emerging fields of study such as game design give opportunities for music educators to think beyond our borders and into other disciplines. Chapter 7, 'Music, Play, Games and Education' by Summers is one such approach that uses music and play through video games and how this may inflect upon teaching. Scaffolding and the role of music interfaces is considered alongside interactivity and music dialogue and cultural participation in informal learning for musical and technical expertise. There is also a suggested lesson plan for teachers wanting to follow

this approach in their own practice. In Chapter 8, Sarti, Antonacci and Bernardini explore how music-makers reach beyond the outcomes of previously achieved acoustical properties of musical instruments to harness technology as an aid in further tapping into the listener's emotional state as elicited by their music. Describing the dramatic historical shifts of music technology on the listener's experience (e.g., the development of digital reverberation rather than sole dependence on environmental acoustics; change of listener consumption habits from dependence on a physical store to retrieve music to retrieval automation through algorithmic search of music content metadata), the authors identify how technology can be used to influence our musical perceptions. Implications from this research has particular significance in the application of music in immersive technologies and how adjustments of spatial acoustics as a form of expressivity can further influence the listener and their sense of environmental space.

The 'State and practice of music education software design' chapter aligns with the industry voices we heard at the start of this section. Nowakowski and Hadjakos stress the necessity of understanding the historical perspective in terms of new developments and the importance for music education. This approach provides a helpful context for music education software developers and highlights key empirical papers in the domain. Voices from industry are again highlighted in Chapter 10 in 'Audio Education: Perspectives from Industry'. This interview-based study contains insights into professional projects, technology, and collaboration online in the recording industry, tools, and workflow, as well as recent developments in the field of Artificial Education. For many music production students, the industry professionals represent their goal in terms of a career path. However, there is often a dichotomy between experienced audio professionals utilizing analogue workflow methods in a digital domain with students who are approaching from the standpoint of only ever engaging in digital approaches. This chapter shares some insights into the domain of pedagogical recording studio practice whist also setting out implications for the curriculum. Staying with audio production teaching, Chapter 11, 'Strategies for Teaching Audio Production Online', is put forward by Torrens and Doornbusch. This autoethnographically informed approach in Australia examines the challenges and opportunities of a group of staff members teaching audio production online. This is achieved by considering not only the curriculum but also the skill of the instructor in delivering in this way.

The final part of this edited volume, Environments and People, begins with an authoritative voice not only from industry but also academia. Dr. Phil Harding achieved a great deal of commercial success as an audio engineer and producer and has also entered the world of academia, writing extensively on the music industry. In this vignette, Harding gives perspectives of collaborating with people in the professional studio, the technological developments during their career, as well as the commercial aspects of the music industry alongside the environment for audio professionals. There are some important insights for educators and students about sustaining a career in the industry over several decades.

People are an important part of any conversation about music, technology, and education. Gold and Purves address the issue of ethical choices in the shifting landscape of music education as a result of technological development. AI in music education, as discussed in several of the chapters, will become a more dominant force within industry practice and education over the next decade. Important questions are raised here about musical innovation and ethical risks concerning making music *easier*. These include an awareness of issues for educators, sustainability of technological development, and cultural inclusivity. This environment we now find ourselves in requires careful navigation for the future of music. Environments are an important part of our next chapter, 'Acoustic Ecology: exploring the role

of sound and technology in understanding climate change'. Barclay shares an important narrative the possibilities of this domain in 'addressing the major challenges of environmental conservation and ecological engagement'. The interdisciplinary approach of many composers, sound artists, and researchers is drawn out in this contribution, and the possibilities to use the arts to engage communities and industry are highlighted in this important work.

Generative AI and music then become the specific focus of Chapter 14, after emerging in various guises during the volume. Laidlow explores this topic through the lens of AI and musical creativity by using four case studies of musical compositions by the author. The approaches used include symbolic-generative machine learning and audio-generative machine learning in their practice, and they share unique insights into this new world. There is a lot for music educators to learn from this chapter, especially considering potential future approaches to composition. The final chapter of this edited volume innovation highlights a collaboration between Himonides, Purves, and Gold. Together, they explore literature on using LEGO to learn coding and music, but also work at the intersection of construction, coding/electronics, and music. Following the rehearsal of the evidence-based experiences are shared findings presented from a short-scale, exploratory funded case-study with participatory research components. Pupils engaged in creative exploration of instrument making, collaborative project management, musical performance, and rehearsal of instrument making principles within both the acoustic and digital domains.

We close the book with our 'Final Considerations' for music, technology, and innovation in music education. Our current period in history places us with many potential creative opportunities for the use and development of music technology in music education. Bringing together the threads of innovation and technology across the book, we provide some commentary on the potential growth for technology in the music classroom and the enlargement of the music classroom environment with immersive technologies and their potential contributions.

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Part 1

Technology, Performance and Context

Industry Perspective

Chester Thompson

The first major artist I played with was Frank Zappa back in the 1970s. From there I went into a band called Weather Report, did quite a lot of freelancing recording after that, and then ended up in a band called Genesis, which led to also doing Phil Collins' solo tours as well. Most of the need for technology happened during the Genesis period. Being a drummer throughout the 1970s, I've experienced the emergence of new music technologies that allowed for the development of many hallmarks in musical styles. Across the years of my music career, technology became more advanced and integrated for those of us recording in the music studio and playing live music performances. Innovation in technology has allowed many of us musicians to advance many aspects of our performances – and the listening experience of our audiences.

I started my performance career back in the '60s – 1962, to be exact. I started out playing in local bands with cover songs, and then eventually writing songs with other bands. Basically, I played just purely drum set. None of what we use today for music technology really existed when I started playing. Back then, you just played your instrument. Even overdubs in the recording studio were pretty new at that point. We tracked almost everything live in the studio. (It wasn't until a few years later that a lot of the professional studios became able to overdub.) For the most part, recording music meant you played it down until you got it right – and that was it. Even in my own drum performances, there wasn't really any sort of trickery or anything other than just playing the songs down.

In my practice time, I learned cover tunes by listening to recordings. We bought singles, the actual 45 RPM singles. If it was a complicated part, you would play the recording at 33 RPM (revolutions per minute). Even though it changed the pitch, it allowed you to hear the actual parts that were being played. You just had to put them back in the right key.

From 1973 to 1975, I played with Frank Zappa. Zappa was ahead of his time both musically and technologically. I remember when I played with him that he had a big old eight-track recorder – a big reel-to-reel. It was like one inch or something – I think he eventually maybe got into a 16-track recorder – but he would actually take this thing on the road. He recorded every rehearsal, every concert. He recorded everything with every band – every rehearsal, every concert. He built his famous vault under his driveway at his home, and all of those tapes lived there. Sometimes in rehearsal, he would use a recording to play back a section if it wasn't clear what needed to be done. We used the big one-inch eight-track machine in rehearsal to listen to the parts, and then cleaned up whatever needed to be cleaned up for performances.

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I was with the band Genesis from 1976 until 1992. When I started touring with Genesis, we just played everything straight down. At first, it was all prog rock (progressive rock) and every song had different movements. In one case, one song was around 19 minutes – a kind of hallmark of that style. As they got into more pop material, the length of songs changed – to both shorter and more accessible songs.

Phil Collins (Genesis' lead singer and drummer) incorporated drum machines when they first came out. He created percussive loops that would go along with the songs. This meant that when I played, I had to have that loop playing in my monitors to play in sync with the song. It also meant that monitors had to be loud enough for me to be able to play along with the loop and hear the rest of the band in the monitors. That was probably the beginning of performing with live drum loops. There were other songs, too, like "Land of Confusion" (from "Invisible Touch," 1986), that required me to play with a loop originating from a synthesized bass.

There were a lot of "firsts" with this band from a music technology point of view. Playing live, from beginning to end, in a song with something that wasn't just a drum machine loop was another first. From a musical viewpoint, the keyboard player actually played live along with the loop. Yet, it was such a distinct synthesized sound that we used it almost as sort of a click (i.e., electronic metronome). The line was doubled live, as well as coming through the system.

Moving from the Studio to Live Performance

The technological innovation of drum sounds can be heard on "In the Air Tonight" (from "Face Value," 1981). This has probably become the best-known drum fill. It was really, really heavily processed in the studio; it was two or three kinds of compression as well as reverbs and gated reverb, in fact. They created that sound and the sound of the snare. All the drum sounds were very affected.

Moving this song to its live concert form, we initially tried having the sound engineer manipulate it live while he was also mixing the rest of the band. It was understandably a little overwhelming for the sound engineer. So, we decided to sample those drum sounds directly from the multi-track tape. At that time, I had a really good sampler, made by the German company Dynacord.

There was a lot to be done prior to the live concert performance of this song and others to get the Genesis sound from the 1980s. To prepare for the live performances, I went after hours into a studio in England near where we rehearsed and sampled the snare drum parts and then loaded it into the sampler. I triggered these parts from my snare drum – it was a little tricky adjusting the timing live.

Overall, getting everything in sync took a little doing. The sampling proved to be the simpler way to make the Genesis sound in a live situation – otherwise, you would likely have required two different people trying to mix sound while covering all the sampling that needed to happen. Time was taken in the studio to play with sounds and effects and all of that. For example, the natural snare was basically blended with the sound of the sampled snare in the live concerts. Eventually, two or three tom sounds were triggered from the acoustic drums as well. Other effects developed in the studio used cymbals as well. For example, they recorded a cymbal sound (i.e., basically a cymbal hit) and then reversed the actual sound wave. So, instead of a cymbal sound growing to a crescendo, it started with the louder part first. It sounded like something was sucked into nothing.

The tricky part about this cymbal sample was that it wasn't triggered in time with the song. I had to figure out when to trigger the sample to start it so it ended at the proper time. From a playing perspective, it wasn't about the timing of hitting it but ending it. I had to start it so that it actually ended on the right beat. For example, if the song is in 4/4 with a 16th beat feel where I'm playing a broken-up 16th pattern on the hi hat and I wanted the sample to end on beat one, I would probably hit it on third 16th note of beat two of the prior measure. It was about thinking about the sample ending, not its beginning. It was always pretty wacky because it was definitely not playing within the groove. The outcome sounded like part of the groove, but initiating the sample trigger required careful musical calculation.

Together these, and other kinds of technology, made the Genesis sound that everyone expected from the recordings.

Innovations in technology for performance went beyond the creation of sample sounds that we used in live concerts. Early on, we used monitor wedges on stage, but this meant I had a lot of sound coming from both my drums and the wedges. One of the main reasons we moved to in-ear monitors was because the Front of House (FOH) engineers and members of the group preferred it as it meant a lot less stage volume.

When the technology of in-ear monitors came out, the initial appeal was that it would quiet down all the stage monitors and eliminate a lot of the bleed from those monitors going into the instrument mics. The plus side was that you could hear a much cleaner version without all the stage ambience going on around you. The negative side was that there was a bit of a coldness when using in-ear monitors – it isolated you from hearing the audience sound. However, for it to be effective for drums, the monitors had to totally seal out that outside noise. This made in-ear monitors quite practical. They block out about 18 decibels of sound from the stage, yet they feed in a really good blend as far as the track and the drums and whatever else is needed. In-ear monitor technology was also directly connected to being able to accurately play along with the loops and affected sounds. Each band member could now have a separate monitor mix, feed in specific loops, and each of us could hear ourselves at an individual level. At the time, it was quite revolutionary for live music performance.

When we were using analog, there was always a separate sound console, or board, for mixing stage monitors. It meant a sound engineer was on stage to mix the stage monitors, in addition to an engineer for FOH. They both fed sound signals back and forth to each other while the band played. One big challenge was that the sound levels had to be adjusted for each different stadium. When automated sound boards came out, this allowed for pre-sets to be created at rehearsals the day before and then recalled for the next show. The scene pre-sets were about 80 to 90 percent ready before the next show started. There would still be some tweaking to get it exactly where you wanted it for the live show, but the automation of pre-set levels saved a lot of time for everyone.

Because everything's digital these days, consoles can recall the exact sound you had before. But in those early days, the combination of the automated boards and the in-ear monitors made sound checks a lot more efficient than they had been without the automation. For the most part, what could easily take an hour, hour and a half, could be done in under an hour, and much more efficiently between the automated boards and the in-ear monitors.

From a signal perspective, we still had analog sound coming into the microphones to keep the quality of sound fidelity for a live show. The analog sound was then converted to digital at the sound board. Within the board, the digital signal was then converted back to analog

when it was sent to the speakers. Over several years, the quality of components got better and better, which meant the sound was better and better.

Technology Innovations for Performance Venues

It's not unusual to perform in stadiums made of concrete – they are often built for sports rather than concerts. Adoption of technology has helped make the stadium concerts better fidelity. One of the challenges of playing in a large stadium is that sound takes time to travel to the back of the stadium. For example, I would hit the snare drum on stage but there might be a quarter of a second, or half a second, delay before I heard that beat coming back to me. This often happened acoustically, without amplification. This can get really challenging for live performances because once you put music into the sound system and out to the stadium, you have the delay multiplied.

Technology and the skills of the sound engineers obviously had to grow with the size of venues and the sound required by particular bands. Because the sound is being reflected off the stadium's back wall, there would be delay towers near the back, so people heard what they were supposed to hear coming from the stage. The sound from the delay tower would have to be a little louder than the "slap back" coming off the back wall. The acoustic challenges also meant that the speakers at midway and back of the stadium required set up for synchronicity. These speakers were set with a specific time delay to match the sound coming from the stage. This wasn't something that you would think about as a concert-goer, but you would hear the sound delay if the speakers were not set for synchronicity. Technology had to be used to create a quality sound experience for the audience at those large venues.

Recommendations for Musicians Starting Out

When I learned to play, songs were very imperfect, which made them very "warm" as opposed to being purely "clean." A clean sound can be perceived as cold and sterile. But you need to be able to play both in this generation. The pretty serious players still look to Jazz to really learn how to hone their musical craft.

For musicians starting out today, they still have to learn to play their instrument well. I would recommend practicing with a metronome. A lot. Many shows today, especially the big-name pop groups, have the whole band playing along to loops and various bits that have already been recorded. Many of the pop singers are incredible dancers, and it's almost impossible to be dancing with that amount of energy and have a clear vocal at the same time. It might mean that the audience is actually hearing a vocal track and the person is singing along with a track. A performance scenario like this requires the band to be locked in with that vocal track. As a musician, you need to have solid time. A metronome can help develop and solidify that skill. You will spend quite a bit of your career having to lock in and be in sync with automated music and cues. The accuracy required is at a much higher level.

From a live performance perspective, companies like Ableton were well-prepared for the use of tracks in live performance. Their software Live can be recorded in sections, as opposed to a linear recording. You can record the verse separately, or the chorus separately, and either of those sections could be triggered at any time. This means that if something gets out of sync, the person running the software can hit a button and the band could catch up to the music. With everyone hearing the band through in-ear monitors, you hear the sync update and know where to go musically. Being able to shift and play any section means you

have to not only know your instrument, but the details of the music itself. Learn to listen what to others are playing and be able to adapt your playing to what is needed.

There is a new breed of drummer out there today. They use loops and recordings to create incredible performances in multiple time signatures. I toured with Marco Minnemann, who literally could play six time signatures at once. He did this by creating an ongoing pattern between sounds – simultaneously playing with four limbs playing individual time signatures and creating the other parts with other sounds, such as the bell of the cymbal, etc. He developed the skills to play like this from practicing with a metronome. Playing with a metronome can help develop an amazing sense of time and consistency which is a requirement for musicians today.

When we look at music education and technology, I don't think we can separate them anymore. Schools and higher education programs have music technology subjects which highlight the importance of musicians needing to be both fluent on their instrument and with technology. Musicians need to know how to use basic music software programs to record digital and analog (e.g., ProTools software); it opens up possibilities in ways that never existed before.

But creativity still wins out over anything. And that, combined with technology to create things that probably weren't possible before . . . it's just a wonderful horizon.