Issues of ubimus archaeology: Beyond pure computing and precision during the analogue-digital transition

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Abstract. *The transition between the analogue-based practices of the 1950s and the digitally based techniques employed during the 1960s provides an interesting confluence of factors that may illuminate some of the challenges faced by post-2020 music making. We apply a ubimus archaeological perspective to address two aspects of creative practice: precision and simulation. Our discussion is based on first-hand sources extracted from the repository Fonds Risset and on a selection of writings by key early practitioners.1 We provide a working definition of ubimus archaeology and furnish documental evidence to challenge the assumption of precise methods and pure computing in the early days of digital music making. We question the current strategies of repurposing, highlighting the emergence of conflicts between sustainability and innovation.*

"[We should not] presume to tell a composer what should or should not be done but rather what the results might be if a given thing is done".

James Tenney (1963)

1. Introduction

Arguably, the two decades spanning the 1950s and 1960s featured some of the most radical changes in music making of the last few centuries. These changes set in motion many of the large-scale technological and cultural transformations that we witness today. For instance, the widespread usage of synthesised sound has its origins in the early experiments with analogue equipment that took place in the 1950s. The first compact and portable synthesisers were introduced during the following decade. The first application of digital technology to music making was done in the early 1950s in Australia and the first fully computational works -- encompassing not only symbolic data but also digitally generated sound -- were realised in the late 1950s and early 1960s at Bell Labs [Doornbusch 2004; Tenney 1963].[1]

In previous works, Lazzarini and Keller (2021) addressed part of the targets and challenges laid out by an archaeological approach that takes into account not only the music made during the 50-60 transition, but also how it was made [Lazzarini and Keller 2021]. Their assumption is that the available technology constrained the way artists and developers approached music making, but at the same time the artistic and societal demands pushed forward an agenda of technological expansion. This situation was geographically localised and only included the large institutional facilities located at the central countries, which could spare funding for "low-priority" activities such as music – see [Keller and Costa 2018] for a summary of historical trends that led to the emergence of ubimus.

[1] http://sfsound.org/tape/Guttman.html.

The technologists' and artists' discourses of the time, despite demonstrating awareness of the innovative profile of their contributions, often emphasise obscure or ad hoc aspects of their work. Granted, it is very hard to assess how a new technique or conceptual framework will impact artistic practices before the resources have been widely deployed in the field. Thus, a theoretical perspective grounded on current knowledge may have better chances to filter the actual contributions within a distinctly proselytist discourse of the time. This is one of the reasons why the ubimus approaches could yield new light on veiled, controversial or unresolved issues of the past. According to Parikka (2012), "we do need many more critical archaeologies of post-World War II cultures of computing; software and design; the institutionalisation and commercialization of software production as well as open source; the military-industrial complex behind the emergence of network culture; the formations of creative labour and work inherently connected to new forms of production; alternative media that emerged from open source as well as hacktivists engaging in hardware hacking and circuit bending" [Parikka 2012: 2]. While not necessarily targeting all the aspects listed by Parikka, we believe archaeological ubimus (a-ubimus) may furnish useful contributions for the study of past music making, complementing the proposals focused on media products.

Take, for instance, the claims of precision. Much of the early electronic music writings are filled with passages describing the importance of precise methods in electroacoustic music [Eimert 1957]. Little is said about the intrinsic limitations of the interfaces of the electrocoustic analogue-based studios. Did these limitations work against or in favour of this music? Is the unavoidable randomness of the methods of realisation of analogue sound a flaw that had to be eliminated or did this characteristic set this family of sounds apart from more easily replicable techniques? Furthermore, early electroacoustics trends were characterised by harsh and dismissive arguments between the adopters of synthesised sounds and those who worked from recorded sources – cf. Risset's comments in Erbe and von Blumröder (2008). These biased views of the sources also implied prejudices regarding the development of techniques, hence stalling advances and creating barriers. Incorporating technological support without introducing unnecessary constraints in the ways of thinking about creativity is one of the targets of the ubimus movement. We address this issue as an attempt to clear the ground for future a-ubimus endeavours.

This paper addresses the 50-60 transition through an archaeological ubimus perspective. Firstly, we attempt to provide a working definition of the field through a revision of the concepts laid out by Tenney (1963). The next section deals with an issue that is time and again invoked as a central feature of digitally enabled music making: precision. We place this claim within the context of the proposals emerging from the early electronic music practitioners and we contrast it with the material and procedural limitations encountered by first experiments in digital music making. Then we address two aspects that may configure potential contributions of a-ubimus endeavours: sustainability and replicability. These issues are considered both from their implications in post-2020 practices and from the analysis of the procedures applied by Jean-Claude Risset in his early computer-based projects. The last section provides the conclusions and points to future avenues of inquiry.

2. A working definition of archaeological ubimus

A perspective on music theory (initially applied to a theory of harmony) laid out by a pioneer of computer music, James Tenney, may furnish a useful prism for archaeological ubimus initiatives. Tenney proposes a general and flexible definition of theory: "the analysis of a set of facts in relation to one another [...] the general or abstract principles of a body of fact[s], a science, or an art [...] a plausible or scientifically acceptable general principle or body of principles offered to explain phenomena." He lists three requirements for this framework. "First, it should be descriptive – not pre- (or pro-)scriptive –and thus, *aesthetically neutral*. That is, it would not presume to tell a composer what should or should not be done but rather what the results might be if a given thing is done. Second, it should be culturally/stylistically general — as relevant to music of the twentieth (or twenty-first!) century as it is to that of the eighteenth (or thirteenth) century and as pertinent to the music of India or Africa or the Brazilian rainforest as it is to that of Western Europe or North America. Finally, [to] qualify as a 'theory' at all in [a] pervasive sense [...], it should be (whenever and to the maximum extent possible) *quantitative*." [Tenney 2015: 281-282, our italics].

Some aspects of this definition need to be tuned to account for the changes in scientific orientations and music perspectives post 2020, but they remain mostly valid and applicable as a provisional definition of ubimus archaeology. We highlight two features: aesthetic neutrality and quantitative methods. Tenney complements aesthetic neutrality with an attempt to reduce the biased perspectives of culture which characterise the discourses of the time. In ubimus terms, this view can be labelled decolonial and situated (cf. Keller, Messina and Oliveira 2020). These perspectives have been applied in multiple ubimus projects involving a variety of stakeholders and locations [Brown et al. 2014; Aliel et al. 2018; Lima et al. 2012], featuring both situated approaches [Keller 2018] and decolonial frameworks [Messina and Aliel 2019]. Paraphrasing Tenney, music making in the Brazilian rainforest becomes just as valid as music making in the Russian tundra or in the Australian desert.

As suggested by Lazzarini and Keller (2021: 2), software archaeology not only engages with computer code, it also needs to take into account the culture in which the code is deployed. The design decisions (materialised as software) reflect multiple negotiations among the stakeholders to grapple with contextual factors that lie beyond simple, immediate and utilitarian purposes. These factors point to ethics, aesthetics and cultural forces that constrain and shape computing. Therefore, the perspectives of culture featured in decolonial and situated ubimus practices might have better chances to avoid the pitfalls of the self-centred discourse found in several discussions of aesthetics of the 50-60 transition – examples of the latter can be found in [Babbitt 1958/1998; Eimert 1957].

Tenney's call for quantitative methods is probably grounded on the small number of experimental studies of the 50-60 transition. Current ubimus approaches involve both quantitative and qualitative techniques within the context of practice-based research. A key difference with other approaches in media archaeology is its strong emphasis on hands-on methods. As ubimus practitioners, we are not only interested in expanding our understanding of music consumption or musical products, we also want to expand our knowledge of the creative processes involved in music making. Thus, implementing and recovering working software and hardware from extant traces or relics is an initial and particularly relevant stage of archaeological ubimus methods. The obtained ubimus replicas can be employed not only to validate or to question the theoretical underpinnings, they also serve to expand the range of creative outcomes in the form of both epimusical and extra-musical resources.[2] In turn, these resources help to fine tune and assess the design strategies thus providing the material groundings for the selection and validation of design techniques.

In other words, a-ubimus constitutes a distinct approach to the study of technologically grounded music-making of the past that engages with the use of tangible and intangible resources and that points to geographically and culturally diverse ways to deal with creativity. A key aspect of this framework is its reliance on practice-based research to unveil creative

[2] Keller, Messina and Oliveira (2020) define epimusical resources as those which have direct impact on sonic results.

processes that may be obscured by the discourse of the stakeholders or by the use of a frozen snapshot of the musical work as an isolated ‘object’. In this sense, the targets proposed by Lazzarini and Keller (2021) may prove to be useful to complement the musical works as archaeological units of study. These include the implementation of working replicas that yield potentially meaningful sonic results and the analysis of ecosystemic interactions by means of partial reconstructions of extinct or hard-to-access musical experiences.

3. To be or not to be, precise

After a decade of the application of serial techniques in analogue studios (cf. Babbitt 1958/1998; Eimert 1957), the overblown insistence on the importance of precision was inherited by most of the early practitioners of digitally based music making. The awkwardness of the hardware and the obtrusive procedures imposed by the early computer facilities demanded the adoption of low-resolution sound rendering and, for practitioners that employed symbolic data in their music, also involved an extremely laborious process of decodification for musical purposes.

Anybody that has worked through the process of splicing tape knows the amount of extra work demanded by analogue editing. Risset`s (2008) description is illustrative of the caveats of the early analogue-studio methods. “If you have to cut into the tape, you take the tape out of your machine, you take the scissors and you cut. That's a decision you most likely can't repair: you can re-glue it but you hear the edit most of the time. Working with [a DAW] is different, since you have virtually unlimited steps of undo as opposed to the tape-scissors situation where one has to say: I'm doing this now! And then I'm going from that step onward” [Risset 2008]. The irreversible quality of the operations on the material support forces a strong reliance on planning and limits the amount of exploratory actions for decision-making. Thus, it could be argued that from an interaction perspective, analogue editing demands a *higher* level of precision than digital editing. Similarly, the process of transcribing data to notation was anything but straightforward. Aesthetic decisions were made throughout a complex and laborious process implying a wide range of considerations not accounted for by the “precise computer” discourse.

Julio Estrada worked with Xenakis throughout the development of the UPIC system and was involved in the early phase of computer-generated data transcriptions into instrumental notation. He argues that “transcribing graphical recordings has become a central issue of the methodology here described, both as an attempt to record data with precision and as a new process for creating a score. From an aesthetic perspective, transcription as conversion maintains an identity closer to the original object in which the resulting score becomes a realistic, figurative version. In turn, transcription as a compositional choice leads to a dialectic between the original object and the score, or even between it and its permutational or topological variations” [Estrada 2002: 88]. Hence, the second class of processes described by Estrada did in fact involve aesthetic decisions that lie beyond the reach of ‘precise’ computational methods. Current approaches may rely on a more intense level of automation. But this refinement of automation is often related to a reduction of the parametric details demanded from the user rather than to the type of precision defended by Stockhausen and others (although, through a positive prism, this could also be construed as craft or refinement through exploration). So the tendency that we observe when comparing the 50-60 practices with post-2020 methods is an increased reliance on computational decisions which do not necessarily reflect an increase in human control of the creative processes or an increased demand of craftsmanship [Keller, Aliel, Filho, Costalonga 2021].

The parallel suggested by Estrada of a “realistic, figurative” aesthetic versus a generative or abstracted usage of the data is also worth considering. The adjective ‘real’ in this context is misleading. We are dealing with computationally generated data transcribed to allow for acoustic-instrumental performance. No material phenomenon is being modelled. Hence, ‘direct’ may be a more accurate description of the process. Nevertheless, direct does not necessarily mean automatic. Work-intensive stages, such as card-handling, may be necessary for direct transcriptions. On systems that did not support sound-rendering, it could take several weeks (and sometimes months) before any sonic outcome could be obtained.[3] Consider Beauchamp’s description of the standard computer-music practices of the time. “While the digital computer proves to be an excellent sound synthesizer, ordinary analog techniques are much more convenient for producing the final orchestration of the individual sounds. This is due, in part, to the difficulty of predicting combinational nuances. At the present stage of the art of computer music, computer ‘voices’ do not adjust their amplitude levels of their own accord to provide an aural balance. Therefore, in order to work efficiently on a large scale, the composer – programmer must have a very good intuitive grasp of the ‘acoustical laws’ which relate amplitude and spectrum specifications to the actual [loudness and timbre rendered and perceived]. Also, prediction is not enhanced by computer turn-around times in excess of several hours” [Beauchamp 1971: 349]. Beauchamp underlines the limitations of the hardware of the 1960s in providing support for mixing. This is confirmed by various practitioners of the time, such as Risset. He dates his first exclusively digital piece in the year of 1998. Hence, claims of pure computational approaches need to be critically assessed since – with the exception of Tenney`s Ergodos I (1963) – the compositional processes usually involved an important stage of decision-making by means of analogue editing and mixing.

Consequently, direct transcription during the 50-60 transition may be described as three separate cognitive stages: 1. Planning and implementation, 2. Data generation and selection, and 3. Sonic rendition (acoustic or computational). Each stage involves its own set of tools, outcomes and assessments which are not necessarily integrated with the evaluation of the final sonic results. This detachment between compositional thinking and sonic outcome is not exclusive of the digital milieu. It is shared with most forms of acoustic-instrumental practice, particularly those that rely on the mediation of the score as a knowledge-sharing mechanism. Furthermore, the strong reliance on analogue procedures for the final stages of the compositional work places a question mark on the claims of “pure computing”.

4. Computer Music as Simulation

From a Computer-Science standpoint, an interesting aspect of early digital music is how the software quickly evolved from basic non-programmable sound-synthesis methods to more flexible compositional environments. This development anticipates the appearance of object-oriented languages (acknowledged to have begun with the Simula language in the mid 1960s). Mathews’ MUSIC III system, which is possibly the earliest sound-synthesis programming environment, already embodied basic principles of object orientation, even though it was based on a limited set of assembler macros. It introduced the concept of *unit generators* as building classes for sound processing which could be instantiated to make up an *instrument*, the computational instrument being defined as a class instantiated to process sound.[4] This idea was then carried on to MUSIC IV, which provided the model for many systems to follow, including

[3] An example of this situation is reported by the composers working at Princeton, who took their cards to the Bell Labs facilities and had to wait for the queue of tasks to be processed before they could retrieve their sonic results.

[4] A detailed discussion of the parallels and differences between the instrument as a computational concept and the acoustic instrument as a music socio-technical device are beyond the scope of this paper. See [Keller et al. 2021] for philosophical aspects linked to ubimus and [Lazzarini 2013] for a technical treatment of the computational aspects.

several tools used to this day such as Csound, SuperCollider, Pure Data or Max.

Lazzarini (2013) discusses in detail how the object-oriented paradigm (OOP) is useful for the development of musical signal processing environments. Another dimension to this is how OOP enables the implementation of *simulations* in a fairly straightforward way. This application opens a new perspective for ubimus initiatives. We can conceptualise the use of the computer for music making as a simulation of an imagined musical space. The 50-60 transition composers partially engaged with this strategy, for example in the modelling of certain sonic behaviours and dynamically evolving textures. This perspective has several implications for the design of creative support for music ideation. A classic example is Risset's experiments with acoustic illusions such as his translation of Shepard's never-ending scale as a sequence of continuous glissandi.

More generally, the principle of simulation is increasingly becoming a significant feature of modern music software, impacting the commercial and professional spheres. Many tools (e.g., plugins) are nothing but simulations of existing hardware. This is of course a pedestrian application of the idea. Nevertheless, it can gain a wider scope for diverse creative uses in collaborative music making including the difficult challenges posed by lay-musician interaction. From an archaeological perspective, the ability to simulate the behaviours of extinct systems without demanding a large investment in hardware reconstruction and maintenance opens a promising avenue to explore ways and means of creative action without a negative impact on sustainability.

The next section of the paper provides an example of the application of a-ubimus to analyse the implications of the analogue-digital transition on Risset's creative strategies for his theatrical music project Little Boy. We present original findings grounded on first-hand sources found at Fonds Risset. The documents are included as supplementary materials.

5. Case study: Analogue procedures in *Little Boy*

Lazzarini et al. (2022) report a valuable collection of *Little Boy* MUSIC V scores included in Fonds Risset. Besides the MUSIC V printouts, the call number W20_003_2 contains numerous handwritten notes. Pages 11-13 are entitled *nouveau mixage pour le fanfare: entièrt computer. Episodes 16, 17, 18.* Page 15 is a sketch for the design of a feedback amplitude modulation instrument. Page 20 entitled *Fanfare by Feedback* is an interesting example of a working process that involves both analogue and digital approach from the planning phase (Figure 1). It shows how Risset modifies the tempo of *Fanfare* section from 0.125 for the eight note (BPM 120) to 0.1024, at first sight an irrational decision. This tempo increase of 20% is explained thus: "all the notes must occur [as a multiple] of 512 samples [to avoid] feedback trouble". Without detailing what the 'trouble', Risset suggests that the obtained tempo is "a little faster (but can be corrected with [the use of a] variable speed tape recorder or sampling rate [adjustments] if necessary)." On the same page there is an example of a CONVT subroutine that implements this tempo change. These observations point to two issues: a) work with MUSIC V involved constant revisions of the source code based on partial sonic results, and b) analogue methods were an integral part not only of mixing and post-processing, the entire creative compositional process was approached with analogue solutions in mind.

Risset appears to have used the full potential of an analogue electroacoustic studio. Page 92 (Figure 2), entitled *Mixage Contre apothéose. Episode 23,* gives us more details on the role of analogue mixing as a compositional process. Besides a list of magnetic tapes used for overdubbing, there are several indications of different tape speeds (7 ½, 10, 15 or 30 ips[5]), indications on stereo panning and rather vague temporal indications of different events ("qqs seconds après le début"). Additionally, part of the tapes were played backwards ("longs accords feedback fanfare triomphe à l'envers" and "...puis Manh.Bl.[6] ± alteré entre 2 channels avec drum[7]. A la fin Manh.Bl. à l'envers"). Additionally, reverb was added (indicated on page 93, not included in the supplementary materials).

The outline for the mix on pages 93 to 95 provides evidence of Risset's compositional ideas that precede mixing, but succeeded the sound generation process. Due to the duration limits or due to the impossibility to generate multitrack audio digitally,[8] Risset was forced to apply analogue-based solutions from the beginning of the creative process. These solutions were not just cosmetic. On the contrary, they are an essential part of the process. Thus, composing was approached as an analogue-studio activity, with the exception of the generation of sonic sources. The call number W20_003_3 (typewritten pages 10-12, entitled MUSIQUE POUR LITTLE BOY : EPISODES SUR BANDE) provides evidence to support this notion (Figure 3). Some of the section titles on the score printouts are somewhat cryptic (*bruit de caméra*, *Klaxon*, etc.) and not referred to in Risset's documentation of *Computer Suite for Little Boy*, but these three pages clarify the situation.

Twenty-three episodes are listed with their exact durations, the keyword lines for starting the playback and a short description of the sounds. It seems that the preserved scores of *Little Boy* were initially meant for the theatre play *Little Boy.*[9] But it remains unclear whether Risset targeted an independent piece at the moment while working on the composition for the play. In any case, our initial findings support the thesis that *Computer Suite for Little Boy* might have been an analogue mix of the digital sounds produced for the play *Little Boy*. As a bonus, we can now consider not only the reconstruction of *Computer Suite for Little Boy* but also gain preliminary insights on its first incarnation – the music for the play *Little Boy,* of which neither audio nor video documentation exists.

6. Wrapping up and future steps

A working definition of a-ubimus targets the usage of traces from the past to illuminate the relationships among the material and intangible resources in music making. It implies an open and flexible approach to aesthetics that takes into account the local social and cultural needs. It also involves the application of hands-on methods to unveil not only aspects of the musical products but also the limitations and opportunities afforded by artistic ecosystems that may have become extinct or inaccessible.

How big was the impact of precision when the tasks entailed punching hundreds or thousands of cards, then running multiple iterations of very short snippets of sound and eventually combining these low-resolution sonic snippets by means of analogue recording equipment (which had its own idiosyncrasies)? Our explorations of Risset's documents, our usage of the MUSIC V platform as a faithful replica of the original sources and our analysis of the demands and

[5] Inches per second.

[6] Mahn.Bl. (Manhattan Blues) refers to Paul Desmond's *Take Five* recorded by Dave Brubeck Quartet. This may also point to the Manhattan Project that yielded the first nuclear weapons.

[7] Risset often mixes French and English in his annotations.

[8] MUSIC V disposes of the adder, a generator that permits summing up to four signals together. In *Little Boy* score code it was not used for mixing purposes, possibly because of the difficulties of controlling the levels of each individual signal input.

[9] *Little Boy*, a play by Pierre Halet with music composed by Risset.

expectations of the practitioners of the 50-60 through their published reports indicate that 'precision' was likely an overloaded word when analysed from a post-2020 perspective. Intuitive and unobtrusive procedures for copying and mixing digital sounds only became available during the 1990s. These techniques underlie the development of the Digital Audio Workstations. Thus, because the 50-60 transition continued to rely heavily on analogue tape-based editing and mixing, the creative cycle involved several stages of decision-making that demanded cognitive processes divorced from the digital realm and compromised any computationally 'precise' outcomes.

Despite Stockhausen and other electronic-music composers' efforts to eliminate the impact of contingencies, the inexact interfaces of the analogue studios may have added variability[10] to the analogue-based musical processes and products (see a current interaction-design strategy through the application of the concept Gelassenheit to enhance originality in ecomprovisation – Aliel et al. 2018; Messina and Aliel 2019). Within the digital realm, Tenney's approach contrasts sharply with the insistence on precision voiced by almost all the technologists and artists of the time. He explicitly targets variability and adopts computational methods that strive to yield nuanced results through the incorporation of randomness.[11] Working independently and possibly unaware of each other's works, Tenney and Xenakis lay out the basis for a significant family of compositional techniques that would only start to be thoroughly explored and understood during the 1980s [Roads 2012; Truax 2015].

Given the widespread impact of the Capitalocene on the planet [Crutzen 2002; Moore 2016], how can we deal with the menace of disposable technology? Ubimus archaeology may open a window to the past that could furnish useful information on both the computational and the artistic strategies applied before, during and after the execution of a musical project. Some of these strategies may involve design choices that make sense at a specific historical context but over the years they eventually become conceptual culs-de-sac. Some strategies may survive as legacy approaches which linger on despite their drawbacks. And finally some of the early designs may prove their applicability in multiple contexts despite the sharp differences in social and aesthetic expectations between past and current music practises. Future a-ubimus deployments may need to address these three types of strategies in light of the current targets on technological sustainability. The issues involved in creative endeavours, as unveiled by our analysis of Risset's practices, may demand compromises pushing toward an increase of the creative potentials in some cases and holding back innovation to foster stable infrastructure and reliable know-how in other cases.

The adoption of repurposed hardware sometimes may imply inheriting the limitations and the biases of the extant hardware designs. Risset's annotations and the multiple iterations of Mutations and Little Boy indicate that the available hardware constrained the compositional processes employed in these pieces, forcing alternative solutions such as the usage of analogue mixing. Also, his change of focus from applying alternative tunings to the exploration of new timbral possibilities related to sonic perceptual phenomena was very likely encouraged by the specific possibilities afforded by MUSIC V. This may indicate that while a stable technological infrastructure tends to reduce electronic waste and is potentially good for the planet, its stability may also reinforce preconceptions on the aesthetic targets of music making. Whether this

[10] Howe's remarks on the lack of precision of the analogue synthesis equipment question the relevance of the minutely overspecified pitch structures in Stockhausen's *Studie II*, based on microtonal differences: "As tedious as it may seem, the process of piecing together each individual melodic strand is often not so difficult as the process of producing the individual sounds desired in the first place. The oscillators in classical electronic music studios are often so unstable as to make it impossible to produce music with tempered pitches" (Howe 1975, pp. 64-65).
[11] Despite his arguments and careful documentation of compositional methods which show a conscious usage of randomness, Tenney also had difficulties to avoid the precision-centric discourse.

perspective proves correct or not will demand comparisons between historically documented practices and observations of creative processes supported by working replicas in post-2020 contexts. This is one of the threads of future archaeological ubimus initiatives that may flourish in the next few years.

7. Supplementary Material

Figure 1. https://doi.org/10.5281/zenodo.6508655
Figure 2. https://doi.org/10.5281/zenodo.6508697
Figure 3. https://doi.org/10.5281/zenodo.6508699

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