

What constitutes a valid musical instrument? Historic approaches to instruments and instrumentality in studio-based music creation

James Mooney

School of Music, University of Leeds, UK

j.r.mooney@leeds.ac.uk

Abstract

In this paper I use the concepts of musical instrumentation and instrumentality as a way of placing the development of studio-based electroacoustic music in historic context. Histories of mid-century electronic music have often been framed primarily in terms of compositional philosophy: *musique concrète*, *elektronische Musik*, etc. Here, however, I highlight a different aspect of the story by casting the development of studio-based electroacoustic music as a radical shift in musical *instrumentation*. My core argument is that, with the emergence of studio-based electroacoustic music, tape recorders, digital computers, and electronic music studios became *musical instruments*. This development was paralleled by a radical rethinking of the very concept of musical instrumentality—albeit one that appears not to have gained traction in the wider public imagination (in the sense that tape recorders, computers, and studios are not widely considered ‘musical instruments’). My aims in this paper are: to revisit this instrumental rethinking from the perspectives of some of those involved in designing and making the new instruments in the 1950s and 60s; and to assess what was radical about it by weighing it against the more conventional criteria of musical instrumentality outlined by Hardjowirogo in her article ‘On the Construction of Instrumental Identity.’

1. Introduction

As a researcher I am interested in exploring ways of placing electronic music in historic context.¹ In this paper, I would like to consider the concepts of musical instrumentation and instrumentality as a way of doing that. In particular, I intend to focus on the emergence of studio-based music creation in the post-World War 2 decades.² Historiographically, that

¹ See, for example, the special issue of *Organised Sound* on ‘Alternative Histories of Electroacoustic Music’ that I co-edited (Mooney, Schampaert, and Boon 2017).

² Although I focus primarily on electroacoustic music in this paper (in line with the core interests of the Electroacoustic Music Studies Network), my use of the more general phrase ‘studio-based music creation’ here and in my title and conclusion is quite deliberate. My claim, in essence, is that a radical shift in musical instrumentation in the decades following World War 2 is reflected in the development of studio-based music-making practices *in general*, including but not limited to ‘electroacoustic music.’ Certain developments in sound recording and popular music production practice during this period, for instance, such as the increased use of tape editing, multitracking, and signal processing to create ‘studio born’ musical works that could not have been realised any other way (see Zak 2012; Horning 2013, chapters 5, 6, and 7) could also productively be read, I argue, as evidence of a new musical instrumentarium of tape recorders, mixing consoles, and signal processing

episode in music history has often been framed in terms of the rise to prominence of certain new compositional philosophies—*musique concrète*, *elektronische Musik*, and so on—and those of course were important aesthetic developments.³ Here, however, I wish to highlight a different aspect of the story by framing the advent of studio-based electroacoustic music as a radical shift in musical *instrumentation*.

My central argument in this paper is that with the emergence of studio-based electroacoustic music, tape recorders, digital computers, and studios became *musical instruments*—instruments, furthermore, that remain central to studio-based music production today (albeit with more computers and less tape than was the case in the 1950s). If these tools do not seem like ‘musical instruments’, that is because to view them as such requires a rethink of the very concept of musical instrumentality as conventionally understood. Such a rethink began to happen in the 1950s, but it appears not to have taken hold in the wider public imagination. My aim in this paper, then, is twofold: first, to revisit and explore this rethink of musical instrumentality from the perspectives of some of those involved in designing tape, computer, and studio-based instruments in the 1950s and 60s; and second, to pinpoint what was radical about this instrumental rethink by weighing it against the more conventional criteria of instrumentality outlined by Sarah Hardjowirogo in her article “On the Construction of Instrumental Identity” (Hardjowirogo 2017). One of my ultimate aims, here, is to reclaim some sense of instrumental identity for studio-crafted music—a move that I hope might help to bridge the unhelpful cultural schism that currently exists between instrumental music and music technology.

2. Hardjowirogo’s ‘On the Construction of Instrumental Identity’

What constitutes a valid musical instrument? Or, to put it another way, what is it that causes an object to register as a musical instrument in the public imagination? That is the question that Hardjowirogo addresses in the above-named article, and she identifies seven criteria that seem to be important based on her review of relevant literature. Briefly, these can be paraphrased as follows: (1) sound production (perhaps self-evidently); (2) intentionality: there must be a perceived intention to use the objects in question to make music; (3) learnability and virtuosity: musical instrumentality is often associated in the public imagination with the learning of techniques which are difficult and thus take time and practice to master, and with the public demonstration of those techniques in a way that makes their difficulty apparent (as happens in a virtuosic performance); (4) immediacy: there is generally expected to be a degree of ‘immediacy [...] between the instrumentalist’s actions and the instrument’s sound’ (Hardjowirogo 2017, 19); (5) corporeal expressivity: there is generally expected to be a connection between the physical, bodily gestures of the musician and the expressive control of sound; (6) cultural embeddedness: whether an object is recognised as a musical instrument or not is, to a large extent, culturally determined; (7) audience perception of liveness: the status of musical instrumentality is more readily conferred in situations where an audience perceives that the sound production is happening live (or plausibly *could* happen live in the case of recorded music) (Hardjowirogo 2017).

devices that found creative expression in the work of innovative engineers, producers, and musicians during those decades.

³ Books by Manning (2013) and Holmes (2020) are two examples of well-known accounts that represent the development of studio-based electroacoustic music post-WW2 in this way.

Not all of these criteria have to be satisfied for an object to be apprehended as a musical instrument; but they all help, according to Hardjowirogo. Already, then, one can perhaps imagine why some of the instruments of studio-based music might not be widely recognised as musical instruments. However, let us now look at this issue from the perspective of some historic protagonists.

3. Hugh Le Caine's 'Special Purpose Tape Recorders'

In the 50s and 60s, Hugh Le Caine (1914–1977), a Canadian physicist and ex-WW2 radar engineer working at the National Research Council in Ottawa, designed several multi-track tape recorders to meet the needs of electroacoustic composers. Le Caine was aware that the process of producing electronic music on tape was cumbersome and time-consuming. In his view, this was because commercial tape-recorders had not been designed with sound transformation and compositing in mind. Hence, he designed several "Special Purpose Tape Recorders" for use in electroacoustic music studios (see Figures 1 and 2). From Gayle Young's account, we know that these enabled the user to transpose, group, mix, and combine sounds from multiple two-track tapes, as well as add reverb and vibrato (Young 1990, 194–98).

Le Caine was highly preoccupied with musical expressivity, which for him meant continuous, instantaneous control of timbre and dynamics. We see this in his best-known instrument, the Electronic Sackbut—which 'had a touch sensitive keyboard and continuous controls for pitch and timbre (Young 1990, xii)—and it is also evident in his tape-recorders, which, likewise, included a touch-sensitive keyboard to enable the user to produce subtle inflections in dynamics as well as pitch, and mixer controls that were ergonomically laid out, allowing channels of recorded material to be deftly rebalanced.

When Le Caine presented his tape recorder to the Institute of Radio Engineers in 1961 he titled his presentation 'The Tape Recorder as a Musical Instrument,' apparently a clear statement that he viewed this device as a musical instrument. However, he may have been conflicted about this, since examining Le Caine's archival papers reveals that he actually gave his presentation two titles, the other title being 'The Tape Recorder *as a Tool* in the Electronic Music Studio' (Le Caine 1961, emphasis added).

Did Le Caine consider his Special Purpose Tape Recorder to be a 'musical instrument,' then, or not? On the one hand, the opportunities for instantaneous expressive control that Le Caine engineered into the device clearly ought to place it in the category of a musical instrument when judged against Hardjowirogo's criteria of immediacy (criterion 4) and corporeal expressivity (5). On the other hand, as a studio instrument used to create fixed-medium works, the techniques employed in its use would not have been publicly displayed (criterion 3); and even if they were, this was a recording and playback device, where the sounds on the tapes could be anything and the performer commands and shapes the (semi-)automated action of tape-playback.⁴ This would likely confuse an audience's perception of liveness (7) and obscure the relationship between performer actions and resulting sounds (4, 5). In other words, while Le Caine's tape recorders obviously fulfil some of Hardjowirogo's criteria for

⁴ Elsewhere I have argued that a new category of 'machine-instruments' is needed to better represent the instrumentation of studio-based music. See (Mooney 2021).

musical instrumentality, they seem to fall radically short, or have a vexed relationship, with others. Perhaps this is one of the reasons why Le Caine appears to have been divided about whether these devices should be called ‘musical instruments’ or ‘tools.’

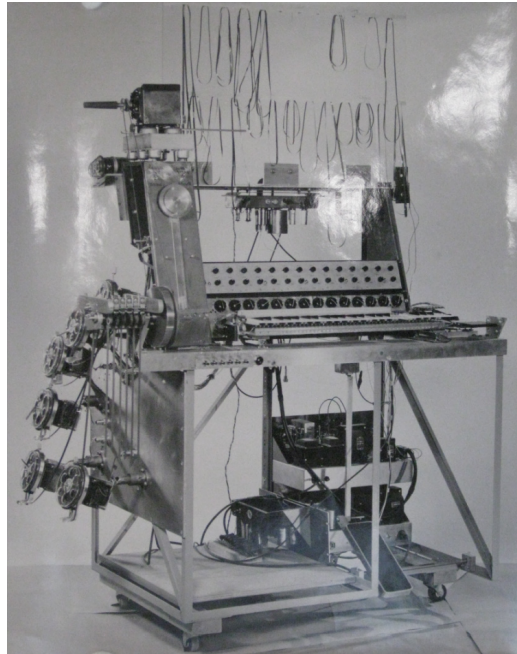


Figure 1. Prototype ‘Special Purpose Tape Recorder’ designed by Hugh Le Caine.
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Source: Library and Archives Canada/Hugh Le Caine fonds/MUS107/2 1979-17.



Figure 2. ‘Special Purpose Tape Recorder’ designed by Hugh Le Caine. Author’s own photo used with permission of Ingenium: Canada’s Museums of Science and Innovation.

4. Max Mathews, Joan Miller, and ‘The Digital Computer as a Musical Instrument’

Max Mathews, a telecommunications technician and later researcher working at AT&T’s Bell Labs in the 1950s through 80s, was in some ways more radical in his instrumental thinking. In

1963 he published his landmark *Science* article ‘The Digital Computer as a Musical Instrument’ (Max V. Mathews 1963). Figure 3 shows the kind of computer he was talking about: Bell Labs’ IBM 7094 data processing system, while Figure 4 is a photograph of a similar system that gives a better impression of scale and shows more of the system’s components (which I have labelled).

Nowadays, most electronic musicians will be familiar with the idea of ‘virtual instruments’, where, conceptually, the instrument does not exist *physically* but, rather, resides in the immaterial space of digital simulation. Hence, it may be tempting to assume that this is what Mathews meant: that it was not really the *computer* that Mathews was referring to as a musical instrument but, rather, the *virtual* instrument that resides within the computer’s memory. That would, however, be a misinterpretation, I argue. Close reading of Mathews’ writings reveals that he *really* was referring to the *digital computer*—a room-sized appliance of multiple interconnected hardware components—as a musical instrument, and that for him, the process of programming a virtual instrument was one possible way of *playing* this instrument. (He went on to develop others, such as the GROOVE system (M. V. Mathews and Moore 1970) and Radio Baton (Max V. Mathews 1991), taking advantage of rapid increases in computing power.)

As Mathews explained in his 1963 article, the digital computer is capable in principle of producing any sound—any waveform—as a sequence of numbers. This makes it unique as a musical instrument, but, as he goes on to say in a section tellingly entitled ‘Playing a Computer’, it also creates a problem for the player of this instrument, because ‘to specify individually 10,000 to 30,000 numbers for each second of music is inconceivable’ (Max V. Mathews 1963, 554).⁵ To address this problem of playability, Mathews continues, researchers at Bell Labs wrote ‘a program for computing the many samples’ (Max V. Mathews 1963, 554). The program Mathews goes on to describe—actually two programs—is what later came to be known as ‘MUSIC’: one program allowed the user to specify, on IBM punched cards, the parameters for a set of simulated ‘instrument-units’⁶ known collectively as an ‘orchestra’; the other program allowed the user to specify, again on IBM punched cards, parameters for a so-called ‘score’ to determine which sounds the simulated instrument-units should produce. Upon loading Mathews’ program together with the orchestra and score cards into the computer, the computer would calculate the sequence of numbers required to represent the resulting waveform and output this to IBM-format digital tape via utility programs written by programmer Joan Miller (Miller and Mathews 1959). This digital tape could then be played back via a custom-made digital-analog converter called ‘Tapex’ (Cutler and Netravali 1984, 150). Only then would it be possible to hear the sonic results.

The process described in the previous paragraph was, for Mathews writing in 1963, what ‘playing a computer’ involved. This is a radical departure from the orthodox model of musical instrumentality outlined by Hardjowirogo, where (criterion 4) there is expected to be a degree of ‘immediacy [...] between the instrumentalist’s actions and the instrument’s sound’ (Hardjowirogo 2017, 19). That is clearly not the case with Mathews’ system, which, *au*

⁵ 10,000 to 30,000 Hz were the sampling rates Mathews was working with.

⁶ Note: not ‘instruments’ but ‘instrument-units’. This point is important because it supports the argument that, conceptually, Mathews viewed the *computer itself* as the ‘instrument’ and the specification of virtual instruments—or ‘instrument-units’ as he calls them here—as the method of playing. Instrument-units were, in turn, built from smaller interconnected virtual components that Mathews referred to as ‘unit generators.’

contraire, introduced a very significant time-gap between the action of specifying parameters on punched cards and the eventual production of the sound. Furthermore, there was no longer a direct connection between the physical, bodily gestures of the musician and the expressive control of sound (5). And, while there can be no doubt that conceptualising and programming virtual instruments were difficult techniques that took time and practice to master, those techniques were not generally demonstrated in public, removing the element of virtuosic spectacle (3). Even if they were publicly demonstrated, the time-gap between programming and sounding results would likely destroy an audience's perception of liveness in any conventional musical sense (7). If anything, then, Mathews' and Miller's proposition of 'the digital computer as a musical instrument' was even more radical—when judged against Hardjowirogo's criteria—than Le Caine's concept of the 'tape recorder as a musical instrument.'



Figure 3. Bell Labs's IBM 7090 Data Processing System.
Image used with permission of the Computer History Museum.

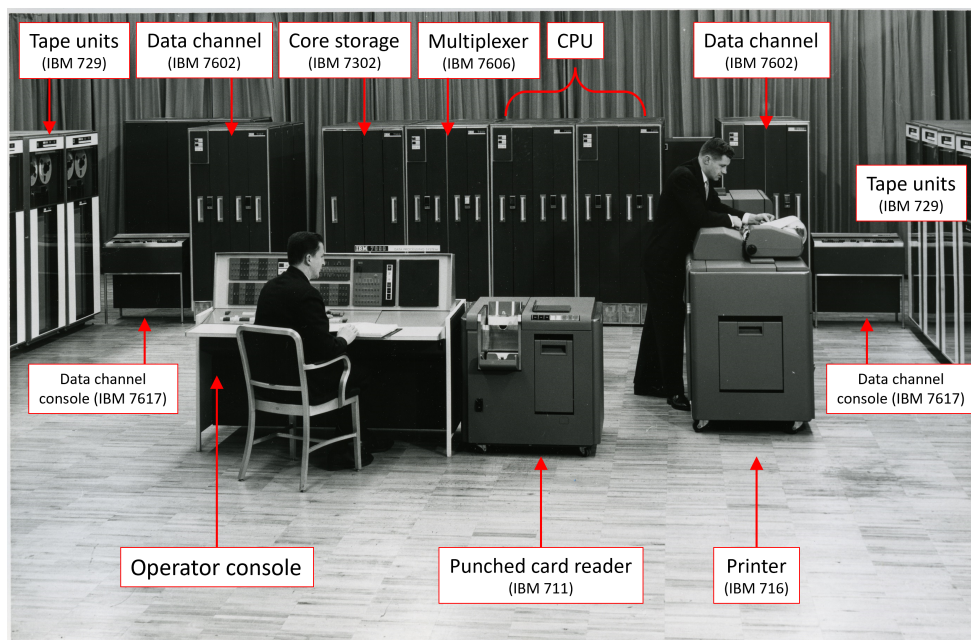


Figure 4. Another IBM 7090 Data Processing System. Annotations by author.
Image used with permission of the Computer History Museum.

5. The Studio as a Musical Instrument

Tape recorders and, later, digital computers became central components of electronic music studios, along with other interconnected devices. One example of a well-equipped institutional studio of the mid-1960s was the IPEM studio in Ghent, Belgium, which in 1966 comprised some 62 individual devices (according to IPEM's technical director, Walter Landrieu, 1927–2005), including tone and noise generators, microphones, sequencers, and so on (Landrieu 1966). Another was the University of Toronto studio (UTEMS), whose facilities included two of Le Caine's tape recorders as well several other devices designed by Le Caine, by the studio's director, Myron Schaeffer (1908–1965), and a range of commercial hardware (Le Caine 1966). Many studios were more modest than these, of course. As Hugh Davies noted in his *International Electronic Music Catalog* of 1968, many of the 560 studios listed in that publication 'consist[ed] of only the barest minimum of equipment (such as one microphone and one tape recorder)', 'collected together into a "studio" just for the realization of a particular composition' (Davies 1968, xiii). Meanwhile, computers were associated with the activities of only a small handful of studios and did not start to become *common* studio fixtures until at least two decades later.⁷

With the proliferation of studios in the 1950s and 60s arose the question of their instrumental status. IPEM's director, Hubert Vuyksteke (1904–1964), and artistic director, Louis De Meester (1904–1987), referred to the studio as an 'electronic ensemble', a term suggesting

⁷ In Davies's *Catalog*, the use of general purpose computers is associated with the activities of only 23 studios, just over half of which were in the United States. In most cases the computer was not installed in the studio itself but, rather, at the computing centre of an institution, such as a university (often the same university where the studio was based) or corporate research facility like Burroughs (Pasadena, CA) or Bell Labs (Murray Hill, NJ) (Davies 1968, 307–14).

multiple instruments working together—but they also referred to the entire facility as a single instrument (n.a. 1962).⁸ Similarly, Le Caine and his Toronto colleagues Myron Schaeffer and Gustav Ciamaga referred to individual studio devices as ‘units’ or ‘component instruments’ (Le Caine 1963, 1), suggesting that the studio functions as a single instrument while at the same time being made up of multiple component instruments. As Ciamaga put it in a letter to Le Caine, ‘the composer in a studio specifies the instrument by patching an arrangement of apparatus’ (Ciamaga 1971).

Although the concept of the ‘studio as musical instrument’ has occasionally resurfaced in musicology,⁹ generally speaking, studio technologies have tended to be regarded as different in kind from what most people would understand as ‘musical instruments.’ Perhaps the most radical difference, thinking again of Hardjowirogo’s criteria, is that when such devices are used within the off-stage confines of a studio, they are by definition not being used to perform music live in front of an audience. Hugh Le Caine recognized this in 1959 when he proposed a categorical distinction between live performance instruments on the one hand, and instruments that allow music to be composed ‘out of time sequence’ on the other (Le Caine and Bowsher 1959). In the wider public imagination, however, the term ‘musical instrument’ still seems to be most readily associated with live performance instruments, while instruments that allow music to be composed out of time sequence tend to occupy different categories, like ‘apparatus’, ‘devices’, ‘machines’, or ‘technology.’

6. Conclusion: Bridging a Cultural Schism

Why is the aforementioned state of affairs a problem? Why does it matter if most people tend to think of the tools of studio-based music creation as ‘technology’ rather than ‘musical instruments’? One reason it matters, I argue, is because it exacerbates a cultural schism between the domains of instrumental music and music technology that is detrimental to both constituencies.¹⁰

The idea that studio devices are ‘technology’ rather than ‘instruments’ sometimes goes hand-in-hand with the assumption that the skills associated with studio-based music creation are not properly *musical* skills, or that electronically-generated or -manipulated sounds are ‘gimmicks’ with no serious aesthetic value.¹¹ Such assumptions are, of course, detrimental misrepresentations of the creative disciplines of music technology. The need to actively advocate for the creative and aesthetic legitimacy of electronic music in the face of scepticism has a long history, as I have discussed elsewhere (Morgan and Mooney 2021)—and this is

⁸ [*elektronisch ensemble*].

⁹ Note, for example, the titles of Adam Bell’s book, *Dawn of the DAW: The Studio as Musical Instrument* (Bell 2018), chapter 4 of Susan Schmidt Horning’s book, which is ‘When High Fidelity was New: The Studio as Instrument’ (Horning 2013, 78–103), and chapter 2 of Virgil Moorefield’s book, entitled ‘The Studio as Musical Instrument’ (Moorefield 2010, 43–78).

¹⁰ For an account of some of the implications of that schism in the context of UK higher education in ‘traditional music’ and ‘music technology’ degrees, see (Born and Devine 2015).

¹¹ This view came to the fore in popular music discourse in the 1960s, a period when electronic musical instruments and studio techniques were making increasingly prominent in-roads. One prosaic example can be found in the cover text for the American surf-rock band The Ventures’ 1964 album, *(The) Ventures in Space*, which proudly declares that ‘all of these unusual and other-worldly sounds have been created with musical instruments rather than electronic gimmicks’ (The Ventures 1964).

partly, I suggest, because the instrumentality of studio-based music-making is not well recognised and understood outside the social circles of music technologists and their closely associated constituencies.

The cultural schism at issue also acts to the detriment of institutions that are more readily associated with ‘traditional’ models of musical instrumentality and would like to represent electronic and studio instruments better than they currently do. The American Musical Instrument Society, for instance, has been making clear gestures in this direction for a number of years now, most recently in the call for papers for its 2022 annual conference, which stated that ‘[p]resentations on topics relating to [...] electronic music are especially encouraged’ (American Musical Instrument Society n.d.). Similar efforts have been pursued in the UK by the Musical Instruments Resource Network (MIRN) and Galpin Society. And yet, in musical instrument studies journals, the number of articles that focus on electronic instruments remains stubbornly small, while the number that focus on studio instruments appears to be even smaller.¹² This situation is perpetuated, I suspect, by a lack of music technologists among the membership of the associated musical instrument societies.

I would like to conclude, then, by suggesting that reclaiming a sense of instrumental identity for the tools and techniques of studio-based music would help to bridge a cultural divide, benefitting parties on both sides. To bridge that divide would require the acceptance of an expanded concept of musical instrumentality that includes off-stage, out-of-time processes of studio-based music creation rather than excluding them, and admits as ‘musical instruments’ the full range of devices that are used to create and manipulate sound electronically in the studio, as I have recently advocated elsewhere (Mooney 2021). Revisiting historic debates around instrumentality to frame the advent of studio-based music creation as a radical shift in musical instrumentation represents one possible pathway toward achieving those goals.

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¹² A full literature search is in progress. Indicatively, searching the *Galpin Society Journal* (via JSTOR) for the keyword ‘electronic’ suggests that, up to 2015, there were no research articles in that journal that focussed exclusively on electronic or studio instruments, and only 2 articles that made any significant mention of such instruments as a sub-topic (Montagu 2006; Anderson 2009). In the past 5 years, the *Journal of the American Musical Instrument Society* has published (non-exhaustively) an article on David Tutor’s electronic instruments (Nakai 2017) and one on Elisha Gray’s Musical Telegraph (Knight 2019), though in general electronic instruments seem to be poorly represented.

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