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Technical Support and Professional Development: Using Remote Desktops to Address Bottlenecks in Music Technology

Abstract

This paper presents research findings about the use of remote desktop applications to teach music sequencing software. It highlights the successes, shortcomings and interactive issues encountered during a pilot project with a theoretical focus on a specific interactive bottleneck. The paper proposes a new delivery and partnership model to widen this bottleneck, which currently hinders interactions between the technical support, education and professional development communities in music technology.

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Introduction

There is a current focus in music technology on networking between spatially disparate locales, digital tutorials and real-time, intuitive sequencing. These worthwhile innovations fail to acknowledge that the information and knowledge experts possess is not meeting the growing demands of aspiring music technologists. This paper outlines a professional development model that will widen the flow of knowledge and information between educators, students and music technology experts. By treating music production as a socialising medium (DeNora, 2003), this model increases the frequency and quality of interactive exchanges to provide more personalised learning and work experiences.

The paper presents a new research topic for music technologists: the education and commercial facets of a specific knowledge and information bottleneck. It reports on the first music technology pilot in Australia to use the 3G mobile network to teach sequencing software using remote desktop applications. The pilot project spread one educator's technical and teaching skills across a network of learning centres in Queensland, Australia. This paper outlines the pilot project, shares its research findings and demonstrates a range of practical applications that address distinct interactive issues within music technology communities.

Context

The transmission and communication of music related skills are critical to the music industry, education institutions and anyone developing their musical interactions. For musicians, rehearsal via videoconferencing and online solutions has proved expensive, unfeasibly slow, or limited by interface considerations (Lancaster, 2006). To date, remote communication of musical expertise in Australia has neglected the fields of performance and production. This is because of preconceived (and untested) perceptions that such interactions do not meet standards of teaching and learning quality (Arthurs, 2008). As a result, remote locations have denied aspiring musicians access to new and advanced opportunities for music making, learning, and mentoring across local, regional, and international borders (Lancaster, 2006).

International research about playing musical instruments online does exist. In the USA, specialist schools and professional musicians use synchronous and asynchronous technology in musical activities (Brand, 2004; Callinan, 2000). These applications confine teaching and mentoring to individual and master class settings, intended to supplement rather than replace normal learning processes. In Canada, McGill University has tested a successful but expensive format of synchronous performance across remote locations, employing technology developed for medical applications (McGill, 2002). Other cases at Oklahoma University and the University of Northern Iowa demonstrate the use of videoconferencing in synchronous performance across locations (Lancaster, 2006). More recently, the London Symphony Orchestra has also undertaken trials along these lines.

In Australia, there have been only a few attempts to use synchronous and asynchronous media for music education, and to date, only one demonstration of synchronous mediated learning. The VideoLink program, established at Sydney Conservatorium by Mark Walton in 2001, allowed teachers in Sydney to provide individual instrumental instruction via videoconference to students in remote
locations (Callinan, 2000). Although the cost was low, the institution has not continued the project.

Developments in high-speed broadband networks now deliver a more accurate representation of both graphics and audio and failure of the technology is less common. Callinan (2000) found that remote interactions with a teacher in Sydney motivated the students involved (p. 151). Further, Walton extended the benefit of the project by involving senior students from the Conservatorium. As graduates, now working in regional centres, they form a new generation of teachers accustomed to the medium and are extending its use in some remote locations.

These projects underline the fact that relevant research in this field is sparse. Current remote projects concentrate on playing musical instruments, not music production. Essentially, recent projects transposed the traditional face-to-face, teacher-student model to a mediated one. These remote music interactions indicate a need for enhanced communication between professional and student musicians, their colleagues, instructors and mentors in remote situations. The context suggests the ability to interact, despite remoteness, is essential if musicians are to enjoy access and equity as students and professionals. This paper addresses this gap in the research, theorises pilot data and proposes a model that capitalises on the mobility and capacity of all music technologists.

The bottleneck concept allows us to focus on the education and commercial sectors as part of an integrated system for sharing knowledge and information. Throughout the paper the bottleneck concept refers to the flow of knowledge and information (see Castells, 1999, for a detailed exposition of the distinction between the two). This research addresses all those agents who want to learn and share knowledge and/or information related to music technologies. They include

- a student of a structured course of study
- an auto-didactic
- an educator who requires professional development
- a technical expert (Research, Manufacture, Software, Retailer, Private Tutor)
- an individual or group (open source, community workers, artists)

These agents benefit from an increased flow of knowledge and/or information related to music technology. This paper treats all members of this group as users and producers of music technology as it aims to improve the support they provide and receive.

Drawing on recent research into systemic inadequacies of professional development policy at state level (Luke & McArdle, 2009), the paper presents a many-sided solution to these interactive problems. It demonstrates how technical support and professional development bottlenecks currently hinder the interactions between, and amongst, user and producers of music technology.

The paper is organised into three sections. The first presents research findings from the pilot program. The second section builds on these findings to present the specific case of a bottleneck in the field of music technology. The third proposes a new
delivery and partnership model for professional development with longitudinal research, teaching and learning outcomes.

Section 1: Using remote desktop applications to teach music sequencing

Between February 2007 and December 2008, a music technologist used remote desktop applications to teach music sequencing software across the state of Queensland, Australia. This educator has 15 years experience in the UK and Australia, providing formal qualifications, private tutoring and workshops to adults and young people across education, non-profit and commercial agencies. The pilot took place across a network of flexi-schools, which provide a re-engagement pathway for young people who, for numerous reasons, have disconnected from mainstream schooling (Brader, 2004). As the network employed this music technologist to deliver courses across schools and outreach projects (totalling 400+ full-time students, some separated by more than a thousand kilometres), the pilot project encountered a familiar logistical problem. One school site boasted an industry standard recording studio facility. The other sites had standard PCs and internet connections, no staff with music technology expertise and high student demand for such skills. The music technologist visited each site and installed one PC with music sequencing software, a remote desktop application, a MIDI controller, microphone, speakers, a royalty free sample library containing 50 gigabytes of sounds, and digital tutorials. The trial aimed to train students and teachers in music sequencing through a mixture of synchronous/asynchronous delivery and peer-to-peer education. The pilot started remote desktop teaching at the site most geographically separated from the others and then rolled out the revised project to less remote sites, as and when time allowed.

The music technologist prepared a two-day visit to the first site to install hard/software, introducing the pilot project to students and staff. To provide a flexible delivery structure the first day attended to the technical details and discussions with the on-site teacher. Day two involved meeting and greeting interested students, presenting the soft/hardware setup and its capabilities, and exploring how the remote desktop would function.

This preliminary face-to-face visit allowed students and staff to attend a real-time demonstration of the sequencing software's capabilities (creating multiple musical styles, mixing Mp3s and burning CDs). The music technologist clearly articulated and clarified the course structure as a weekly, one-hour remote desktop lesson supported via real-time teleconference. In addition, he encouraged students towards a self-directed, off-line component of two hours per week, allowing for experimentation with the sample library and tutorials, arranging and recording. He also informed students and staff about how the exchanges would occur between the expert, the on-site teacher and the students. He expected the students would learn quickly and provide peer-to-peer tutelage by sharing knowledge and/or information with new students. Peer-to-peer tutoring, it was explained to participants, has numerous, overlapping learning benefits: "teaching someone else what you can do helps your own learning and that of others". Peer-to-peer tutoring could also be effective as a practical response to the fact that more students wanted to learn than could be accommodated.

The formative role music plays in shaping individuals and societies is clearly demonstrable through this peer-to-peer mode of delivery. The phrase peer-to-peer is
not used here in the file sharing sense, but rather to refer to the way the course was structured to share expert knowledge and information about the sequencing software, processes, hard/software and digital resources. Students readily shared the knowledge and/or information they acquired with their peers and these exchanges shaped them as users and producers of music technology (See Latukefu, 2009 for a similar peer learning approach to vocal training). These exchanges also echo Blumer’s (1969) seminal work, in the sense that students interpreted and modified the meanings of things. They modified the meaning of the sequencing software and hardware to suit their own musical tastes. As a result of perceived benefits from participation, most students shared these modified understandings with their peers.

Successes - Four students participated in the first cohort, with two showing real potential to become peer educators (McWilliam, 2007; Topping, 1998, 2003). After a few weeks, students and staff were using their newly acquired knowledge to interact with each other and the hard/software to produce original music. The synchronous remote desktop lessons, complemented by asynchronous tutorials and the remote desktop render facility, which recorded every session for replay, was working well. By the end of the first term, two students and the on-site teacher had produced numerous music recordings and had successfully tutored several new students.

The delivery mode encouraged sharing amongst peers for both educational and logistical reasons. The on-site teacher and school principal reported that these students, as peer educators, gained significant social status within the school community, which had multiplier affects on their other endeavours. This confirms research into community music making that posits this learning style as a suitable vehicle for engagement with disadvantaged groups (Brader, 2003; Dillon, 2007). Lead students negotiated unsupervised access to the facilities, which increased their transferable social skills, symbolic status and confidence overall. Because they learned to negotiate with staff for extra time to experiment and interact alone with the technologies, they progressed quickly.

These students also encountered inevitable technical barriers. The pilot course design anticipated these barriers and incorporated them into lesson planning, so every week's remote desktop lesson started with a review of the previous weeks learning. The music technologist dedicated a time slot to questions about the "stuff we couldn't get to work properly".

Once the remote desktop format had proved effective and stable, the second site started a roll out, building on key learnings from the first. By the end of second term, sites were sharing their work through social networking services. Cross-site interaction increased as students started to upload, listen, collaborate and critique each other’s work on-line. This is a key learning from the pilot study. Participants replicated the delivery mode with ease, which aided communication between the school sites and the digital worlds of experts, teachers and students (Topping, 2009). Bernstein's (1999, p. 13) vertical and horizontal discourse of education highlights the contrasts and oppositions between specialist knowledge and everyday local knowledges. This pilot research questions the dichotomous overtones of Bernstein’s structural analysis, whilst recognising the quick spread of horizontal communication after an initial flow of expert (or vertical) knowledge.
Knowledge and information spread quickly amongst peers because it was encouraged, but not enforced by the course structure. This lack of mandatory requirement to interact with other students aimed to re-position the "specialist" language and competencies of music technology. It made knowledge, skills and information more accessible, through peer-to-peer interpretation and dissemination, in efficient and meaningful ways. Students could choose to confine what they learned through interactions with the expert and/or their peers. However, those participants who actively shared knowledge, resources and products with others, demonstrated significant increases in what Bourdieu (2001) called social, cultural, symbolic and institutional capital.

Shortcomings – Initial data analysis locates the pilot’s technical issues within the use of remote desktops to teach and learn. The experienced educator, who had installed the facilities and had intimate knowledge of the specific configuration, minimized technical problems with his pre-emptive design of the music hard/software. This, of course, will not be a practical solution for a large-scale implementation. The pilot report expects that future remote teaching of this kind will encounter hard/software configurations, which need building into the project design (see interactive issues and Section 3 of this paper).

Other technical issues stemmed from poor sound quality over the teleconference. The bandwidth (3G mobile for the music technologist, 512k fixed line broadband for the school sites) was not sufficient to stream audio and graphics through the remote desktop application. Therefore, the lessons used a simultaneous teleconference so the on-site teacher, students and the music technologist could communicate in real-time, whilst sharing a desktop view. The quality of the telephone signal did have a small, but detrimental effect on the quality of the teaching and learning in this pilot. At certain times, students would speak over each other, which is no different to face-to-face lessons. When this happened in a remote desktop scenario, it was difficult to comprehend who was talking over whom. This is important because it used up precious on-line time. When coupled with the notion that the speakers and telephones were not high quality, this made lessons about sound recording difficult to implement. For instance, this remote desktop format forced students and educators to rely on VU meters and qualitative descriptions of sound distortion during recording and mixing sessions.

Access to the facilities and to the music technologist outside agreed time slots were also pertinent issues. There was a lack of on-site technical expertise and a limited physical resource. Students struggled to keep to agreed meeting times, both for their remote desktop lesson and for their follow-up sessions. In search of a quick response, the students would call (or SMS) the music technologist ad-hoc when they had forgotten, or did not know how to find the correct information. Occasionally this worked well and their questions received a quick response. More often than not, the time of their request did not suit the music technologist, so a response was slow. This is an important finding for the proposed model of delivery and cohort, for whom educational progress has documented links to quick response times (Brader, 2003).

Interactive issues - From a technical perspective, there was an obvious (information) bottleneck in terms of bandwidth. Had all sites been equipped with a faster internet connection, the pilot could have streamed the remote desktop and a concurrent web cam. The music technologist has since tested this audio-visual configuration and
found it made a considerable interactive contribution. The lack of a webcam (i.e. audio and desktop only) meant the music technologist and students were not able to notice and respond to each other's non-verbal cues. This does not make teaching and learning impossible, but it does make it more difficult, particularly for young people with limited experiences of successful learning. The students who started the course without attending the face-to-face introduction session also tended to interact more with their peers than with the music technologist. This was to be expected and could be addressed through structural alignment of future projects. For instance, all students could be required to interact with remote experts socially before moving on to the technical requirements of the course.

The 3G network claims theoretical speeds of 3.6 mbps, yet it rarely reaches such speeds unless the receiver is within 100 meters of a mobile tower. The music technologist used the 3G network for all the remote desktop sessions and reported that the application never dropped out during more than 70 hours of teaching. He taught lessons from a variety of locations and in some cases used the same 3G sim card for the teleconference (the sim card reserves bandwidth for calls whilst data is in transfer). More often, however, students initiated a landline teleconference with a simultaneous remote desktop session.

In terms of interactive practices, the removal of all visual cues (apart from the shared desktop view) had both benefits and limits. A tactile approach to training on equipment such as rotary EQ dials and aftertouch on MIDI keyboards is difficult, but not impossible to demonstrate without close physical proximity between the educator and student. However, the music technologist also reported benefits in terms of improved communication skills. A common issue for the teaching of technical subjects is the fact that the experts are sharing their specialist knowledge, not their social skills. This remote desktop pilot reported that the music technologist improved his verbal communication skills and technical vocabulary during the project. In the same way that sound engineers traditionally relied on their ears rather than their eyes to record and sequence, the expert here had to explain everything verbally with the aid of the mouse. This was a foreign concept, but the technologist reported that this audio/visual configuration improved his communication of technical procedures and processes.

In terms of graphical interactivity, the paper draws on a continuum first outlined by Pullen (2000:3 Figure 3.). He began to report on teaching in higher education using remote desktops in the 1990s and outlined preliminary concepts that are useful for this paper. Pullen reported the following representations in computer aided remote learning environments, suggesting all delivery modes fell somewhere within a spectrum, where text is the lowest level representation and total immersion within a virtual realm is the highest level.
The interactive issues manifest in this pilot confirm the validity of this spectrum for the evaluation of remote teaching in music technology, up to, but not yet including, the immersion level. Of course, a text-only based approach to music sequencing will not suffice, neither will audio only. Static graphics have been used in books, but the current array of moving graphics in digital tutorials suggests that static graphics are probably not the most effective. The annotated display was evident in digital tutorials provided as learning resources, as was motion video. However, all students who worked through the remote lessons and these resources indicated that they preferred tutorials with voice over a desktop display of the actual sequencing software. As mentioned earlier, bandwidth was the only bottleneck preventing this pilot from using the webcam as a visual/audio communication device. The evidence presented here and further tests since that pilot confirm that currently, the best combination of interactive audio-visual elements to provide a stimulating distance-learning course in music sequencing is a combination of real-time remote desktops and webcam interactions (both streaming audio). Such courses, however, must be complemented with social interactions before delving into technical topics.

Temporal issues also affect levels of interactivity between experts and student in this context. In Figure 3, Pullen’s vertical scale shows how temporal feedback affects learning. This pilot concurs with Pullen’s findings by restating the importance of the fastest possible responses with both teenaged and music technology students. Quick responses, through SMS messages and email were also valuable in this pilot study (see Bateman, 2004). These findings may seem obvious at first reading, but they have important implications for the role out of the large scale, many-sided solution outlined below.

In summary, the interactive findings of this pilot suggest that remote desktops are a suitable, cost-effective way of sharing knowledge and information to increase participation in music technology. There are several unexplored analyses of
interactions within this data, but the paper's goal is the development of a practical model, not micro-level theorising.

It is not foreseeable that remote desktops will ever replace face-to-face interactions in this field, but as part of a course of study, they demonstrate considerable flexibility and benefits of scale. This peer-to-peer model combined with an encouragement of horizontal communication enables the spread of knowledge and information efficiently across a variety of social networks. The number of audio/visual/temporal possibilities associated with remote desktop applications increases the pool and availability of music making experts. This strategy can widen bottlenecks that hinder interactions between technical support, educators, students and providers of professional development.

The paper now provides a logical argument about the network of music technologists who encounter distinct manifestations of knowledge and/or information bottlenecks. High-speed internet connections may increase the actual bit rate for individuals and groups, but the lack of a cohesive sharing strategy for users limits interactive musical activities.

Section 2: Bottlenecks stifle interactions between aspiring music technologists

The term "knowledge bottleneck" derives from studies into expert systems seeking to find the best means of disseminating new (often technical) information. The term refers to institutionalised processes that slow the flow of knowledge and/or information as they pass through a shape resembling a bottle's neck. Researchers have examined expert knowledge from several perspectives including computing systems, medical knowledge and technical support databases (Hoffman & Lintern, 2006, for expert knowledge or Slonim & Friedman, 2006 for multivariate information bottleneck). However interesting statistical computer modelling may be, this paper is concerned with a sociological interpretation of the bottleneck concept. Specifically, how bottlenecks slow the sharing of both technical information and knowledge about learning processes related to music technologies, thus stifling interactions between users. As we are now in an era that prominent theorists (Bernstein, 1999; Castells, 1999, 2007) characterise by the rise of many-to-many interactions, the term resonates with the internet’s ability to facilitate efficient horizontal communications.

We can use the bottleneck concept to talk about processes (whether intended or not) that slow exchanges between two or more nodes within networks of human interaction. In The Rise of the Network Society, Castells (1999) argues that the space of flows (of capital and information) devalues physical locations and that timeless time challenges outdated measures of time based on the industrial era of production. Whatever the locality or network in question, the bottleneck concept denotes a point at which agents cannot, for numerous reasons, supply expert knowledge and/or information quickly enough to meet demand, wherever and whenever it is required. In networked societies, demand might come from end users and other experts requiring information related to a product or services, or for clarification of a technical procedure, or for access to further sources of knowledge. Crucially, these demands can occur at any time or place.

No group or individual causes the bottlenecks in the music technologies intentionally. Several structural limitations affect the flow of knowledge and/or information
(Graham, 2001). Our current situation is the result of millions of interconnected people and projects expanding their knowledge base (and in some cases attempting to capitalise on the knowledge they have acquired and/or generated). This paper examines the bottleneck in music technology from two angles: technical support and professional development. It offers a solution that challenges the dualism of horizontal and vertical flows of knowledge, which Bernstein (1999) maps on to everyday and expert language patterns. The model proposed below encourages music technology users and experts to organise the sharing of synchronous/asynchronous knowledge and information across flexible times and spaces. This would increase remote interactions and breakdown imaginary barriers between expert and everyday knowledge.

**Advances in music technology increase interactive practices**

This premise is practically irrefutable. The explosion of cheap processing power over the last few decades has revolutionised the way we think about the production/performance of music and creative arts generally. This does not mean traditional music interactions (i.e. one-to-many artist-audience relations) have disappeared. Rather, new practices that democratise many creative processes now complement them. Due to the current speed of dissemination, interactive tutorials and on-line technical support now demystify several music technologies in all manner of formats. To support the premise stated above, the paper offers broad ranging examples of interactive practices contributing to specific forms of socialisation.

The Web 2.0 platform has changed relationships between audience and content creators and challenged traditional means of production. In terms of symbolic interactions, artists and audiences now have more control and scope to transmit and receive creative art works across timeless time and the space of flows. A good example comes from radio stations (analogue and digital), who have increased their interactive scope now that they combine multiple media. This allows audiences to interact with content creators in several new ways and create content themselves. In terms of socialisation, radio stations have sidestepped the tyranny of distance, but not removed it altogether. Radio station's analogue transmitters cannot reach as far as their websites can. Neither can they respond to, and disseminate, additional asynchronous knowledge, art and entertainment. The socialisation impact of these changes is often understated. Many ex-patriots, immigrants and refugees for example, now rely on these advances in radio communication to interact, maintain links and feel connected to their home territory.

More specifically, on-line music creation and collaborations have increased in complexity and frequency alongside high speed Internet connections. We are now witnessing musical production and performances that happen entirely on-line, bypassing powerful music companies altogether. On-line artists now perform in real-time, interacting with audiences in ways that steer and contribute to live performances. This is another dimension to Denora's (2003) view of music as socialisation, which fosters collaboration and encourages new forms of interaction.

Software developers also provide opportunities for users to interact, share and promote their creative works through mutually beneficial agreements. Forums, both commercial and open-source, encourage users to upload their new creations because
they promote the creator's profile and increase exposure of the software or forum. Commercial agents also offer these interactive services to those who have purchased their software, whilst some providers charge a one-off price to use their web portal.

The Jam-to-Jam software is a perfect example of how research is contributing to increased interactions between remote communities. Network Jamming allows people to play music and remix video feeds together over the Internet. Dillon (2007), the project leader, explores ways to enhance learning and increase socialisation through collaborative digital technologies. The project has developed new software that novice users, such as children and people with disabilities, can control over the Internet to increase remote interactions.

The final example of increased interactivity in music technology presented here is the expansion of 3G networks and the possibilities now available through on-line applications. This mobile network extends "on the move" possibilities for laptops and mobile phones, so that users can record, playback, download and upload from anywhere that their receiver signal allows (Castells, 2007). The ever-increasing amount of data that resides exclusively in the cloud (Johnson, 2009) also broadens the possibilities of online collaboration and reduces the need for producers and artists to carry their data physically.

These brief examples point to a rapid expansion of interactive practises that bolster the diverse music making community and increase socialisation across education and commercial environments. As Denora (2003) suggests, the "active properties of music" have shifted our focus from the music and society paradigm towards socio-musical research, which posits the "socialising role of music in its broadest sense" (pp. 175).

These increases in interactivity generate synchronous and asynchronous knowledge and information that flows back and forth between experts, educators and aspiring music technologists in all manner of formats. Through all possible interactive combinations (one-to-many, many-to-many and many-to-one), people share knowledge and information about music technology. The speed at which it is able to flow is critical for making creative projects happen in the real world. This paper highlights how providers of technical support, educators and students can share more efficiently and effectively.

Technical support for music technologies does not meet growing demand. Technology developers are creating new social networks and pushing the boundaries of what we consider socialisation through music. Recent innovations make many traditional functions in music technology, such as rack mounted equipment and overdubbing performed by control room engineers, redundant. Virtual technology, new instruments and real-time collaborations streamed over the Internet have potential to reshape power relations between engineers, artists, audience and music distributors (Bockstedt, 2006). For instance, the record button is a significant symbol of power in most recording studios. Whoever controls the record button has the ability to change the way artists interact. It may be unintentional, but the recording of a performance usually affects artist interactions in some way or other. Democratising the recording power that the sound engineer wields and sharing third party plug-in code, new MIDI controllers (especially wireless ones) will further expand what it means to interact musically.
These developments require increased technical support, some of which is purely instructional. Some is educational in its scope, where support includes complex processes, context, explanation and demonstration for particular hardware or specific learners. Because of this growing need for both technical information and savoir faire (or “how to” knowledge) the paper describes a bottleneck that both flow through.

As a topic, technical support has received little research attention in the field of music technology (Banister, 2006; Seddon, 2009). There are, however, numerous support services worth researching. These include:

**Call centres** - These usually take the form of commercial companies supporting their own products, adding disclaimers to their remit about combined use with third-party hard/software. Smaller music technology retailers also provide post-purchase support. Reports from suppliers (Dodge, 2009) suggest that it is economically impossible to provide such localised support in the long-term.

**Forums** - Software and hardware companies provide technical support forums, knowledge databases, beta-versions, driver updates etc., as part of their post-purchase support, but these services rarely meet the specific needs of every client. Open-source forums share expert knowledge and reviews in a similar fashion. Their point of difference being the fact that they are not tied to a particular brand or product. The forum system works well for auto-didactics, yet many readers of this paper will have spent hours trawling through such forums to find that no one has their exact setup, thus technical problems can remain unsolved.

**Tutorials** (DVDs and online) for specific applications, are often comprehensive but too long in production, which means they can be out of date before release. On-line distribution is clearly more efficient. Youtube (TM) is now a viable source of "how to" knowledge for many home users and auto-didactics. A mass of Internet traffic passes through this network node and it has certainly widened the music technology bottleneck, but the quality (both technical and educational) remains inconsistent.

**Remote desktop applications** - To date, technical support teams use these applications to solve issues in large corporations. They have only just begun to infiltrate the multi-media and education arenas (Frank, 2008). There is huge potential in this format to widen the flow of knowledge and offer greater control and flexibility to users (see Section 3).

These examples point to a bottleneck in terms of technical support for music technologies. End users are not interacting to full capacity because they (or their colleagues, students or teachers) are not up-to-date with music technologies. Providers of music technology knowledge and information are slow to realise long-term potential and are mostly reactive in their offerings. They prefer to concentrate time and energy on current innovations in hard/software, sharing knowledge as an afterthought, addressing demand as it presents itself. Local suppliers have documented this issue (Dodge, 2009), which shares similarities with research findings about the globalisation of support/call centres (Acomb, 2007). Of course, the very nature of technological innovation prevents any individual or group being consistently current. However, that does not necessarily lead to the current situation, where users
are often out-of-date because a bottleneck impedes the flow of knowledge and/or information.

There is scope for improving the flow of interactions between music technology experts, teachers and students through remote desktops and targeted professional development. As there are several causes of this bottleneck, the problem requires a multi-faceted solution. The solutions listed above are helpful and this paper is not criticising these services per se. It is suggesting that these are piecemeal, not cohesive solutions. Call centres, forums, tutorials and, to much lesser extent, remote desktops currently perform important functions in making music technologies accessible. However, these solutions all come at a price. They all cost the end user and/or the provider in some way, shape or form. Current technical support services in music technology do not gear their solutions towards the ongoing dialectic relationship between education and commerce and thus neglect important knowledge generators. The current and future users of music technologies provide a crucial part of a many-sided solution that contributes to long-term employment, education and technical support goals.

To reiterate the second premise - technical support for music technologies does not meet demand - this paper acknowledges several ways users can access knowledge and information. However, current knowledge and information is slow to reach the growing demands of end users for several reasons. It costs (time and money), it does not draw upon all the available expertise, nor does it provide specific types of knowledge and information in formats that are accessible to diverse populations of music technologists. This aspect of the bottleneck in question impinges on the interactions between music technologists and hinders socialising projects.

**Professional development for teachers of music technologies does not meet demand**

In technological fields, educational practices have always lagged behind what is currently and/or commercially possible. This is especially so at secondary/high school level where, due to a range of mandatory requirements, schools are rarely on the cutting edge of music technology innovations. The secondary school sector understands the importance of maintaining currency, but research from the UK (Webster, 2006), USA (Barrett, 2006) and Australia (Brader, 2004) suggest it is rare to find a state school with a broad range of multi-media subject areas and sufficient resources to teach more than a few students at a time.

Although this educational aspect of the bottleneck is under resourced, there are always alternative funding streams to improve the situation. The growth of the professional development (PD) sector provides a potential source of funding that can increase the flow of music technology knowledge and information. Across all sectors, numerous initiatives from federal and state governments espouse the benefits of professional development in education. However, PD is far from comprehensive in its presentation and evaluation. The evidence shows, despite the multi-billion dollar industry that exists in western societies, there are no published models for policy implementation, budgeting or evaluation, which researchers and practitioners can use to devise effective professional development (Luke & McArdle, 2009). This is the case for PD across the entire state education sector, so it is safe to assume that the fringe subject of music technology, with its high costs and small class sizes, reflects
this trend. Below, Brown (2007) discusses the situation from an Australian perspective, highlighting the PD solutions available for music technologists.

Depending upon the significance of the music technology integration and on local circumstance, there can be a range of options for professional development. It may be possible for an existing staff member, alumni, or a student to assist staff with how to operate new software and hardware purchases. Staff or retail outlets from which equipment is purchased may agree to run a session covering installation and operation of the equipment. It may be possible for staff from outside the music department to offer their experiences in pedagogical approaches or to facilitate a workshop. A number of institutions run short courses in particular software applications or on music teaching ideas with computing technology that staff could attend. (Brown, 2007, p. 3)

Most stakeholders would agree that music technology in education settings requires specialist professional development. Although there is broad consensus that both human and physical resource investments are crucial, neither education nor commercial institutions orchestrate any of the solutions outlined by Brown (2007). They certainly do not form part of what Luke and McArdle (2009) call a "research-based approach to professional development policy and implementation". The four sources of professional development outlined above - music staff, students, retails outlets, education specialists and short courses - are available to potential and existing music technology educators, but they are piecemeal and poorly evaluated. This leaves school principals, who do not have sufficient budgetary power to stimulate large-scale change, with little evidence on which to base their PD priorities and budgets.

This paper offers three key issues that contribute to professional development not meeting demand in this area. These examples help form the argument that a lack of systemic planning in professional development contributes to the bottleneck in music technology.

The first issue is the relocation of skilled educators in the field, who seek promotions and high-level technological investments, thereby leaving a facility without a suitable substitute. Several researchers report this issue in ICT more generally and a few refer specifically to music technology (Mills, 2001). This common scenario highlights frustrations about the technology lag in education generally, investments in people and infrastructure. Technical issues related to the speed and size of data backup also pose a major problem for most small-scale music technology facilities. So too does the cost, maintenance and upgrade of hard/software associated with this course of study. If a skilled music technology educator does not receive the IT support they require, or the funding they need, to maintain a simulated studio facility to an industry standard (a requirement of many vocational education music qualifications), research evidence suggests that educators will often seek employment elsewhere (Berry, 2007).

The second issue is a lack of appropriate professional development modes in specific software/hardware applications. The familiar PD model for most educators consists of training courses (often 1 or 2 days), which are not readily accessible for many aspiring music technology educators due to time/space/cost constraints. There may well be a course or digital tutorial package that covers a specific application the educator wants to use. Yet bottlenecks and other constraints hinder the technology
experts imparting knowledge to these busy professionals. According to (Borko, 2004) educators are now more likely to spend their time on jobs they consider core business such as marking, assessing, reporting and lesson planning, than they are sourcing professional development opportunities.

The third issue is the high monetary and time costs of training to increase staff proficiency in music technology. Anyone who has spent more than a few hours working through a digital tutorial linked to an industry standard music-sequencing package will testify that it takes considerable time to become proficient, let alone become confident enough to plan a lesson around a software application.

Presumably, providers of PD related to music technologies are doing the best they can in fragmented societies, where education institutions are slow to adapt to the latest innovations. There are online and face-to-face solutions available, but they are difficult to access during the course of typical schoolteacher’s busy timetable. Brown (2008) refers to specific associations in the UK, USA and Australia who dedicate significant online resources to solve this problem. These solutions invariably follow a familiar pattern of using the Internet to make traditional face-to-face courses available on-line (Pullen, 2000). All the websites Brown (2008) signposts offer short courses in specific software packages that suggest they are “music industry current”. Having researched these links, this paper argues the providers all offer solutions in a traditional format of professional development, which is often poorly evaluated and based upon preset learning outcomes (Sadler, 2008). None of these courses offers flexible delivery of remote desktop applications to disseminate music technology knowledge and/or information. There are exceptions to this trend (See Berklymusic.com), which provide flexible offerings for students. Many flexible courses are theoretically available as professional development for teachers, but their website’s provide little evidence of requesting personalised information to tailor their offerings to clients needs. Such courses, although useful for some, are unresponsive to the needs of specific educator requirements. The packages they offer require the educator to fit the provider’s definition of professional development, whereas the model outlined below argues that providers of such PD should respond to the specific needs of the professionals in ways that suit their knowledge base, time, place and financial requirements.

These examples point to inadequate professional development for music technology educators, which makes a significant contribution to the bottleneck under examination. The lack of suitably qualified educators, relevant professional development opportunities and the high costs associated with course delivery means those educators with energy to acquire new skills often fail, or give up because they find the task too arduous. There are, of course, exceptions to these trends. Educators can, and do, find ways to deliver exciting courses despite these obstacles. However, there are more teachers for whom the thought of learning new technologies is repeatedly pushed to the bottom of their "to do list". Professional development, which purports to increase the knowledge base of music technologists, must also improve the ways it offers technical and educative support.

To reiterate the second premise—professional development for teachers of music technologies does not meet demand—this paper argues that, currently, knowledge and information is slow to reach teachers for the same reasons as the first premise: it costs (time and money); it does not draw on all the expertise available; it does not provide
specialist advice in formats accessible to diverse populations of potential music technologists. This aspect of the bottleneck impinges on music’s interactive ability to increase all manner of socialising projects. When flows of knowledge and information are wide and controllable by end-users, music technology has massive potential to shape individuals and societies through its interactive focus.

Section 3: A professional development model that maximises the flow and control of exchanges between education and commercial providers

This section will inform and inspire students, teachers, music experts and commercial agents to forge new partnerships. The bottleneck that exists in the music technology community requires a new delivery model and partnership between commerce, higher education music students and secondary school students and staff. The partnerships must be able to provide a responsive 24/7 remote desktop solution, call centre and booking system that offers ad-hoc technical support and structured, interactive (remote desktop) tutorials (across all platforms) to all users; individual and groups.

The proposed model builds on the central tenets of this paper, pilot research and numerous anecdotal reports the author has documented in commercial, non-profit and education sectors.

The remainder of this paper provides a "how-to guide" as a specific application of Luke and McArdle’s (2009, p. 15) model for research-based professional development. It is adapted from their Asia Pacific model and applied to the case presented above. This model offers generic examples so that music technology communities can forge new partnerships and adapt it to their current situation.

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**Phase 1:** To identify the policy priorities in this situation, consider local, state, federal and international policies that impact on music communities. As policy makers often consider music technology a low priority course of study compared to Science, Maths or English, it would be wise to research benefits associated with music and technology and link them to locally defined needs. ICT, Music, Arts, Literacy and Health all display existing and potential connections to music technology and thus form part of the contextual policy framework.

How and why is local ICT policy in schools linked to skills shortages and the knowledge economy at state and federal levels? What kind of health, education and community initiatives could use benefit from music technologies? These are the type of questions to ask in Phase 1. This information will provide an overview of where strategic priorities lie and how to access funding sources. New partnerships should also identify priorities in the business sector so that all partners are aware of market trends, leaders, failing products/services and latest innovations. Although such business policies are not all publicly available, several indicators can contextualise the
bottleneck from commercial perspectives. This background data helps the new partnership to focus on specific education and technical problems identified by a range of users. For example, the new partnership might include a music technologist from higher education, a secondary school principal and a local supplier of music equipment. Those partners would be able to identify current frustrations of a technical expert, students and a school teacher - issues that impact on their levels of musical interactivity. This phase, which reconfigures frustrations as education and commercial issues linked to policy priorities, ensures the team bases interactive solutions on empirical evidence, identifying as many user requirements as possible.

**Phase 2**: To reframe the educational issue and goal, a move away from the generic towards the specific problem is critical. Luke and McArdle suggest three sources of information to reframe the issue (2009, p.14): existing empirical data on the problem, commission surveys and extrapolated data from national and international studies. Each potential data source is useful in music technology, but existing data will be difficult to find, so the surveys will probably take a lead role here.

Internet surveys and SMS polls might focus on music technology skills that students want to learn and teachers want to offer. The result of Phase 2 data gathering would be a specific statement of the problem. For example, a generic statement that often informs a PD strategy might state, "we need professional development in Music Technology so teachers can inspire students to create". However, Phase 2 would suggest reframing this to a specific, evidence based statement: "we need to target professional development at IT literate teachers to increase reporting on music technology outcomes", or even more specific "to address student's demands we need to train IT literate teachers in music sequencing and assess their professional development using student's CD/Mp3 productions".

**Phase 3**: To identify teacher cohorts means avoiding a one size fits all mentality. This paper's author has reviewed a selection of "off-the-shelf" music technology short-courses that treat potential clients as a homogenous group, required to fit the structure and mode of delivery, rather than the other way round. The user(s) requiring skills identified in Phase 2 must be known to the new PD partnership before any remote desktop training occurs. The variables to consider are:

- **Location**: the region, remote/rural, scope of internet speeds in the area or community site.
- **Subject Area**: the PD partnership must know what the teachers already teach, what they have taught in the past and what they want to teach.
- **Grade/Phase/Level**: information is required to provide appropriate material that allows stimulating teacher-student interactions with music technologies.
- **Age**: actual and literacy/numeracy age (if available) for all students and teachers
- **Credential level**: in music technology and other areas. What formal qualifications do the teacher(s) posses? Are their credentials of a higher level than the ones they are offering to students?
- **Experience/background knowledge**: For instance, a teacher might identify as needing personalised PD in music sequencing. They may have a music background, but are not computer literate. Alternatively, a youth worker may present with formal credentials in music, but no experience of music production. As a facilitator of music technology PD the new partnership must have a clear understanding of the teacher's fields of experience.
Knowledge of the student cohort: For example, work with disengaged youths, who want to learn how to sequence drum loops, will require quick response times. Whereas senior citizens wanting to record their barbershop quartet might require a completely different approach. These variables will change the speed, content and style of personalised or group PD delivery for music technologists. It is crucial that this information is built into PD planning and is discussed with teachers as part of negotiable, not preset, learning outcomes.

**Phase 4:** Categorise teacher learning and knowledge into four groups:

  * **Content**
  * **Pedagogical**
  * **Curriculum**
  * **Knowledge of students/communities**


Content knowledge is what the teacher knows about specific fields of practice, and how they pitch their own knowledge in relation to competing paradigms. For example, how much does the teacher know about modern and classical forms of music notation? Alternatively, which sequencing package does the teacher prefer to use? How do they justify the methods they use to teach music? Is their delivery mode appropriate to their student cohort?

Pedagogical knowledge is concerned with field-specific and general pedagogy, assessment strategies and techniques. For example, how does the teacher approach their subject area? What kind of artefacts do their students produce? Do they believe their approach shares generic qualities with other learning communities? How does the teacher currently assess their student’s progress? Can they situate their assessment strategy within a theoretical framework? Do they agree with the assessment functions they perform? Or, do they adhere to preset criteria begrudgingly? Does the teacher want advice about integrated forms of assessment?

Curriculum knowledge depicts what the teacher knows about the syllabus goals, standards and available learning resources. For example, has the teacher been involved in the design of the course? Did a school invite them to deliver an existing course? Does the teacher even deliver a course? Maybe they work in a community centre or provide 1:1 private support. Does the teacher believe they have the facilities to teach effectively? Do they have good facilities, but too many students, or a great collection of learning resources, but not enough hardware to deliver? Maybe the teacher has excellent music students and recording facilities, but no knowledge of hardware/software. Are these limitations affecting the quality of their teaching? Can the teacher actually progress students through their curriculum with their current knowledge and resources?

Knowledge of students and communities requires teachers (and PD providers) to acknowledge and cater for background, cultural and cognitive resources, and linguistic and community contexts. The PD partnership must focus on the impact that
Student diversity has on teaching and learning and how teachers interpret specific types of diversity. For example, does the teacher present knowledge in formats that exclude students with low traditional literacy level? If the teacher's cohort is mostly Samoan, is it appropriate to for them to provide learning materials from American rock music? Does the music sequencing software require esoteric knowledge of western music vocabulary? Has the teacher provided a user-friendly glossary of these terms for their student cohort? Is a certain type of interaction with technology not acceptable within the cultural protocols of their student cohort?

**Phase 5:** Select a Professional Development Mode. This phase combines all the information gathered from phases 1-4. If a client omits any information from phases 1-4, it will have an adverse affect on the mode of PD delivered. Choosing an appropriate mode of PD for teachers requires decisions about

- Goals
- Scope/cohort
- Content
- Timing/duration
- Delivery mode(s)
- Outside expertise
- Sustainability

This model’s point of distinction is its degree of flexible, 24/7 solutions. The PD mode will accommodate the client’s needs and provide evaluations appropriate to their level. The expert provider and the client will negotiate and agree on the type of learning opportunities and goals required before any PD actually takes place. For example, the PD mode for a youth worker with existing knowledge of music sequencing, delivering a formal music industry course in a low-socio economic area will be a distinctive mode. However, that mode will require some generic knowledge about the curriculum and industry standards.

The cyclical nature of the model allows any music technologist to register as both a receiver and transmitter of knowledge and information. As a user, they could search for experts and as an expert they would update their fields of expertise and availability. A hypothetical scenario describes the model’s sustainable qualities.

A teacher requires some high-level software expertise and registers on a database for personalised PD. The teacher attracts funding from his/her school principal and negotiates a series of 1:1 remote desktops lessons. The teacher wants the lessons to occur from 11-12 pm every Thursday evening for six weeks. The teacher searches the PD database and finds an available expert. As part of the agreed delivery mode, and for evaluation purposes, the client is required to update his or her own records to reflect their knowledge acquisition. They then have the choice to become an expert, subject to availability, to share knowledge and information. The PD partnership automatically renders and stores all remote lessons and shares them via an FAQ database as audio/visual resources for future users.

If the teacher is clear about the learning opportunities they want to pass on to students, Phase 5 will widen the bottleneck and allow a rich flow of communication to pass back and forth. To further the bottleneck metaphor, this model does more than simply widen the bottle's neck. It gives both the transmitter and the receiver of PD access to a
tap so each can control the flow - slowing or speeding up the flow of their delivery mode to suit specific learning and teaching needs.

**Phase 6:** Evaluate the program using formative and summative assessment techniques. This requires the correct mixture of outside expertise from Phase 5 to provide realistic and sustainable PD in music technology. Luke and Mc Ardle (2009) suggest a range of techniques that will elucidate the teacher's efficacy and the quality of the knowledge they share with others:

- Teacher surveys/interviews
- Longitudinal student outcomes data
- Observation data
- Commissioned case-study research
- Quasi-experimental comparative studies

Phase 6 ensures the model is replicable and reliable across cohorts. If this phase is taken seriously, unlike many tokenistic PD evaluations, it will feed into the available knowledge and information that PD budget holders (and policy makers who set priorities) use to inform future decisions about the spread of funding. Especially in fringe fields like music technology, where the pace of innovation increases daily, comprehensive evaluations of PD can steer talented professionals into, rather than away from education.

This music technology application of a PD model requires effort and cooperation from several agencies that have a stake in widen this specific bottleneck. If interested parties adapt this model to their local situation there is real scope for a longitudinal approach to be pro, rather than reactive in terms of sharing music technology practices. There is scope to reduce the technology lag in secondary school education, for auto-didactics to learn and share more efficiently, for teachers to source flexible PD, for students and commercial agents to gain valuable learning and training credentials.

**Conclusion**

This paper presented research findings from Australia's first use of the 3G mobile network to teach music sequencing using remote desktop applications. The combination of empirical evidence and the arguments presented in Section 2 prompted a many-sided solution to improve the flow of exchange and interactions that occur between music technologists.

The paper outlined some of the ways bottlenecks stifle interactions between aspiring and established music technologists. A new delivery model for professional development in music technology aims to widen the bottlenecks thus increasing user/producer interactions. The paper presented three related arguments to build a case for the proposed model. First, it demonstrated how advances in music technology increase interactive practices. Second, it suggested that technical support for music technologies would never meet growing demand. Third, it stated that no one has orchestrated flexible professional development for teachers of music technologies.

This cyclical delivery model, which supplies required knowledge/information to assemble a fully searchable database, would make an excellent public-private finance
initiative. In fact, it is a direct response to Luke & McArdle’s (2009) call for a research-based approach to professional development policy and implementation. This 24/7 delivery mode, using remote desktops, mobile devices, shared calendars and SMS, delivers a flexible addition to the piecemeal solutions already on offer. The intention of this paper is to inspire relevant parties to organise themselves and maximise the knowledge and information they produce, transmit and receive. This model has the potential create new experts, knowledge, information, research data, training and employment opportunities. It also increases interactive opportunities for all users and producers of music technology. If new partnerships implement this delivery model systematically, they will generate commercial, education and research benefits that will feed off each other indefinitely.
Bibliography


