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Author(s):	Gabriele Boccio
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Abstract

Electronic lutherie is often understood as the design or construction of new devices. This paper instead proposes reading it as a compositional condition, defined less by the object produced than by the position a composer occupies in relation to an instrumental and electronic apparatus. Building on the discourse of composed instruments, this study distinguishes three such positions—composer-luthier, composer-user, and composer-appropriator—through which the instrument may be composed, integrated, or appropriated. These positions are proposed as general within creative practices related to contemporary electronic lutherie. The repertoire for strings and electronics is examined here as a paradigmatic site, as it clearly stages the encounter between established historical lutherie and emerging practices from a new one. Three case studies follow: Michelangelo Lupone, whose systems embody compositional thought; Kaija Saariaho, whose electronics, sometimes optional, extend an autonomous instrumental imagination; and Johannes Fritsch, whose *Partita* (1965–66) appropriates practices and devices of the Cologne studio and, together with an inherited Baroque form, reorients them toward his personal experiences as violist and electroacoustic performer. Read as "porous" positions rather than fixed identities, these categories become a flexible analytical tool for tracing how agency is distributed among composers, performers, and acoustic and electronic instruments.

1.INTRODUCTION

1.1 Situating the question: composed instruments in existing discourses

In the repertoire for strings and electronics, electronic lutherie should not be understood solely as the design or construction of new devices. It may also be approached as a compositional condition in which instruments, gesture, analogue and digital processing systems embody specific aesthetic intentions and shape musical thought from within, intersecting in different ways. In this sense, the question is not only what a tool is, but how it bears the stamp of its creator, how it suggests particular musical purposes, and what forms of agency emerge when performers and composers interact creatively with it (Alperson 2008). Electronic lutherie, then, is also a way of organising technological relationships inside the performance configurations.

The conceptual ground for such an inquiry has been prepared, over more than two decades, by a substantial body of work on composed instruments and on the porous boundary between instrument-making and composition. For example, Marc Battier and Norbert Schnell introduced the notion of a composed instrument to describe computer-based systems in which the sound-producing and gestural performance components are decoupled, so that gesture is linked to sound production in non-direct ways; the instrument thereby comes to carry "as much the notion of an instrument as that of a score" (Battier 1999; Schnell and Battier 2002), destabilising the separation between tool and work. More recently, Tomás (2016; 2026) has extended this by arguing that the instrument's score is not intended as an external prescription imposed upon the device, but emerges from its material and symbolic affordances, mediating the performer's engagement with its sonic and physical properties—reconnecting this idea to the experimental practices of the Sonic Arts Union, where, in Alvin Lucier's account, the scores were inherent in the circuitry rather than written for it, and electronic instruments were already understood as embodying compositional elements. Furthermore, music researcher Marije Baalman argues that "the act of composition within electronic and computer music is conceptualising and building a system" (Baalman 2017). This perspective resonates with a broader discourse on the active role of invention and reconfiguration of technological means in musical practice. Quite recently, Stefano Alessandretti, Laura Zattra, and Paolo Zavagna (2021) argue:

> The musical instrument becomes the "instrumental apparatus" of the new electromechanical lutherie: one that eludes a classificatory approach centred solely on the mechanical means of sound production and its acoustic qualities, and that comes into being from the fundamental need to abstract the musician's mechanical labour through processes of digital computation.
>
> (Alessandretti, Zattra, and Zavagna 2021)

In their contribution, they introduced a collection devoted to the ways in which artists "invent the tools of their expression" (Fleuret 1985), emphasize how composers and sound artists have translated their musical thinking into technological inventions and, more broadly, how existing technologies may be "recontextualized" or diverted from their "native identity." This latter possibility is particularly relevant to the present inquiry, since the compositional agency invested in an apparatus need not originate in its design or construction: it may also emerge through the appropriation and reorientation of an existing technological environment. Together with the broader trajectory of digital lutherie—a field Jordà proposes to approach as

a form of craftsmanship (Jordà 2004)—and instrument studies (Bovermann et al. 2017), these contributions help to provide the horizon within which the present article situates itself.

The three figures discussed below extend this discourse by distinguishing different positions the composer may occupy in relation to the apparatus, with particular reference to electronic lutherie. A tripartite scheme already exists within the same genealogy: Schnell and Battier (2002) read electronic instruments through the categories of *instrument*, *machine*, and *representation*—a triad describing what an apparatus is and how it encodes a task. The present framework asks a different question instead, foregrounding the *position* the composer occupies in relation to the apparatus and the modes of authorial inscription that emerge when it is composed, integrated, or appropriated. One scheme classifies apparatuses, the other relations to them.

That the third of these relations has a longer history than the case discussed here is worth stating at the outset: composers in the Milan studio of the 1950s were expected to accept the constraints of the technical environment and to work through a technician, yet Berio, Pousseur and Cage quickly found degrees of liberty within it (Schnell and Battier 2002). Appropriation was already part of compositional practice before it became a category. It is also crucial to highlight that the three positions proposed here are not specific to bowed strings: they are offered as general to contemporary electronic lutherie. Sergi Jordà frames the underlying difference sharply: acoustic instruments impose their own rules of playability, leaving room for refinement of control but scarcely for capricious decisions or radical redesign, whereas the digital luthier begins from a condition in which any input may be linked to any output—a freedom whose difficulty is not scarcity but excess (Jordà 2004). Strings are chosen as their paradigmatic site because in this repertoire an old lutherie—sedimented over four centuries into the instrument's body, technique, and repertoire—is directly confronted with a new one.

1.2 Three positions: the composer as luthier, user and appropriator

These issues are addressed by identifying three complementary paradigmatic figures: the *composer-luthier*, the *composer-user*, and the *composer-appropriator*.[1] These are not rigid taxonomies but critical, heuristic models: they help articulate tendencies that often coexist, overlap, or shift even within a single composer's work. The discussion, therefore, does not aim at exhaustive historical coverage but focuses on three figures whose work illuminates distinct yet related ways of understanding the role of the instrument and the electronic apparatus in composition.

Michelangelo Lupone exemplifies the composer-luthier, for whom the compositional process includes the design of systems for synthesis, sound transformation, and spatialisation,

1 A word on terminology, since the verb "use" can carry more than one sense. Three questions need separating. First, what is used: in Saariaho's case a digital reverberation unit, a harmonizer and, in the later works, Max patches realised by others—that is, commercially or institutionally available processing, not instruments conceived for the work. Second, at what depth: she does not merely select these devices but configures them, prescribing reverberation time and wet amount in the score and, for the harmonizer, an exact programme and parameter set; what she does not do is conceive or build them. Third, whose relation to technology the term names: it is the composer's relation to the apparatus, not an expectation that the performer become an operator—in this repertoire the performer remains an instrumentalist. "User" is therefore retained here in a restricted and specifiable sense: the composer who configures and integrates an apparatus she has not conceived. It is deliberately not retained for the third position, where "expert user" would import from ergonomics and human–computer interaction an emphasis on proficiency over authorship and would understate the transformative character of the engagement described below. "Appropriator" is preferred there.

and the elaboration of models redefining the relation between instrumental gesture—in particular extended playing techniques—and technological mediation. Kaija Saariaho represents the composer-user, deploying electronics not as the origin of compositional thinking but as a means of extending an already autonomous instrumental imagination. Johannes Fritsch, finally, exemplifies the composer-appropriator through *Partita* (1965–66), in which the apparatus of the Cologne studio—contact microphones, magnetophones, filters, and regulators—is inherited from the Stockhausen Ensemble and reoriented towards the relationship with the viola, the composer's own instrument.

Taken together, these figures make it possible to distinguish situations in which the apparatus is generated as part of the compositional process, those in which it extends an already autonomous instrumental poetics, and those in which a historically situated technological environment is appropriated so intensively that its configuration becomes a compositional strategy in itself. In general, instruments and technological systems are not neutral means placed at the disposal of compositional will; they condense constraints, affordances, historical developments, and aesthetic decisions, shaping the performer's action and redistributing agency across composers, performers, tools, and spaces.

2. MICHELANGELO LUPONE AS *COMPOSER-LUTHIER*

Among the figures exemplifying a compositional lutherie approach, Michelangelo Lupone (1953) offers a particularly clear case. His work shows how the compositional process may extend well beyond instrumental writing, to include the design of systems for synthesis and sound processing, the development of spatial models, and the exploration of instrumental gesture as a field of technical and formal invention. Here the entire apparatus is not a neutral support, but it is the place where the work takes shape.

This is especially evident in the second of the four pieces of his *Ciclo Astrale*: *Altair* (1986) for violin, digitally synthesised sounds on tape, and live digital processing. Written for violinist Diego Conti, his piece can be contextualised within that phase of research, unfolding across the 1980s and 1990s and bound up with developments in the means of real-time digital sound processing, in which computing expertise—largely a matter of configuring a host computer with a dedicated processor—was complemented by close investigation of performance practice and extended instrumental techniques. Altair's quadraphonic tape materials were generated with the Fly10 system, a programmable digital synthesizer designed by Lupone and developed in collaboration with Laura Bianchini in 1983, among the first Italian systems for real-time digital synthesis through additive and frequency-modulation algorithms (Di Scipio 2021, see Figure 1). The technical notes accompanying the score record that the synthetic sounds on tape were generated in 1986 at Michelangelo Lupone's private studio in Rome using the four-channel Fly10 system driven by an Olivetti PC 8086, with additive and frequency-modulation algorithms written in Assembly and temporal parameter control were handled by the Fly10 Editor and Sequencer programs (Lupone 1986).[2] Each TMS32010 DSP board communicated with the host computer through a 16-bit parallel interface; an entirely programmable interface served two 61-note keyboards operating in

[2] The resulting material was recorded in four-channel analogue format through a Soundcraft 600 Series mixer onto an Otari MX 5050 four-channel recorder.

parallel, with a polyphony of twenty or ten notes each, and the conversion stage comprised four 20 kHz D/A converters (see Figure 2).[3]

Figure 1. A historical photograph of the Fly10 console; from the CRM archive.

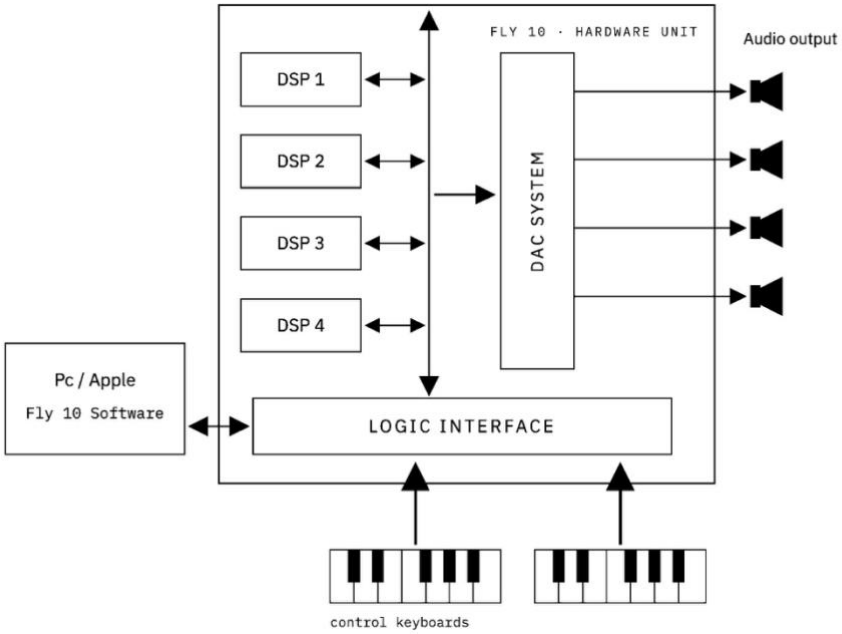

Figure 2. Architecture of the Fly10 system.

3 A first version ran on Apple hardware in 1983, a second on the Olivetti PC in 1985; the system was presented publicly at the V Colloquio d'Informatica Musicale, Mostra d'Oltremare, Naples, 1985.

The live chain of the first version combined a reverberation unit with control over duration and decay, and a chorus unit whose frequency shift the composer confines to a quarter tone above and below.

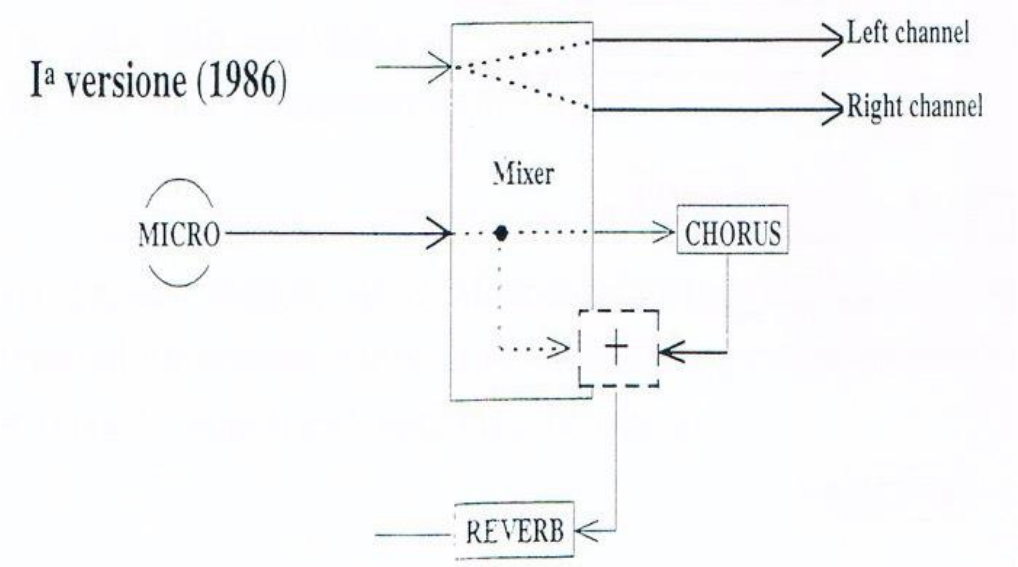

Figure 3. Setup diagram for Altair (first version, 1986).

A second version was realised in 1992, after the opening of the CRM (Centro Ricerche Musicali) in Rome, and it revised the two electronic components separately. The live chain (see Figure 4) was rebuilt around the more advanced Fly30 system for real-time processing, with the processing algorithms re-implemented. The Fly30 was a hardware-software system for the analysis, synthesis, and processing of sound in real time, which was developed in 1989–90 by the engineer Antonio Pellecchia and Lupone himself with the specific aim of rethinking traditional numerical calculation algorithms through their implementation on a floating-point DSP, and to experiment with original algorithms and new control systems for real-time applications. The software was developed in collaboration with the CNR (National Research Council), providing musicians with a set of object-oriented software modules for musical composition at every stage: orchestration, score generation, and real-time performance control, as well as a powerful interface for parametric control (Pellecchia 1991; De Vitis and Pellecchia 1992). The pre-recorded material, meanwhile, was reduced to a stereo digital master on DAT: the technical notes to the score notes that this was done on a four-channel Fly10 system controlled by a PC-AT 80486, with recording and editing performed through Digidesign Sound Tools on an Apple Macintosh Quadra 800. The two tracks were then transferred to a digital multitrack with the time-scansion (click) on a separate track, sent to the performer's earphone for synchronisation (Lupone 1986).

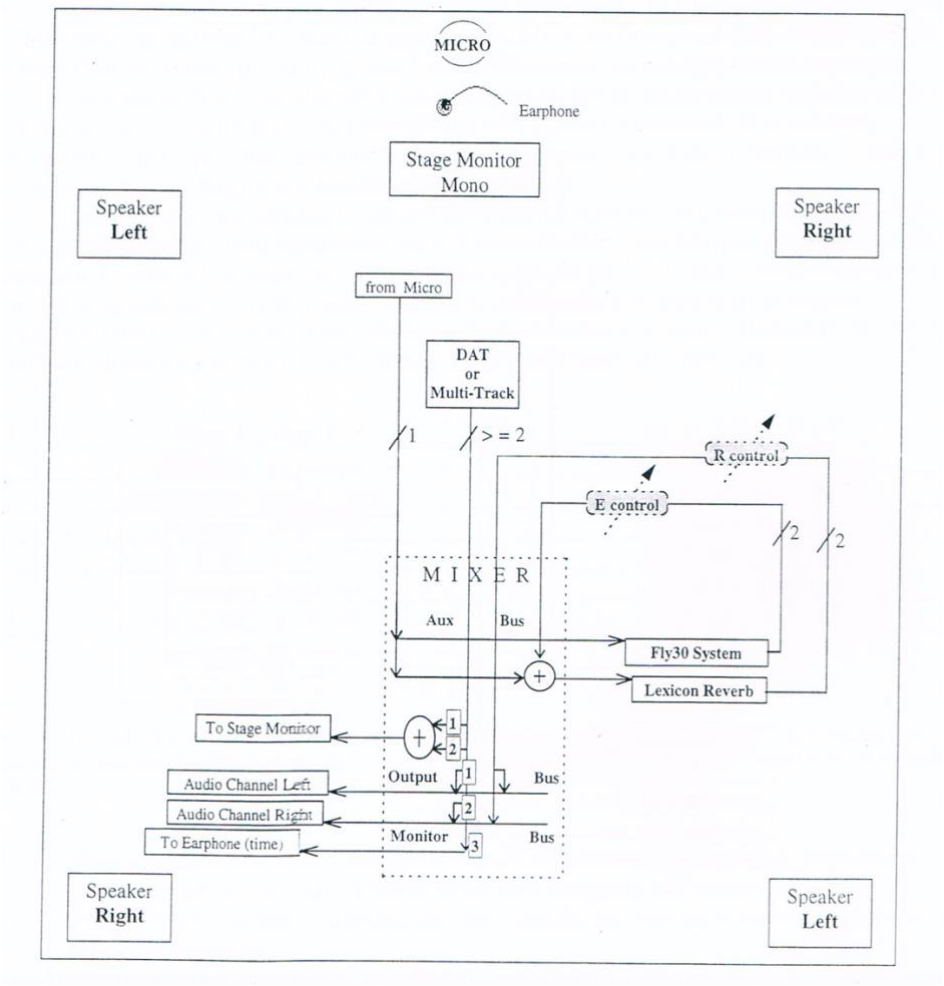

Figure 4. Setup diagram for Altair (second version, 1992).

Another important dimension in Lupone's work is the centrality of instrumental gesture (see Figure 5). In the repertoire for strings and electronics, gesture can easily be reduced to input data, or else treated as a residue of instrumental tradition surviving beneath technological mediation. Instead, in Lupone's case, gesture becomes a site of inquiry through which the relation between performer and system is reshaped (Di Scipio 2021). The performer's action is linked to electronic and spatial processes in such a way that the sonic identity of the work cannot be reduced either to instrumental execution alone or to electronic design alone.

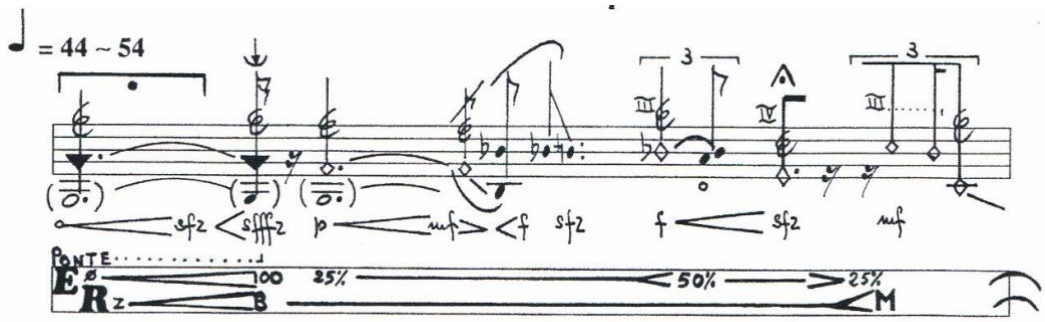

Figure 5. A score excerpt from Altair by Michelangelo Lupone, showing the particular notation developed for the piece. Reproduced by kind permission of the composer.

Paradigmatic in this case is the treatment of vibrato, the principal string playing technique on which *Altair* is built (Figure 6). Lupone extends control over it by articulating it into four parameters—left-hand pressure on the string, speed of the gesture, amplitude of the gesture, and direction along the string—a decomposition that stands in direct correlation with FM synthesis, particularly when sub-audio frequency values are applied to the modulating oscillator. A technique so historically sedimented in string practice is thus rethought according to the logic of a system the composer himself designed: instrumental gesture and synthesis algorithm become structurally homologous. The same convergence operates in the opposite direction. Since certain positions on the fingerboard do not yield harmonics of precise pitch, this indeterminacy—consistent with the synthetic materials on tape—is turned to compositional account: where violin and synthetic sounds tend to fuse, the composer invites the performer to imitate the pitch indeterminacy of the electronic part through coherent vibrato, quarter-tone inflections, and the short glissandi notated in the score.

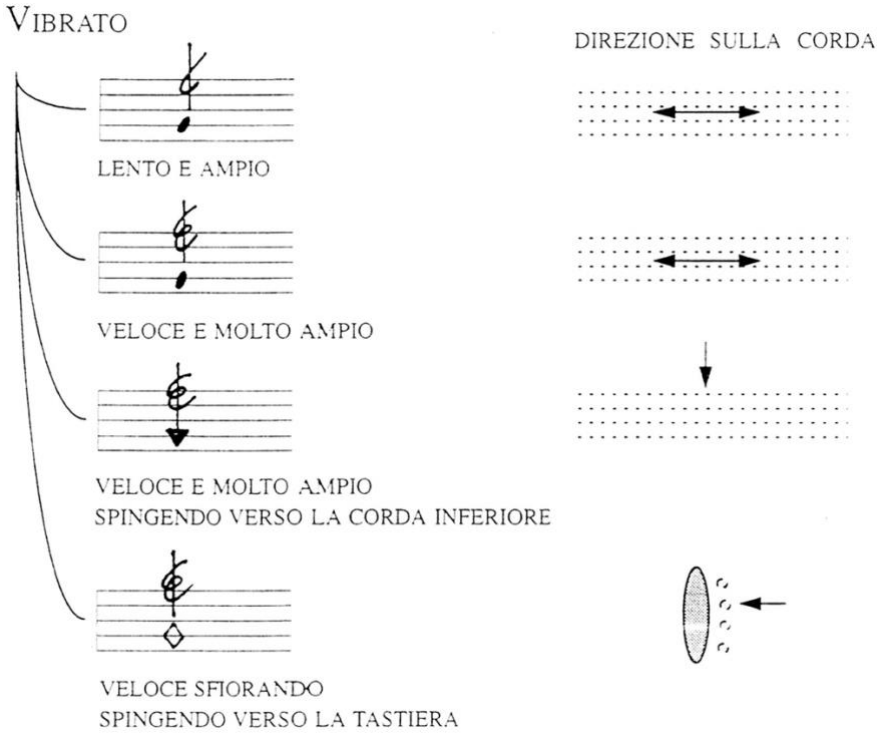

Figure 6. Notational scheme for the vibrato variants and for the direction of the left-hand displacement along the string in Altair.

Video1: A video-performance of Altair by Michelangelo Lupone (Federica Vignoni: violin) https://www.youtube.com/watch?v=rHvK-Q_W6_U

Lupone pursued this research further in *Corda di metallo* (1997) for string quartet, tape, and the Fly30 system (Lupone 1997). It was commissioned by the Kronos Quartet and realised at the CRM in Rome, where the compositional process extended to a physical model of the string and the bow, developed with Marco Palumbi and Lorenzo Seno, and to a precise

treatment of sound diffusion in the listening space.[4] That the model formalises not only the string or the resonating body but the bow is telling: what is modelled is the coupling of gesture and material (see Cianciusi 2005; Andreuccetti 2024, pp.109-115). Extended string techniques are accordingly central here not as a catalogue of unusual sounds, but as a way of articulating the relation between gesture and process, and the parameters the model exposes belong to the compositional logic rather than to external technical data (Boccio 2026).

Also in this case, the musical instrument, the electronic system, the physical model, and the spatial behaviour of sound are not separate domains, but they are brought into a single field. In this sense the "instrument" of the work is not simply the violin or the string quartet, nor even the combined ensemble of strings and electronics: it is an apparatus composed through the interaction of instrumental technique, technical design, synthesis, modelling, and diffusion. Lupone has since given this condition a name of his own—the *strumento-opera*, the instrument-work, the point at which, in his formulation, music takes on matter and form.[5] This also reveals how the creator's stamp may be inscribed into an apparatus. Lupone's systems embody a clear aesthetic orientation—an interest in physical modelling, in the continuity between extended techniques and electronic transformation, and in spatialisation as a compositional dimension. Their affordances are not generic but directed, shaped, and constrained by an underlying compositional thought.[6]

What defines the composer-luthier is therefore not simply the fact that the composer builds or helps design technical tools, but the extent to which this design activity becomes constitutive of the musical work. The instrument is conceptually composed, and the boundary between tool-making and the composition process becomes unstable.

3. KAIJA SAARIAHO AS *COMPOSER-USER*

The Finnish composer Kaija Saariaho (1952-2023) illustrates a different model in her work, in which electronics extend and amplify an instrumental and timbral imagination that remains fundamentally autonomous in the compositional idea. The category of "user" can be misread as a less inventive or less technically informed practice, but actually her work shows the opposite. In fact, the approach is highly selective, deliberate, and aesthetically precise, drawing on the teachings of the French spectralist school, particularly those of Tristan Murail. What distinguishes it from the composer-luthier model is not a lack of sophistication but a different agency distribution, nor a lesser depth of technical intervention—she specifies her

4 The model provided control over the string's tension-to-density ratio, friction coefficients, bow speed, bow pressure, and discrete bow contact points. For the underlying physical modelling see Palumbi and Seno's work on bowed-string models developed at the CRM (Palumbi and Seno 1998).

5 The trajectory continues in the family of "augmented instruments" Lupone designed at the CRM from 2000 onward—Feed-Drum, SkinAct, WindBack—and in the thread of the corda virtuale, the virtual string, which runs from the physical modelling of *Corda di metallo* to acousmatic works as *Canto di madre* (1998) and *Linea fugace* (2015).

6 The score extends this calibration into the performance situation. The disposition, number and placement of loudspeakers, and the listening levels, are to be regulated in relation to the acoustic response of the venue, respecting the dynamic relations indicated in the score; the sound engineer tests and optimises timbral and dynamic balance at the points marked in the score's legend, while the string player is asked to stand away from the frontal axis and from areas of strong reflection, in places where the direct sound of the instrument predominates over the processed one (Lupone 1986).

processing quite in detail—but a different distribution of compositional labour. Electronic tools serve a mode of thought whose structural and poetic identity does not depend on the design of the tools, but rather on their configuration.

The technical means she employs largely reflect the IRCAM environment, yet they consistently direct timbral extension toward an instrumental part that remains autonomous (Barrière 1999). Her language inherits the "vertical" thinking of the French spectral composers, less oriented towards the contrapuntal development of individual lines than towards the internal morphology of sound. Electronics accordingly emphasise, rather than counterpoint, the timbral and expressive potential of the live instrument; sound diffusion follows the instrument's dynamics according to the performance context—interpretation, available tools, room acoustics—without ever overwhelming it.

> Kaija Saariaho started using amplification as a refined form of orchestration, in parallel with processing by means of reverberation and harmonization of orchestral instruments, already in her earliest works. Starting at the end of the 1970s, Kaija used the amplification of sounds resulting from unusual or complex modes of instrumental playing, the sound levels of which are too weak to be clearly perceived in a normal listening context, such as harmonics produced by string instruments. The discovery of these sounds was allowed by what has at times been called "multiphony." [...] Amplification used in this way can be modulated over time and controlled with a computer during a concert.
>
> (Barrière 1999)

Petals (1988) for cello and live electronics exemplifies this with particular clarity. By the composer's own account, its material stems directly from *Nymphéa* (Jardin secret III, 1987) for string quartet and electronics—and the harmonic structure of that quartet rests in turn on complex cello sounds analysed by computer, with technical support of some RIM (*Réalisateur en informatique musicale*) at IRCAM, in particular Jean-Baptiste Barrière. The electronic imagination here grows out of a close listening to the instrument and does not precede it. The electronic part requires a digital reverberation unit whose reverberation time and wet amount are varied as specified in the score, a harmonizer producing microtonal frequency shifts, and a stereo pair of loudspeakers to receive the processed signal (Saariaho 1988, Figure 7). In particular, Saariaho has used the Yamaha SPX90 (Figure 8) in some of her earlier works: a digital multi-effects processor designed for real-time audio signal processing that provides a range of effects, including reverb, delay, chorus, flanger, phaser, pitch shifting, compression, and other signal-processing functions. Its programmable architecture let users select and modify effect parameters, while its MIDI interface enabled external control and recall of stored programs.[7]

As a commercially available, general-purpose device, the SPX90 could therefore be incorporated into a compositional setup without requiring the composer to design or construct the processing system itself. The apparatus is "user-friendly" and, crucially, complementary. In fact, the writing retains its full meaning without it: the instrumental writing retains its full

7 As specified in Petals score, Saariaho specifies settings should be used with an SPX90 as harmonizer: programme 22 (pitch change B), with pitch1 +0 / fine1 +45 / delay1 20 ms, and pitch2 +0 / fine2 −50 / delay2 15 ms (Saariaho 1988).

structural and expressive meaning without it, and the electronics extend, colour, and prolong a sound identity that is already complete.[8]

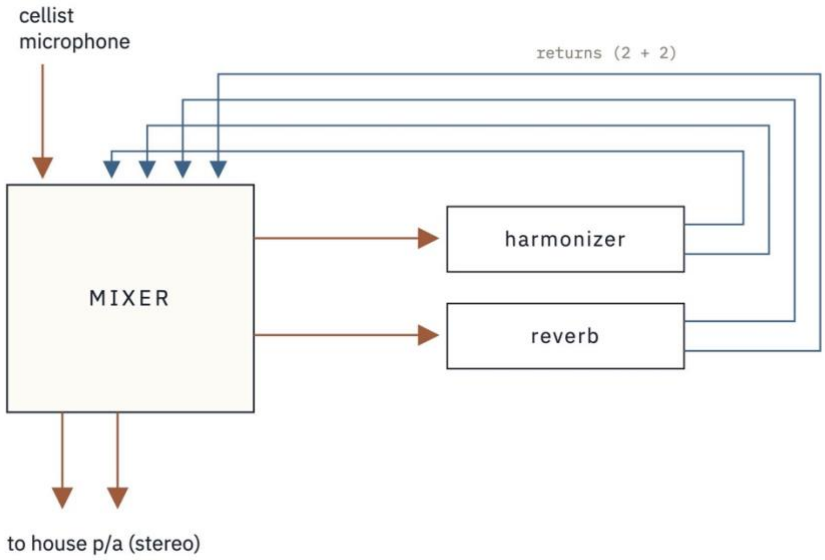

Figure 7. The electroacoustic setup of Petals by Kaija Saariaho.

Figure 8. The Yamaha SPX90 digital multi-effects processor used by Saariaho in her earlier works with live electronics.

These aspects are legible in the organisation of cello sound materials on the piece. *Petals* alternates fragile, coloristic harmonics passages with more sharply focused figures of clear rhythmic and melodic profile (see Figure 9), the former giving birth to the latter before they dissolve back into filigree; timbrally this maps onto the sound/noise axis Saariaho had theorised a year earlier, along which noise assumes the role of dissonance and sound that of consonance, so that timbre takes over what she calls "the dynamic function of harmony"

8 An analogous setup—digital reverberation and a multi-effects processor—returns some years later in Folía (1995) for double bass and live electronics, realised not at IRCAM- as the largest part of his works -but at GRAME in Lyon. The position described here does not depend on a single institutional apparatus: it characterises Saariaho's relation to whatever apparatus is available.

(McAdams and Saariaho 1985; Saariaho 1987b). In *Petals,* the axis runs from the purest high harmonic to the dense scratching produced by heavy bow pressure near the bridge.

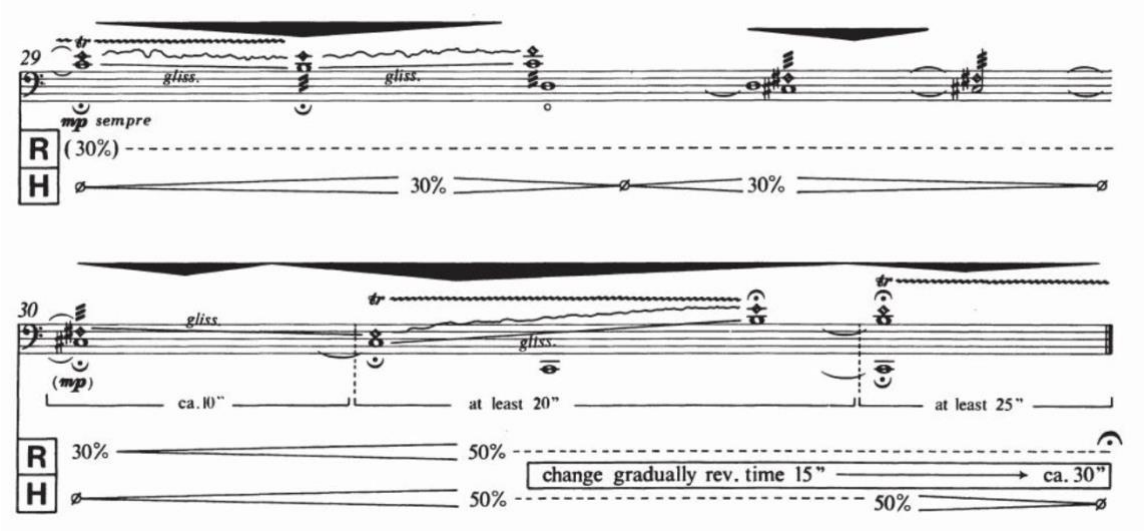

Figure 9. Bars 29–30 from Kaija Saariaho's Petals.

What is striking is that the two electronic processes run along it: reverberation prolongs and diffuses, carrying a sound towards the blurred pole the bow already reaches by other means; the harmonizer's microtonal detuning sets the signal beating against itself, clouding a pure harmonic much as increased bow pressure would. The apparatus extends one axis that is already inscribed in the acoustic instrument. This, rather than any modesty of means, is why the electronics can be declared optional: they are redundant in the strict sense—a second route to a region of the sound-world the cello can already reach alone. The two excerpts below are drawn from separate recordings—the 1993 solo version and the 1997 version with live electronics—and present the same passage across that axis, so that the claim can be heard rather than asserted.

Audio file 1: Petals by Kaija Saariaho - excerpt from mm.29-30 without electronic part (1993; cellist: Anssi Karttunen)

Audio file 2: Petals by Kaija Saariaho - excerpt from mm.29-30 with electronic part (1997; cellist: Anssi Karttunen)

The same operational position persists as the technology grows more elaborate. In *Près* (1992), also for cello and live electronics, this relationship with electronic lutherie deepens without changing. Its three movements are based on recordings made with the cellist Anssi Karttunen, subsequently analysed and used as a point of departure for the work's harmonic language and synthesis parameters.[9] Compared with *Petals*, the real-time processes are far

9 The synthetic element was realised through resonant filters capable of operating in real time, on a MaxMSP patch developed at IRCAM, with the performance environment built by the technicians Xavier Colella and Jean-Baptiste Barrière. Barrière's role recurs across the catalogue: he also realised the Max patches for Vent Nocturne and Frises, and the explanatory accounts of Saariaho's electronic procedures adapted on the composer's official site derive from his presentations in the CD *Prisma* (Barrière 1999).

more numerous, and the electronics also acquire a formal function: they delineate sections, identify cadences, and lend fluidity to the musical discourse, as a kind of electronic punctuation. Yet the harmonic structure remains determined almost entirely by the cellist: here the apparatus simply articulates the form. In later works with electronics such as *Vent Nocturne* (2006) for viola and *Frises* (2011) for violin, real-time processing takes the signal of a miniature microphone mounted on the instrument, joined by the triggering of pre-recorded material by a pedal, on patches realised in Max MSP by Jean-Baptiste Barrière. Across roughly twenty-five years, the apparatus becomes quietly more complex, yet the compositional position does not shift: the instrument is never redesigned, the systems are consistently realised by others—especially RIM—and their role remains that of extending a consolidated and articulated mode of writing. The composer-user could also be defined by where authorship of the apparatus lies and what function it is assigned.

In Saariaho's case, the stamp of the creator lies in the "poetically oriented" configuration of what a given apparatus can do: as we have seen in *Petals*, the score prescribes reverberation time and wet amount, and for the harmonizer a programme and a parameter set, without prescribing the existence of the devices themselves. The performer remains central and the instrumental writing retains its autonomy, while electronics modify the perceptual field in which the performance is received—agency less visible as technological invention than as "aesthetic mediation" (Leman 2008)—a tool may bear the imprint of compositional intention because its affordances have been selected and integrated into a highly specific musical idea.

4. JOHANNES FRITSCH AS *COMPOSER-APPROPRIATOR*

Where Lupone composes the apparatus, and Saariaho integrates an already autonomous one, the violist, electroacoustic performer and composer Johannes Fritsch (1941-2010, Figure 10) represents a third position, in which the appropriation of existing technological devices itself becomes a distinctive compositional mode. The figure that emerges could be best described not properly as an *expert user*—a term whose origins in ergonomics and human-computer interaction emphasise proficiency over authorship—but as a *composer-appropriator*: electroacoustic instrumentation that defines the apparatus is neither conceived by the composer, nor merely absorbed into an existing language, nor built for him by others: it is actively reoriented—through his own intimate knowledge of the instrument—towards ends he defines himself.

Figure 10. Johannes Fritsch; from Johannes Fritsch Foundation Archive.

This position is exemplified with particular clarity by *Partita* (1965–66) for viola, contact microphones, filters, and regulators, scored for four players and dedicated to Karlheinz Stockhausen (Fritsch 1968)[10], who also appears here as one of the electronic performers. The electroacoustic apparatus—including tape machines Telefunken M 5 model (see on the right side of Figure 11)—is recognisably that of the Cologne studio in the mid-1960s. For example, the same band-pass filter (Maihak W 49; see on the left side of Figure 11) and regulators were used as live instruments that Stockhausen deployed in his *Mikrophonie I* (1964), the first European live-electronics piece.

Figure 11. Maihak W 49 band-pass filter (left) and Telefunken M 5 tape recorder (right).

In *Partita* this reorientation is legible in the electroacoustic architecture (Figure 12). Two contact microphones on the viola feed a system built on a ten-second tape delay with controlled feedback (Fritsch 1968). The technical notes in the score names precisely the devices used: Telefunken ELA amplifiers for the microphones (a rebuilt 2 V 610 with V 644, and a V 617 with V 644), a Maihak W 49 filter with W66 faders, a final amplifier Tonographie V 301 with a configuration of eight inputs and four stereo outputs, used here to route signals to the speakers (and one output is connected to a tape recorder for recording), and two Telefunken M 5 machines: one for recording and the other one for stereo playback. The delayed signal is reinjected through a feedback regulator, then filtered and spatialised across loudspeakers moved through the space. This interaction between tape recorders is called "tape echo delay" and is generally thought to have originated at the Cologne Studio about ten years earlier through the work of researcher and educator Werner Meyer-Eppler. It consisted of a simple delay created by feeding the signal back between the recording and

10 The work was premiered in Helsinki in April 1967 and later recorded at WDR in Cologne. The score gives the cast of the performance up to 1968 as Johannes G. Fritsch (viola), Rolf Gehlhaar (fader 1), Alfred Alings (filter, fader 2) and Karlheinz Stockhausen (filter, fader 3) and notes that after the première the work was performed in Oslo, Stockholm, London, Cologne, Darmstadt, Berlin and Vienna (Fritsch 1968). All of them were members of the ensemble Stockhausen founded and named from 1964 to 1970.

playback heads of tape recorders (Di Scipio 2021). Also in the score, Fritsch emphasises that the circuit may, of course, be realised with equivalent equipment (Fritsch 1968).

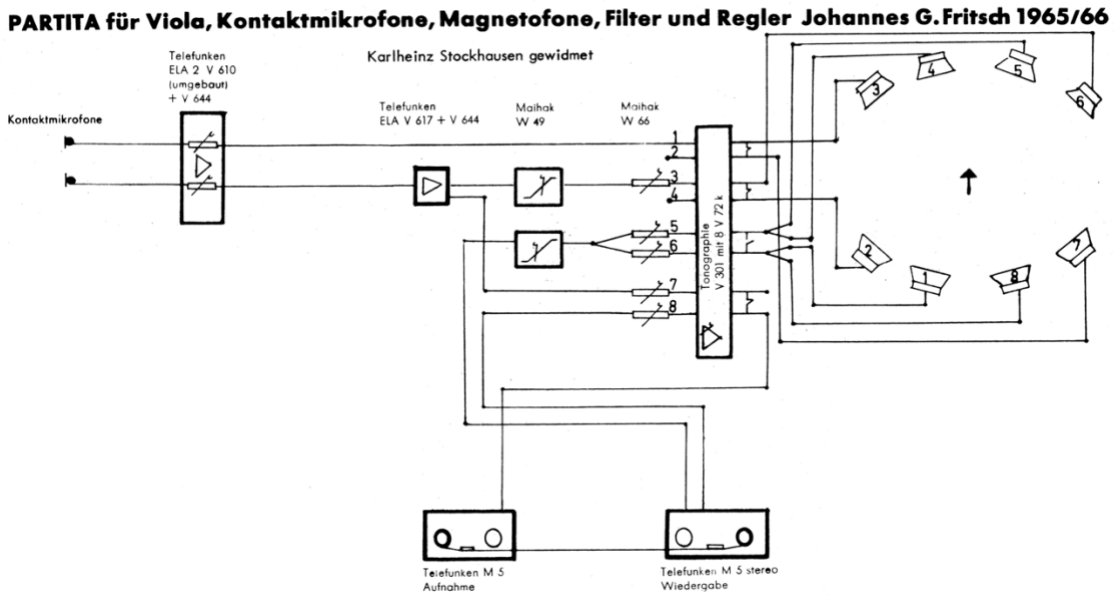

Figure 12. Electroacoustic chain of Partita—contact microphones, ten-second tape delay with feedback, filters and regulators, and eight loudspeakers organised in three groups for sound projection.

An interesting element is that Fritsch occupies, at once, positions that in the other two cases remain distinct. He was composer, violist, and—through the 1960s—technical assistant on many Stockhausen productions connected to the WDR in Cologne and to the Osaka Expo of 1970. The relation between composer and performer here lapses: he writes the piece, plays it, and knows the apparatus from inside its operation. Certainly, appropriation takes place from the adoption of someone else's tools—the instrumentation of the Cologne studio—but above all as a turning of an apparatus he helped run. The writing is accordingly conceived as input for the microphonic system, its extended techniques are generative of the overall sound quality—overtones varied through bow contact points, short impulse produced by maximal bow pressure with minimal motion, bowing on the tailpiece or behind the bridge (Fritsch 1968)—each producing the noise—and overtone spectra the contact microphones disclose with their non-linearity and the electronic players contribute to articulate. Writing and electroacoustic apparatus both live in a co-agency: this is particularly significant insofar as the writing assumes an idiomatic, soloistic character consonant with the historical musical form the work invokes. Yet the appropriation of both the violinistic language and the electroacoustic setup yields a more unified sonic field, as writing and apparatus converge in and through the violist's instrumental gesture. This convergence extends beyond the performative domain, becoming inscribed in the work's very form. The five-movement structure of *Partita*—Fantasia, Präludium, Fuge, Ciacona, and Fantasia finale—invokes the Baroque suite for solo strings, and with it the most codified stratum of the string tradition. Fritsch runs an inherited musical form through the electronic apparatus of the Cologne studio. Appropriation therefore operates on two levels at once: an inherited electronic and acoustic lutherie corpus and an inherited musical form, bent towards a personal compositional end.

Fritsch describes the score not as an exact determination of the sonic result, but as a *Spielanweisung* (general playing rules for performers), within whose prescribed limits

performers are expected to engage in maximum *mitkompositorisch*—co-compositional—shaping (Fritsch 1968).[11] In Figure 13, there is a score excerpt of Ciaccona from Partita: in the specific case it is possible to see the direct citation of the most famous Ciaccona in D minor written by Johann Sebastian Bach, which is in this case transposed to G minor and deformed by using some unconventional string playing techniques and live electronics analogue processes. Agency in *Partita* thus resides neither in the composer, nor in the apparatus, nor in any single performer, but is distributed across the violist's bodily knowledge, the electronic performers' co-compositional articulation of the electronic part, and the technological sedimentation of the Cologne studio. The composer-appropriator here is the figure who organises these components into a coherent work—not by inventing them, nor by passively assembling them, but by re-authoring their relations.

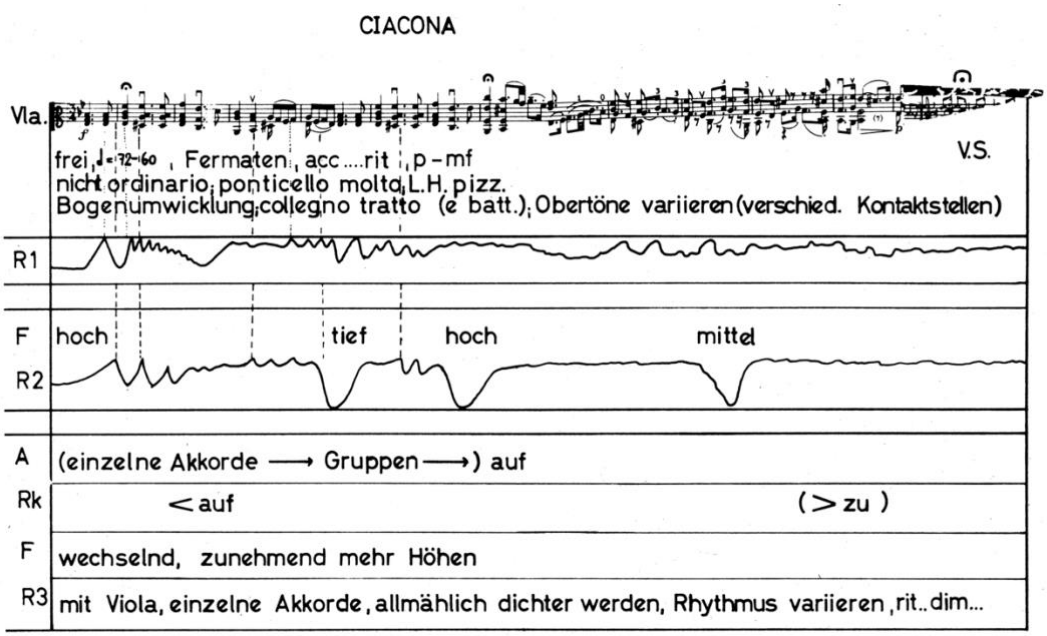

Figure 13. Score page of the Ciacona from Partita, showing the graphic and verbal notation of the electronic part. Reproduced by kind permission of Edition Modern.

Audio File3: Johannes Fritsch - Ciacona (excerpt from Partita, 1965-66_fur Viola, Kontaktmikrofone, Magnetofone, Filter und Regler)

This position could be extended to the markedly more improvisatory *Violectra* (1971) for viola d'amore and live electronics, realised at the Feedback Studio in Cologne—which Fritsch co-founded, breaking free from Stockhausen's influence—and built on the portable EMS Synthi A analog synthesiser, realised by Peter Zinovieff. Even once he had helped establish an institution of his own, the devices remained ones he had not designed. Seen alongside Lupone and Saariaho, Fritsch's position appears as a third, irreducible mode of engagement with technological apparatus. In conclusion, if Lupone composes the instrument and Saariaho

11 One detail of the score makes the direction of fit unusually explicit. Fritsch observes that the Maihak W 49 filters used in the performances up to that point produced disturbing incidental noise whenever their settings were changed, and that at some points the movement of the faders written into the score had been adjusted to this behaviour; with improved filter types, he adds, the resulting stereotyped figure of decrescendo–filter change–crescendo should be avoided. The notation, in other words, accommodates the material defects of an electroacoustic instrument that composer did not design.

integrates it, Fritsch re-authors it: through this appropriation, the instrument becomes, in a certain sense, singular rather than neutral.

5. COMPARATIVE PERSPECTIVES: STAMP, AFFORDANCE, AGENCY

Placed side by side, Lupone, Saariaho, and Fritsch reveal three ways in which electronic lutherie may shape compositional practice. The three cases clarify three distinct distributions of intention, affordance, and agency. In Lupone, the stamp of the creator is inscribed directly into the apparatus, which embodies compositional thought and draws modelling, processing, spatial behaviour, and instrumental gesture into a single technical-musical field: the instrument is, in a strong sense, composed. In Saariaho, that stamp resides in the selective, aesthetically precise integration of possibilities she did not conceive into a pre-existing instrumental imagination. Electronics transform the work's perceptual horizon and extend its timbral range. Here the instrument is not composed from scratch, but recontextualised within an enhanced perspective of listening. In Fritsch, the stamp emerges through appropriation: the apparatus is part of the electroacoustic setup of the Cologne studio of the mid-1960s, yet its configuration and calibration with respect to the viola—and its incorporation with the violist's own instrumental knowledge—yield a result that no neutral redeployment of the same equipment could have produced. Here the instrument is neither simply designed nor simply used, but operationally re-authored.

Precisely because these are positions rather than fixed identities, a composer may occupy more than one and shift between them within a single trajectory. The categories proposed here are therefore not compartments into which œuvres are sorted but vectors of a relation, naming what a given work does with its apparatus rather than what a composer permanently is. Read this way, the framework functions as a tool for tracing movement—between building, integrating, and appropriating—and extends well beyond the three cases discussed here.

This bears directly on the resurgence of modular synthesisers, boutique hardware, reclaimed tape machines, and vintage test equipment that has marked the last decade, for the three positions are indifferent to period. A musician who designs a module and composes from within the constraints it imposes occupies the position of the composer-luthier as fully as Lupone did with the Fly10 or the Fly30 systems; one who integrates a commercially available system into a sonic imagination formed independently of it stands where Saariaho stands; one who reorients obsolete or repurposed apparatus towards purposes its makers did not foresee is doing, with different hardware, what Fritsch did with the equipment of the Cologne studio. The first and the last cases are especially common in improvised practice, where the apparatus could be both created and negotiated in performance. What the historical cases offer is not a precedent but a way of asking, of any such practice, where authorship of the apparatus lies and what it is being asked to do.

The importance of these categorisations is not situated in their classificatory rigidity, but in their capacity to illuminate how works organise relations between people, tools, and sonic processes. Electronic lutherie, in this broader sense, is not exclusively about objects. It is about relations, and how those relations are shaped musically (Bovermann et al. 2017).

6. CONCLUSIONS

Electronic lutherie in the repertoire for strings and electronics is not inscribed into a single practice, nor can it be reduced to the construction of devices. It is better understood as a field in which compositional thought, instrumental gesture, technical design, and performative configuration intersect in different ways. Through the three figures discussed here, it becomes possible to distinguish situations in which the apparatus is generated as part of the compositional process, those in which it extends an already autonomous instrumental poetics, and those in which a historically situated technological ecology is appropriated so intensively that its re-authoring becomes a compositional strategy in itself.

Michelangelo Lupone, Kaija Saariaho, and Johannes Fritsch do not merely exemplify three individual approaches. Together, they make audible three different ways in which instruments may bear the stamp of their creators and participate in the redistribution of agency within artistic practice. Their comparison suggests that tools do not simply serve musical ideas. They help shape them, constrain them, and project them into specific forms of listening and performance.

For this reason, the repertoire for strings and electronics offers a privileged site for rethinking electronic lutherie. It shows that instruments are never just supports for musical thought. They are themselves condensations of intention, history, affordance, and aesthetic possibility (Alperson 2008; Bovermann et al. 2017). To compose with them is always, in one way or another, also to compose them—whether by designing them, by integrating them into a personal poetics, or by appropriating and reorienting them from within an inherited technology.

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