Metastable Inventions: Simondonian concretisation and technical invention in modular synthesis practice

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This article analyses the author's modular synthesis practice through the lens of Simondonian philosophy, arguing that modular synthesis represents a dynamic example of technical ontogenesis in artistic practice. With its emphasis on technical *becoming*, Gilbert Simondon's philosophy of technology provides a detailed framework for the analysis of modular synthesis patching. Following a practice-based methodology, the article references two 'think-aloud' videos filmed of the author patching on two modular synthesis systems. Tracing the genesis of sound sources throughout each session, aspects of Simondonian technical invention are analysed with respect to this creative practice. As these patches concretise, an increasingly saturated *associated milieu* is shown to emerge as the driving force behind technical invention. Seeking resolutions between incompatibilities arising between the *internal milieu* of a sound source and the *external milieu* of the modular system, the analysis reveals the appearance of *metastable states* within the ontogenesis of each patch. By detailing the various forms of recurrent causality in these patches, this article reveals how modular synthesis practice can serve as the site for the co-evolution of musical ideas and technical objects; a theatre of individuation that is both more-than-human in its evolutionary potential, and more-than-music in its practical application.

1. INTRODUCTION

1.1. Background

As a modular synthesist, I have been fascinated by the process of developing patches on my modular systems, and the way in which ideas, patches and musical outputs co-evolve over time. This interest in the process of electronic composition has led me to consider the more-than-human aspects of this practice, and the way in which unique, context-dependent human–material relationships evolve over time. In previous research, I have considered this in relation to what I have termed the *performer–developer* context, analysing the development and use of digital interactive improvisation systems (Carey 2016). Through this research, machine agency emerged as an essential part of my practice, and something that evolves alongside my technical and musical ideas. In the domain of modular synthesis, my previous work has engaged with similar themes, putting Malafouris's *material engagement theory* in conversation with the work of Pickering, Barad and Ingold, all of whom are concerned with the evolution and mutuality of human and material agencies (Carey 2023; Pickering 1995; Barad 2003; Ingold 2017). This research was concerned with the entanglement between human and material agencies, and the way in which human intentionality co-evolves with bespoke technical objects. The work also engaged with Magnusson's *ergodynamics*, a concept concerned with both technical affordances, as well as the wider historical and cultural context of engagements with musical instruments (Magnusson 2019). By contextualising this concept in relation to the work of Gilbert Simondon, this research analysed the *ontogenetic* quality of what I have termed the *secondary ergodynamics* of modular systems, namely *ergodynamics* that evolve as part of the patching process. Through an engagement with Simondon's ideas, this research highlighted how modular synthesis practice represents a unique site for the *invention* of new technical objects, and the evolution of bespoke *ergodynamics* in this context.

The current research critically engages with Simondon's ideas in the context of modular synthesis, outlining their relevance to this musical practice before applying them to my work through a novel, practice-based methodology. By analysing examples of this electronic music practice through the lens of Simondonian philosophy, the article argues that modular synthesis represents a dynamic example of technical ontogenesis in contemporary electronic music practices. Referencing two 'think-aloud' videos filmed of myself patching two separate modular synthesis systems, the article traces examples of context-dependent genesis of sound sources throughout each session, identifying various aspects of Simondonian technical invention in this unique creative practice. Simondon's three modes of existence of technical objects, namely the *technical element*,

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individual and *ensemble*, are discussed with reference to patches developed in each session. In addition, his concepts of the *internal* and *external milieux*, the *open machine*, and of *metastability*, are contextualised from within the context of my modular practice. These concepts are employed to analyse the development of modular patches as they evolve from the employment of *abstract* functions, to concretised ensembles of technical individuals displaying multiple forms of *recurrent causality*.

Throughout, Simondon's work on imagination and invention is used to analyse the co-evolution of musical intentions and technical objects, with particular attention paid to the appearance and resolution of problems through the process of *technical invention*. As patches evolve and concretise on each system, an increasingly saturated *associated milieu* is shown to emerge as the driving force behind technical invention. Seeking resolutions between incompatibilities arising between the *internal milieu* of a sound source and the *external milieu* of the modular system, the analysis reveals the appearance of *metastable states* within the ontogenesis of each patch.

1.2. Research and artistic context

Several authors have recently engaged with Simondon's ideas in the context of music, sound studies and the arts (Döbereiner 2019; Lapworth 2020; de Oliveira and Pessanha 2021; Padovani 2018), including recently in the area of modular synthesis (Randell and Rietveld 2024; Stanford 2024; Troitski and Bates 2024). Across these works, Simondon's conception of *individuation* and *ontogenesis*, as well as his focus on technological *becoming*, have found relevance in broadly new-materialist approaches within sound and the arts. These select examples show a growing interest in the philosopher's work, and its particular relevance to artist-researchers engaged with the development and use of new technologies as part of their artistic practice.

In recent years, there has been a resurgence of interest in modular synthesisers as a creative practice. In academic research, too, modular synthesis has been a topic of interest among artist-researchers. This is evidenced by edited books, republished texts, dedicated journal issues, as well as PhD theses on the topic (Scott 2016; Bjørn and Meyer 2018; Strange 2022; Teboul et al. 2024; White 2024). In the present research, the practice of modular synthesis *patching* is foregrounded as a key element in the compositional process, highlighting the way in which patches co-evolve with musical ideas and concepts in the studio. There is a sense of shared agency in this practice, where both musical and technical ideas emerge through a process of co-creation with the systems with which I am making music. Unsurprisingly, these themes are shared among many artist-researchers engaged with modular synthesis. In his recent PhD research, Alex White has found that discovery and co-creation emerged as an important theme for many artists working with these systems:

> *Discovery and co-creation* refers to the use of a modular synthesiser as a deliberate strategy to experience a sense of discovery, as sounds and structures emerge that are desired but not planned or preconceived. To achieve this the musician gives over a level of agency to the instrument so that they and the machine are in a process of co-creation. (White 2024: viii; emphasis in original)

Similarly, modular performer and composer Bruno has focused on discovery as an important part of working with modular synthesisers, emphasising the ephemeral nature of a modular patch:

> There is an ephemeral quality to the sounds of a complex patch, that it most likely can never be replicated the exact same way because of the sensitivity of the parameters. Modular synthesis gives the composer and the engineer the sense of exploration and discovery. (Bruno 2016)

In White's analysis, the author relates modular practice to the creation of complex systems. The author outlines how in his own practice, such systems are deterministic, but also sensitive to initial conditions:

> In the process of building a new patch, the system becomes more complex as more connections are made. Once a patch is built it is often so complicated that I would need to retrace the connections back through various components to understand a particular aspect of its function. (White 2024: 81)

In discussing his approach to modular systems, Richard Scott has discussed the particularly 'atomic' approach to synthesiser design of Serge Tcherepnin, and the way in which his concept of 'patch-programming' allows for a low-level approach to designing modular patches, often resulting in unpredictability and complexity:

> Although these functions are quite simple in themselves, through modulation, cross-modulation and feedback they can be used to design all of the basic synthesiser functions and, further, it is possible to combine these into complex and unpredictable networks. (Scott 2019)

Finally, in the work of Koutsomichalis this theme of exploration is contextualised with reference to the concept of 'material inquiry', with the author defining the patching process as a form of 'all-inclusive material interrogation' (Koutsomichalis 2018: 14). Referencing Malafouris (2013) and the work of Pickering (1995), the author suggests that his modular practice is centred upon 'prodding and probing', questioning, and consequently uncovering and

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responding to, forms of resistance provided by the synthesiser (Koutsomichalis 2018).

The preceding research reveals that themes of co-creation, complexity and the sense of discovery are inherent in modular practices. However, with the exception of White's study of a broad range of practitioners (White 2024), there is a lack of considered discussion in the literature surrounding the decision-making process itself in the flow of patching a modular synthesiser. Following Simondon's call to understand technical objects *through their genesis*, this research seeks to understand exactly *how* problems, discoveries and resistances arise throughout the patching process, and how they may be explained with reference to Simondonian philosophy. In so doing, I have sought to understand such practices from the perspective of the genesis of *technical objects* created as part of the patching process.

1.3. Methodology

For this project, I documented my work developing patches on three separate modular synthesiser systems, using a methodology loosely based around a 'Think-Aloud' research method (Ericsson and Simon 1993). Three 'think-aloud' videos, each around one hour in length, documented my patching process on each system, beginning from a blank slate to a finished patch. The aim of these sessions was to capture the twists and turns of the process of patching a variety of modular systems. In the spirit of Schön's notions of reflection-in and reflection-on-action (Schön [1983] 1995), I chose to document my verbal reflections to make the otherwise tacit knowledge of my creative practice available for analysis.[1] For the analyses discussed in this article, examples were chosen only from the first two of these sessions.

The three modular systems chosen for this project are used regularly as part of my artistic practice. The systems in question were the following:

- Session 1: Buchla 200e system (Buchla USA – 2 boats, 10 modules).[2]
- Session 2: EuroSerge system (ELBY Designs – 12U/84HP, 27 modules).[3]
- Session 3: Eurorack system (various manufacturers – 12U/104HP, 37 modules).[4]

I chose to develop patches on these contrasting systems as their sonic, interactive and generative potential varies due to each system's unique collection of modules. As evidenced in this article, my patching approach follows a distinctly 'bottom-up' approach to musical generation, and an interest in synthesis patching as a means of discovering and exploring timbres, gestures and compositional structures that are new to me at the time of patching. So, while there are distinct differences between each of these systems, I have evolved a personal approach to patching that has been informed by my experiences patching across each of my modular systems.

1.4. Analytical 'order of magnitude'

In this research, it is important to acknowledge the level of analysis, or the *analytical order of magnitude* in which discussions of concretisation and technical invention are situated. Here a single sound source or 'sub-patch' is conceived of as a concretising *technical individual*; a technical object making use of various *abstract technical elements* as it develops through *ontogenesis* towards *concretisation*. Here then, a conscious decision has been made to limit the analysis of a modular patch to be from a specific *order of magnitude*, namely the patching layer of the system. This is the visible and physically manipulable level of a modular system, represented by the jacks, knobs, buttons and switches on front panels of each module, and the patch cables used to develop interconnected modular networks. This layer of the system is conceived of as the *external milieu* from which each technical object begins the process of concretisation. In this analysis, the functions in each module are treated as both a physical and a metaphorical 'black box', examining their creative usage from the perspective of the inputs and outputs of their circuits.

2. SIMONDON'S PHILOSOPHY OF TECHNOLOGY

In the 1950s and 1960s, Simondon developed a complex and convincing philosophy of *technics*, one that sought to engage with the world of *technical objects* from the perspective of their ongoing becoming. For Simondon, *technical objects* are seen to be *ontogenetic*, arguing that technical objects should be viewed as representing a *genesis*, and not viewed as *things*, or *objects*: 'a technical object is neither this thing nor that thing, given hic et nunc, but that of

[1]The YouTube playlist, containing all three videos, can be accessed at: www.youtube.com/watch?v=1Yo7lSKGb70&list=PL3QJwDKP54-eV2WN90_vkolJSHLHTSO5c. Transcripts from YouTube were edited using GPT-4 to provide basic punctuation (OpenAI 2024). Prompts and explanatory notes can be found at: www.dropbox.com/scl/fi/1y3sgn7wxu372zjpjeegt/Youtube-transcript-processing-with-GPT.pdf?rlkey=oyhinuwmxipb6za3n1i2qjyad&dl=0.

[2]Full system layout can be viewed at: www.modulargrid.net/u/racks/view/2048222.

[3]Full system layout can be viewed at: www.modulargrid.net/e/racks/view/2299331. This system was donated to me by Laurie Biddulph of ELBY Designs to support my research through the University of Sydney.

[4]Full system layout can be viewed at: www.modulargrid.net/e/racks/view/2190833.

which there is genesis' (Simondon [1958] 2017: 26). Viewing the *genesis* of technical objects as of primary importance, Simondon argued for detailed understandings of the way in which these objects evolve over time through the process of *concretisation*. Here, *concretisation* refers to the process in which technical objects move from a collection of *abstract* functions designed for a single purpose, into *internally resonant* objects, engaged in a process of *recurrent* or *reciprocal causality*. For Simondon, a *concrete* technical object is one whose *internal milieu* increases in *internal consistency*. These are objects with a tendency towards organic qualities, able to sustain their own functioning. Concretisation, in Simondonian philosophy, is viewed as an ongoing, continuous process, punctuated by the appearance of *metastable* states, periods of *apparent equilibrium* in an object, charged with the potential for further *concretisation*.

As I have argued elsewhere, a modular system represents a complex, yet limited possibility space for the development of bespoke musical instruments. It is a *machine for building machines*, with modular practice blurring the lines between instrument building, musical composition and performance (Carey 2023: 7). In this context, modular patching can be viewed as a form of dynamic *technical invention*, whereby the synthesist is engaged in iteratively evolving new *technical objects* for use in musical performance and composition. Taking Simondon's project seriously, it is therefore necessary to trace the context-dependent *geneses* of these *technical objects* throughout a patching session. By attending to this *genesis*, we see how *technical objects* emerge through a 'dance of agencies' between both human and material (Pickering 1995: 21). As explained throughout this article, a modular patch can contain multiple *technical objects*, and through the process of patching, the synthesist co-evolves their functionalities in response to the developing dynamics of the patch itself.

In what follows, some core concepts in Simondon's philosophy are outlined and put into conversation with modular synthesis practice.

2.1. Technical invention

In this article, Simondon's concept of *technical invention* is considered as a core aspect of the creative practice of modular synthesis patching. The concept of *invention*, in Simondon's philosophy, was developed with reference to the genesis of the *image*, and of *imagination* in the context of human-material relations (Simondon 2022: 139). Here I propose that modular synthesis patching is constituted by a set of dynamic human–material relationships in which *technical invention* functions as the means by which new *technical objects* emerge from the *technical milieu*. These technical objects take the form of bespoke sound sources, and are put in relation to one another through an ongoing process of concretisation. For Simondon, invention does not arise in a vacuum, but is intimately connected to the ongoing genesis of *technical objects*:

> To invent is to make one's thought function as a machine might function, neither according to causality, which is too fragmentary, nor according to finality, which is too unitary, but according to the *dynamism of lived functioning*, grasped because it is produced, accompanied in its genesis. (Simondon [1958] 2017: 191)

More specifically, Simondon notes that *technical invention* is always in response to a problem, or incompatibility between objects, and their various interrelated *milieux*: 'To what situation does invention correspond? To a problem, which is to say, to an *interruption* due to an *obstacle* or a *discontinuity* acting as a barrier to an operative implementation that is continuous in its project' (Simondon 2022: 139). As Simondon notes in the preceding quotation, invention is a process that responds to the *dynamism of lived functioning* of technical objects (Simondon [1958] 2017: 191). True technical invention is therefore not unidirectional or *unitary*, but responsive to the task environment, and can also provide new opportunities and problems once embedded within the *technical milieu*. As Simondon stated:

> Genuine invention transcends its own end; the initial intention of solving a problem is only a trigger, a mobilisation; progress is essential to inventions that constitute created objects because the object, endowed with new properties beyond those that solve the problem, transcends the conditions of the original position of the problem. (Simondon 2022: 171–2)

For Lamarre, as the invention enters the world of technics, an inventor's understanding of its use shifts as the relational characteristics of the milieu become clearer. This has implications for the way in which *technical elements* are put in relation to one another in a technical object. As inventors use these inventions, 'the design itself begins to demand practical adjustments, bringing into play other aspects of its basic elements, adding new elements and creating new relations among elements' (Lamarre 2012: 45). Further, Lamarre emphasises the more-than-human qualities of such inventions, where concretising technical objects are not passive, but actively *suggest* forms of concretisation: 'The technical individuation proposes connections and new relations. Although it is too much to say that the machine is thinking for itself, it is clear that the inventor and invention are thinking with one another, and this thinking, which, insofar as it is a relation, is on both sides, and it is entirely real' (ibid.: 46).

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2.2. Technical elements

In this research, a *technical element* is conceived of as an *abstract* function available for use from one specific module in a system. A single module in a modular system usually contains multiple *technical elements*, either working independently, or as part of a larger technical object comprising multiple elements working together. Often, these larger objects remain *abstract* because they do not display forms of *reciprocal causality* in and of themselves, but group together various *technical elements* that are dependent upon each other in some linear, predictable way. For example, consider one of the four function generators in the Buchla 281e Quad Function Generator, set to trigger or gate mode. This technical object contains multiple *technical elements*, including an attack and a decay stage with dedicated control voltage inputs, a pulse output that goes high when the envelope reaches the end of the decay phase, and a mode switch, to determine the pulsed, gated or cycling behaviour of the function. Taken together, this collection of *technical elements* constitutes a technical object that is *abstract*, as the architecture of the circuit links these elements together in a linear way. Seen from the *order of magnitude* of the patching layer of the system, each independent function generator in the 281e may be seen as a unique *technical element* within the context of an overall system, as there is no a priori communication inherent between each generator. Such elements remain abstract because they do not by themselves exhibit *recurrent forms of causality*, or *internal resonance*. It is only through interdependent relationships with other elements that a *technical individual* begins to form.

2.3. Technical individuals

Grouping together multiple *technical elements* into their functioning, *technical individuals* are composite technical objects that move from *abstract* to *concrete* as each element contained within becomes *plurifunctional*. Through increasing amounts of reciprocal causality, technical *individuals* differ from *abstract* objects as their elements develop forms of *inner resonance* between themselves and other parts of a system: 'in it each structure exists not only as organ, but as body, as *milieu*, and as ground for other structures' (Simondon [1958] 2017: xv). Through this increasing *plurifunctionality*, *technical individuals* represent a phase transition between different *orders of magnitude*, namely from *abstract* collections of *elements*, to *concretising individuals*. Most important in Simondon's analysis of technical objects is their *ontogenetic* quality. As Stiegler has noted, it is the active and ongoing *genesis* and *organisation* of these objects that distinguish them from being viewed as fixed objects: 'There is a *historicity* to the technical object that makes its descriptions as a mere hump of inert matter impossible. This inorganic matter organizes *itself*' (Stiegler 1998: 71; emphasis in original). While Simondon discusses all technical objects as being ontogenetic, in the context of modular synthesis practice, only *technical individuals* are in the position to evolve dynamically as part of the patching process. In a modular system, *technical elements* exist as predesigned functions that are available for use through patching, whereas it is the process of patching itself that allows *technical individuals* to evolve ontogenetically through the process of *technical invention*.

2.4. Technical ensembles

A *technical ensemble* is what results when multiple *technical individuals* begin to work together as a larger, more complex concretising system. In Simondon's philosophy, *technical ensembles* are those that regulate their functioning depending upon the continuous, reciprocal communication between various *technical individuals*. Throughout this research, *technical ensembles* are conceived of as the dynamic functionality of an overall patch in the system, where invented *technical individuals* communicate with each other through an increasingly saturated *associated milieu* (see section 2.8). Invariably, such *ensembles* comprise multiple sound sources (or 'sub-patches') working as concretising *technical individuals* that iteratively evolve their relationships to each other to create a larger, more complex network of functionality.

2.5. The open machine

While *technical individuals* and *ensembles* may exhibit emergent and semi-autonomous behaviours, in Simondon's philosophy, the concept of autonomy is downplayed in favour of what he calls the *open machine* (*La machine ouverte*), a form of technical object that is 'endowed with a high degree of technicity' (Simondon [1958] 2017: 17). Here, technicity refers to the relational and ontogenetic quality of technology, and the human and non-human entanglements it engenders. For Simondon, the technicity of an *open machine* is evidenced by its possession of a certain *indetermination* in its functioning, with this *indetermination* enabling concrete technical objects (*individuals* and *ensembles*) to be sensitive to outside information, enabling adaptation of their functioning in response to their *technical milieu*. In a modular patch, while certain sound sources may act independently of others, every composite sound source remains a Simondonian *open machine*, with every *technical element* connectable to any other, opening the potential for *plurifunctionality* among these elements. For Simondon, interpreting and working with the inherent *indetermination* of technical objects is seen as both essential and non-hierarchical in its relation to the regulated functioning of the technical system: 'for there to be a true technical ensemble man has to play a functional role *between machines rather than above them*' (ibid.: 150; emphasis added). As noted by Simondon and others, this is a non-hierarchical view that acknowledges the *genesis* of technical objects as being of primary importance when considering their relationship to humans who must engage with them. As Lamarre has stated:

> it is precisely because invention proceeds in a hands-on, practical and inventive fashion—as a sort of dialogue between humans and machines that engages the pre-individual within humans—that humans should not strive to 'use' machines in a purely rational utilitarian fashion. (Lamarre 2012: 51)

2.6. External milieu

In the context of Simondonian philosophy, the *external milieu* constitutes the external (natural) environment outside of the *technical milieu*, which encompasses technical objects such as *technical elements*, *individuals* and *ensembles*. Simondon explains how concrete technical objects *mediate* between their *internal milieu* and the *external milieu* through the creation of a strong *associated milieu* (see section 2.8). In the context of industrial society, it is also true that *technical elements* were once derived from the natural environment itself. Therefore, while technical objects become from within the *technical milieu*, they are also *of the environment*, and interact with this *external milieu* in more and more concrete ways as they concretise into *technical individuals*. In this research, each distinct synthesiser system is considered as the *external milieu* from which *technical individuals* and *ensembles* emerge through the parching process. The *external milieu*, in this context, is therefore conceived of as the environment from which *technical individuals* conscript *technical elements* and begin the concretisation process, bringing these elements into newly developing *internal milieux*. Here, *technical elements* exist as pre-designed and manufactured functions of the modules within a system, with the system representing the *external milieu* with which *technical individuals* form relations through their developing *associated milieu*.

2.7. Internal milieu

The *internal milieu* is the internal, dynamic relational structure that exists inside a single concretising *technical individual*. In the context of modular synthesis, the *internal milieu* is created through the patching process, as a single sound source begins to form through the combination of several *technical elements*. While patching, the *internal milieu* of a newly formed sound source may exhibit dynamic and semi-autonomous qualities, or simpler, linear forms of causality across the array of conscripted *technical elements*. While these sound sources must conscript *technical elements* from the *external milieu*, the *internal milieu* can only contribute to the concretisation process by developing forms of reciprocal causality among its various *technical elements*, and the outside environment represented by the *external milieu*, or system. As these *elements* concretise, the *internal milieu* communicates with the *external milieu* through an increasingly present *associated milieu*, an intermediary space that forms through the regulation between the *internal milieu* of the technical object, and the surrounding *external milieu*.

2.8. The associated milieu

The *associated milieu* emerges when *internal* and *external milieux* are brought into communication with each other. It is a specific, context-dependent milieu consisting of the relational characteristics that help sustain the concretising technical object. For Simondon, *the associated milieu* develops around a technical object as it increases in concretisation and displays *recurrent causality* among its internal *elements*. Lamarre has highlighted the dynamic potential of the *associated milieu*, which he characterises as an 'energetic, charged, potentiality' (Lamarre 2012: 39). In addition, he describes the transformative nature of the associated milieu in reshaping human engagement with technical objects, stating that: 'the new associated milieu is not an imposition of human will upon the environment but presents an opportunity for working with or alongside specific machine–environments or even machine ecologies' (ibid.: 48).

In the context of modular synthesis, the *associated milieu* is the space in which sounds and processes are brought into communication with each other and regulate each other's functioning. Through patching, the *associated milieu* evolves over time, incorporating more and more functions of the *external milieu* and the *internal milieu* of technical objects into its orbit. As such, there is a certain saturation of the *associated milieu* that occurs as one develops a patch, with the *concretisation* process and strengthening the *associated milieu*, as *technical elements* function as part of *technical individuals*, and these in turn work as broader *technical ensembles*. Owing to the constrained nature of such modular systems, new sound sources gravitate more quickly towards incorporation with this *associated milieu*, accelerating the process of concretisation. As a patch increases in complexity, there is a corresponding decrease in the number of unconscripted functions remaining part of the *external milieu*. To develop an entirely new source, one is quickly presented with a limited array of functions that are unrelated to technical objects that are already entangled in this *associated milieu*. Seen from this perspective, we can see how the *associated milieu* is responsible for the *ontogenesis* of technical objects, through what Hoel and Tuin have called the 'ontological force of technicity' (Hoel and Tuin 2013).

2.9. Metastability

Metastability denotes a state in a system whereby the system may be described as exhibiting *apparent equilibrium* (Simondon [1958] 2017). The concept of *metastability* is core to Simondon's philosophy, having taken this from organic chemistry and thermodynamics. *Metastable* states are provisional states in a system, whereby a small change in an otherwise stable system can bring about further rounds of *concretisation*, including radical *phase shifts* between different *orders of magnitude*. In the context of a modular synthesis patch, a sound source is in a *metastable* state when the choice to undergo further concretisation results in a phase transition for this source. By connecting it to the *associated milieu* and fine tuning its relationship to other sources through this connection, the source resolves issues of *external* and *internal compatibility*. As part of this phase transition, this action may also engender further problems of compatibility for itself, the *associated milieu*, and the other sources within the patch, which triggers further rounds of concretisation, until another point of *metastability* is reached.

3. TECHNICAL INVENTION IN MODULAR SYNTHESIS PRACTICE

In this section, two detailed examples from Sessions 1 and 2 of the previously mentioned 'think-aloud' videos are analysed with reference to Simondon's philosophy of technology. These examples trace the *genesis* of individual sound sources, detailing numerous examples of *technical invention*, including both successful and failed attempts at *concretisation*. In addition, the analyses highlight the various creative strategies employed to resolve incompatibilities within sound sources as they reach *metastable* states, and finally move towards further *concretisation* through communication between different *orders of magnitude*. What emerges from these examples is a picture of the dynamic and co-evolving nature of both technical objects and musical ideas in this practice.

3.1. Session 1: Buchla 200e

3.1.1. Initial exploration and concretisation

This patch began by evolving one complex sound source up to a point of rhythmic and timbral complexity. I chose to first explore the 261e Complex Waveform Generator, a dual oscillator source with an internal modulation bus and various CV controls over timbre, frequency and amplitude modulation. Over the course of approximately 20 minutes, a dynamic sound was evolved by exploring various functions of the 261e and connecting them to other modules in the system to create dynamic articulations. The transcript of this section illustrates the exploration of functions of the 261e's modulation oscillator, probing and questioning its routing within the internal modulation bus:

> [3:27–4:18] One thing I didn't realise is that … so when you're modulating this side with the amplitude controlling this, it's actually the … [tweaking mod waveform] … waveform change that will determine which waveform is modulating it. But I think [switches modulation bus to pitch] if you were just to modulate the pitch, give it a bit more … yeah, it's just a sine wave when you're modulating pitch. What about for timbre? Oh, that's interesting. So the 261's modulation oscillator … [pause to listen] … it's only for the pitch that you're only using the sine wave oscillator.[5]

Through this questioning, I expanded my understanding of the external milieu from which I was conscripting technical elements for use in my first sound source. As the modulation bus of the 261e became clearer, it opened the way for me to begin the development of a complex sound source. This example highlights Simondon's conception of the *in-betweenness* that exists between humans and the machines with which they engage. For Simondon, this process is a crucial condition for invention to occur in practice: 'The condition for concrete inventions is *prior exploration, manipulations, and organisation of the territory* in which the problem will arise and the instruments of a solution will be found' (Simondon 2022: 150).

So, armed with this knowledge of the internal and external modulation capabilities of the 261e, I proceeded to begin patching a source. I first chose to use the CV output of the modulation oscillator (at LFO-rate) to control two aspects of the wavefolding circuit of the principal oscillator. The circuit's high-order harmonics were modulated directly from a square wave sent from modulation oscillator's CV output, while this same CV was also used to trigger a sample and hold circuit on the 267e Uncertainty

[5]View excerpt in context at: https://youtu.be/1Yo7lSKGb70?si=AraNpASUn6hpiARa&t=207.

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Source, the output of which was dialled in to randomly modulate an input to the principal oscillator's timbre circuit. Following this, a sequencer was added in the form of the 250e Dual Arbitrary Function Generator. Here, the same CV output from the 261e's modulation oscillator was used to clock the 250e, with outputs from a seven-step sequence on the 250e patched back to sequence parameters of the 261e. Importantly, this included scaling the output level of the modulation oscillator, creating a dynamic articulation of this source.

In the preceding discussion, we can see examples of *recurrent causality* appearing in this sound source as it *concretises* into a *technical individual*. At this point, the modulation oscillator's output was made *plurifunctional* through its control of three separate *technical elements* in the source. These *elements* were both internal as well as external to the 261e. This is an example of an evolving relationship between both internal and external *technical elements*, pushing the sound source further towards *concretisation*. In turn, these decisions increased the size and regulating power of a developing *associated milieu*. Given this system comprises a single clockable sequencer, any subsequent sound source in need of sequencing would be obliged to gravitate towards the dynamic provided by this modulation network. This is a prime example of how the *concretisation* process builds a new *associated milieu* that both sustains the current technical object and regulates any future technical objects that may evolve from this *technical milieu*.

3.1.2. Appearance and resolution of internal incompatibilities

After listening to this amplitude modulation, I chose to further modulate the amplitude of this source, employing a looping function generator from the 281e to control the source's dynamics via a low pass gate in the 292e dynamics manager. At first remaining an *abstract* element, I chose to *concretise* this function generator by controlling its decay time from the same sample and hold CV controlling the source's timbre. This made the 267e's sample and hold *element plurifunctional*. At this point in the development of the patch, the *associated milieu* had begun to grow in its regulating power across the system. With a decreasing array of unconscripted functions available for use, the choice to *concretise* this source was influenced by the dynamic qualities already present in this technical object. Choosing to employ modulation already used elsewhere in the sound source, I had once more tapped into the 'energetic, charged, potentiality' of a growing *associated milieu* (Lamarre 2012: 39). Here, the concretising technical individual had reached a *metastable state*, a state of apparent equilibrium that necessitated a reflection on the source's internal dynamics:

> [19:41–20:08] It's interesting, it seems kind of buried, that amplitude modulation from the 281, and it's buried [pause] because there's so much amplitude modulation coming from the oscillator itself. But that's an interesting one, and it could allow me to relate something derived from this to something else. Alright, let's try that.[6]

Noting that this amplitude control was less audible than I anticipated, I saw an opening to make use of part of this source to control something else. The 'buried' nature of this modulation was found to be an undesirable aspect of this sound. An *incompatibility* was therefore discovered between the *internal milieu* of the sound source, and the *external milieu* represented by a separate *technical element* conscripted from the system, the 281e function generator. The dynamic properties of this looping function generator were then taken as a catalyst for further exploration:

> [20:28–21:16] Alright, so I've got this looping source (the 281e function generator); it could be cool to double that looping source and put it in another input. Now, I'm thinking about something kind of panned, so what we're going to do is I'm going to grab this open channel in the 292, put it in the first mixer channel, which is a panning channel.[7]

In this example, my initial explorations emanate directly from the possibilities presented by this problematic modulation, rather than trying to generate a new sound from an idea external to the system dynamics. Here then, the potential for a new source occurred to me as a way of making use of an *internal incompatibility* in the current source, and the series of possible pathways that this *incompatibility* presented for exploration (e.g., dynamic modulation, panning). This is an example of how such occurrences of *internal* or *external incompatibility* are often used to further the process of *concretisation*, spurring on new examples of *technical invention* in my work. The appearance of a problem at one *order of magnitude* provides for the resolution of a problem at another *order of magnitude*. In this case, a problematic tension in the *internal milieu* of one source opened a channel to communicate with a different *order of magnitude*, namely the embryonic development of another source.

3.2. Session 2: EuroSerge

This session is notable for the more distributed approach to concretisation across the four sources developed throughout this session. There are multiple

[6]View excerpt in context at: https://youtu.be/1Yo7lSKGb70?si=AraNpASUn6hpiARa&t=1181.

[7]View excerpt in context at: https://youtu.be/1Yo7lSKGb70?si=AraNpASUn6hpiARa&t=1228.

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points of recurrent causality present throughout, as I fine-tuned the reciprocal relationship of the first three sources to each other in a responsive, 'intra-active' feedback loop (Barad 2003). The first source in this patch explored oscillator sync, a technique for creating rich timbres based on the modulation of the rise and fall times of looping slope generator (ES75 Voltage Controlled Slope), synchronised by a square wave oscillator (ASM325 VCCO II). My patching process began by manipulating parameters of these two oscillators by hand, exploring the pitch and timbral characteristics of the source, before conscripting two external *technical elements* to automate these aspects of the sound (a looping ES27 Transient Generator, and the Smooth output of the ES01 Random Voltage Generator). Although the resulting sound was interesting and complex, the source did not yet display any form of *recurrent causality*. In Simondonian terms, the technical object remained *abstract*, not *concrete*, with *technical elements* drawn from the *external milieu* each working independently of each other to create this composite sound.

After patching these basic automations to the source, the following excerpt of the transcript illustrates my attempts to *concretise* its dynamics, by increasing the *plurifunctionality* of its various *technical elements*:

> [11:09–12:06] So that's pretty cool, but there's a few things that I'm thinking, though, just as I'm listening to it. Like, obviously … [begins moving the mixer's gain knob to control source volume], I could have some dynamic control over it; I'm just doing this manually at the moment. I wonder if … I wonder if [picks up patch cable], I wonder if I related the um [patches a cable between transient generator and mixer gain] as we get higher in pitch, we get louder? Let's slow this down. [changes rate of random voltage generator]. No, it's too close to it. I would probably prefer something that's a bit more asynchronous.[8]

As this excerpt illustrates, the idea to automate the gain of this source was influenced by the effect of my physical gestures on the overall dynamics: 'I'm just doing this manually at the moment.' I then experiment with automating this gesture through *concretisation*, by employing the modulation source controlling the pitch of the synchronising oscillator to also control its dynamics, without success. So, in the process of searching for an *internally compatible* approach to dynamic control, an attempt was made to *concretise* the source by relating one part of the technical object to the other. This attempt created a perceived *internal incompatibility* in the source, as the modulation controlling the pitch was found to be unsuitable for also regulating the source's gain. By listening to the results of this experiment, I then analysed why this didn't appeal musically, before identifying a musical preference for asynchronous modulation.

Rather than acting upon this new knowledge immediately, however, I began reflecting upon the sound itself at a higher *order of magnitude*, as well as brainstorming another approach at dynamic modulation:

> [12:29–13:18] The cool thing about that oscillator is it's a really rich source, so it's something that is going to stand out. It also allows me to kind of tap it to do something else … So immediately, the thought is okay, grab another slope and then play with the volume that way. But I'm thinking maybe what I could do immediately is tap that sound. And when I say tap that sound, like take it out and put it somewhere else, yeah, it could be putting it into a phaser or something.[9]

This excerpt of the transcript represents my thought processes as I'm both reflecting upon what I've currently developed and then working out where to go next. In the previous quote, I have identified an issue of *internal incompatibility*, and revealed a musical preference of the back of this; however, the preceding excerpt reveals an attempt to think more broadly. An obvious choice presents itself (I could 'grab another slope'), but by musing on the higher-level context of the patch, I discover another path forwards at a different *order of magnitude*. This *internal incompatibility* represents a forking path in the road towards creative *concretisation* in this patch. Without resolving the issue of dynamic control, the current source remains in a *metastable* state. By recognising a problem to be resolved, and finding an inadequate solution, this source hangs in the balance, providing a creative catalyst for a new exploration.

As the patch continues, I move directly into processing the sound of the current *technical object* through the ED105 phaser module, patching its output to a separate mixer channel. Rather than continuing the internal *concretisation* process of the first source, this is left in a *metastable* state, moving once more into a new *order of magnitude*. Even at this embryonic stage, this new potential source represents the first activation an *associated milieu* in this patch, as the new sound sources developed are now entirely dependent on any further changes to the sound of the initial source.

In this example, an initial attempt at concretisation provided a *seed* for the ongoing *concretisation* of the patch as a whole. Leaving this source *abstract* enabled me to envisage a new role for this in the patch. As a

[8]View excerpt in context at: https://youtu.be/53YnBCsTV0w?si=7ZotNshTLCTgSvHM&t=669.

[9]View excerpt in context at: https://youtu.be/53YnBCsTV0w?si=7ZotNshTLCTgSvHM&t=749.

second source developed through the exploration of phaser feedback, the initial source remained *metastable*, charged with the potential for further *concretisation*. Throughout the session, I returned to the first source numerous times to explore how it related sonically to the new sources I was creating, at times radically changing its character to see how this would affect the entirety of the *technical ensemble*. After developing a third source, I began blending all three sources together and experimented with new sounds and forms of control:

> [24:15–26:10] Bringing back in that original source, it's just so different from the way it was when I started. What if I brought some noise into that feedback path? [patches noise into matrix mixer feeding the phaser – continues to experiment with transient generator controlling VCO2 pitch – pausing to listen] Ooh, that's interesting! Okay, so what have I done here? I've got the transient generator, or the slope here, that was originally just going up and down in a triangle fashion to change the synchronising oscillator. I now decided to get audio-rate frequency modulation of that.[10]

Here, my choice to change the rate of the transient generator, the original source controlling the pitch of the synchronising oscillator, was made in an exploratory fashion in response to a mix of the whole *technical ensemble* sounding together. Given the dependency of sources two and three upon the sound of this initial source, I was able to radically shift the overall sound of the patch. By choosing to leave the first source *metastable*, I was able to iteratively evolve new sources, creating a larger and more *concrete technical ensemble* that provided me with a new perspective on the role of the first source in this patch. While the first source remained *abstract* with respect to its *internal milieu*, by processing its output, and returning to it in context with the developing *technical ensemble*, the power of the growing *associated milieu* provided the catalyst for its creative evolution; a radical shift in trajectory. This example shows how a *technical ensemble*, comprising three, interrelated sources, provided a rich *associated milieu* from which to continue to tweak the initial conditions of my sound source, opening up new pathways for further *concretisation*.

3.3. Discussion

When comparing the preceding two examples, one can see that the development of a new source came at different points in the *concretisation* process. The first source in Session 1 could be argued to have undergone a significant degree of *concretisation* before adding a second source. This is evidenced by the multiple layers of recurrent causality explored across the system, including various forms of control voltage feedback between the various functions such as the 261e oscillator, the 250e sequencer, and the 267e random sources. In this patch, it was a perceived *internal incompatibility* in this complex first source that led to the decision to evolve the patch towards a larger, *technical ensemble*. As a largely *concrete* technical object, this first source was surrounded by an active, and powerful *associated milieu*, represented both by the multiple dynamic sources conscripted into its *internal milieu*, and the dwindling array of unconscripted *technical elements* remaining in the *external milieu*.

In the EuroSerge example, by contrast, the first source was less concrete before something new was developed. Through a failed attempt at *concretisation*, considered reflection on the current sound of the patch revealed an alternative pathway for exploration. The choice to leave the first source in a *metastable* state provided a creative catalyst for the development of a new source. This decision marked the beginning of the growth of this patch's *associated milieu*, which would eventually grow over the life of the session through the evolution of a *concretising technical ensemble*, eventually comprising four interrelated sources. As this patch continued to grow, the first and second sources begin to concretise in communication with each other, and the growth of an increasingly saturated *associated milieu* helped to bring about a third source, and the radical redefinition of the original source. While not explicitly referenced here, the fourth and final source was later developed in direct relationship to the saturated *associated milieu* provided by the previous three sources, creating a complex, and largely *concrete* network of sound sources.

4. CONCLUSION

In my work I am concerned with discovering new sounds, processes and music by following the flow of materials as I develop complex networks of electrical signals. Modular synthesisers, for me, represent a theatre of individuation, a space in which the musician co-evolves their musical ideas alongside the *dynamism of lived functioning* of bespoke technical objects. In this article, I have outlined in detail how Simondon's philosophy of technology is directly applicable to this complex, dynamic musical practice. By following Simondon's call for an understanding of technical objects by accounting for their *genesis*, I have shown how modular synthesis practice can be viewed as a prime example of technical ontogenesis in electronic music practices. Through the analyses in this article, I have detailed the process of *technical invention* evident

[10]View excerpt in context at: https://youtu.be/53YnBCsTV0w?si=7ZotNshTLCTgSvHM&t=1452.

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in two specific examples of practice, revealing how musical ideas co-evolve with the technical objects being developed through the patching process. By analysing modular synthesisers in relation to Simondon's concepts, I have sought to show the more-than-human aspects of this practice. Such a view acknowledges the *in-between-ness* of human relations with technical objects, rather than a hierarchical understanding of control and mastery over the technical world.

Here, I concur with Lamarre's analysis of Simondon's project when he states that 'humans should insert themselves into the true tendency of technical evolution—which is non-linear and discontinuous—by situating themselves with technical individuals and thereby participating equally in the relation between technical elements and technical ensembles' (Lamarre 2012: 61). By diving into the detail of two specific instances of modular patching, we are able to understand exactly how such non-linear and discontinuous aspects of technical evolution play out as part of a specific instance modular synthesis practice, highlighting the *ontogenetic* qualities of bespoke technical objects created through the patching process.

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