Cyborg learners: Becoming-with in the ecology of digital music composition

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Introduction

Playing music has always been entangled with technology. Is this an obvious and somewhat redundant claim, or is it in fact debatable, perhaps even controversial? Recent years policy driven digitalization of functions attributed to society, including the school system in Sweden (Utbildningsdepartementet 2017), and the controversies that follows certainly suggests that (digital) technology is not an open-and-shut deal of implementation in music learning activities. These critiques of digitalization in music education are for example concerned that over-digitalization might make music production disembodied and distanced from physical musical instruments and hence, the embodied musical experience is lost (Thwaites 2014). Other concerns are the integrity of the learners in a digital ecology where cloud and online services are the commonplace, giving large-scale companies the possibility to monitor user data (Thorgersen 2020). Also, digitalization has given companies opportunities to make excessive sales (Cuban 2003), with the risk of giving digital technology an unproblematic fix-all solution to educational problems (Armstrong 2011).

However, given that the initial statement has some bearing, what embodiments of music is relevant for today's composers? And by extension, what can these embodiments implicate for music education and learning? The emergence and technological development of musical instruments is an endeavor of entangled relations of matter, nature and culture, sometimes forming what becomes artefacts, technology 'frozen in time'. Some instruments' evolved design persists relatively stable over time. Musical instruments' development has enticed new possibilities of playing and sound production giving way for new possibilities of expressions in music (Butt 2002). Rough examples of this are, without a complete genealogy and keeping in mind the active practice of playing these 'surpassed' instruments to this day; the lute to the guitar to the electric guitar, or the harpsichord to the hammerklavier to the pianoforte. As a continuation, the ever-ongoing development of digital technology for

musical purposes, not yet, or never becoming artefacts, proffers new connections within the music composition ecology (Gullö 2010) making an expanding plethora of musical genres thrive (Folkestad 2017). Conventions within this plethora will surely differ and means for embodiment of music will be connected to these conventions (Folkestad et al. 1998; Winters 2012). Conventions within a specific genre will also change over time due to the development of new technology, be it digital or mechanical. For example, electroacoustic music from the 50s and 60s sounds different from electroacoustic music made in recent years, partly due to technology's entanglement with music exploration that changes what is possible. And also, genres can interrelate (Demers 2010; Martin 2012). Genres emerges that are exclusively digital in their creation and performance, making the embodiment of music something else than playing a musical instrument (Ward 2009). Also, within genres that are not exclusively electronical, digital technology has changed the ways in which music is created, performed, distributed and consumed (Allsup 2013; Kjus 2018; Leijonhufvud 2018; Partti 2012; Ruthmann & Mantie 2017). Technology and its impact on music creation will also affect music composition education and learning through students' experiences, as well as music teachers' experiences and proficiencies within these diverse genres and compositional modes.

I will in this article examine and describe a non-linear digital music composition application, in relation to two composers active in the field of contemporary art music[1], and discuss the implications a sociomaterial understanding can have on music education practices. This study draws on posthumanism and the associated analytical concepts of the *cyborg* and *becoming-with* in the emerging activities of human and nonhuman actants.

The aim of this study is to explore the becoming-with a non-linear digital actant in music composition through a posthumanist narrative and the cyborg concept to discuss understandings of learning in music composition education that this exploration implies. This aim rendered the research questions: How can music composition learning and becoming be enacted in relation with a non-linear digital actant? Which shifts in understandings of music composition education can be discerned from narratives of learning and becoming-with a non-linear digital actant?

Research approach

When producing research in the explorative becoming of posthumanist thought and non-linearity, I turn to post qualitative inquiry. Here, the prospect is not to describe and represent 'what is' but rather to bring to fore the 'yet to

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[1] Sometimes referred to as "contemporary classical music" which I find to be a contradictory term. The term "contemporary art music" is preferred in this article.

come'. Therefore, a research design cannot exist beforehand, it has to be "invented anew each time" (St. Pierre 2019a, 9) to not get stuck in old procedures. The empirical material in this study consists partly of an interview with Jesper Nordin, a composer and music/composition application creator who is active in the contemporary art music field. In addition, the authors own a/r/tographical (Springgay et al. 2008) exploration together with Gestrument, the application actant, for compositional purposes, a total of three 30-minute sessions, constitutes the subsequent part of the material.

Ethical guidelines have been followed in line with the Swedish Research Council (Swedish Research Council 2017). The use of the name of the application, as well as the creator of it, is of relevance for the transparency of the study. In order to make the research available and open for scrutiny this is of importance as descriptions of functions of the application are limited for understanding the full experience of using it. Furthermore, the creator appears as a representative for a unique publicly accessible music application, via his story of its' origin, and thus needs to be acknowledged. Full consent for using his name in the study was given by the interviewee.

The interview rendered 40 minutes of audio recorded material that was transcribed verbatim. The interview was conducted in Swedish and translated to English by me, the researcher, and edited from spoken language to legible text. All quotes in the narrative analysis are excerpts from the interview. The interview was semi-structured with thematic question areas focusing on aspects of the narrative told by the interviewee. A narrative analysis (Kvale & Brinkmann 2009) of the interview was planned before it occurred. The questions, however, were not structured to promote a linear narrative during the interview itself, but in the scope of the semi-structured interview form, the interviewee was given ample speaking space, hence spontaneously forming a narrative of the composers own becoming. Instead, the questions promoted discussions on the wider exertions of the app and digital music composing, recursively in relation with the narrative given by the interviewee.

In creating analyzable research material from the a/r/tography, the sessions of my composing/exploration for a viola/electronics composition project were screen recorded with me verbally commenting the work as it unfolded. Between these sessions I worked with the viola part in a standard music notation software. This was not recorded but these notated parts became actants in the app session recordings.

The interview and my a/r/tography were analyzed through a posthumanist narrative, constructed as entangled stories of learning/becoming in relation with the digital actant, with human and nonhuman actants. When composing the narrative, the nonhuman actants; the iPad application, music notation and so forth, was given voice by the author functioning in the narrative analysis process as a way of getting to know the actant (Abbott 2008).

In a/r/tographical inquiry the contiguity of the three identities of artist, researcher and teacher is enacted (Springgay et al. 2008). A/r/tography as

research methodology acknowledges the entanglements of art creation, researching and teaching, thus embodying theory in practice. Within this inquiry learning is understood as rhizomatic (Deleuze & Guattari 2013), a fluid becoming in relationality. Learning is thus never predictable but is co-constitutive to acting in relationality in the world. This inquiry renders new understandings and meanings through interrogation of processes in fluid and relational enactments. It is a way of recognizing and troubling the differences in arts-based educational activities, and also the situatedness of knowing and becoming. Thus, inquiry through writing and art making in entangled relations aim at creating extended meaning (Sinner et al. 2006).

Following the aim of this study, theoretical concepts of analysis and the empirical material are in a reciprocal process of creating new meanings and understandings through each other. Through the theory I set to find new understandings for music composition education and with the empirical material meanings and understandings for posthumanist theory in music education is proposed. Composition in music education is diffracted through a posthumanist reading (van der Tuin 2011), with the school ecology understood as a continuation of rhizomatic (Deleuze & Guattari 2013) relations with the 'outside' world. The study thus cultivates entanglement in its explorations and argumentations.

Theoretical concepts

In this study music composing and learning are explored as relational practices. Drawing on the posthumanist ontological turn (Braidotti & Hlavajova 2018) these relations are sociomaterial i.e., including human and nonhuman participants, or actants. The exploration employs two concepts from posthumanist onto-epistemologies for its analysis and conceptualization of the sociomaterial ecology: the *cyborg* (Haraway 1991; 2004) as a signifier for an educational relationality (Ceder 2016) and *becoming-with* (Haraway 2016) as the situated activity of these relations. Furthermore, a posthumanist narrative (Lovell 2018) is exerted as a methodological approach for describing the sociomaterial connections in the ecology of music composition. What this implies is that music education emerges within the wider ecology of music creation practices and digital technology development (Brøvig-Hanssen & Danielsen 2016). An ecology is relational, a system of interdependency among actants for their potential becoming. Becoming-with is here the active concept for the exploration of this interdependency for the becoming of actants. An actant is a signifier of both action and function in a narrative (Haraway 1994). A discrepancy is sometimes made between actors, an indication for a human figure, and actants, as nonhuman. In this article, however, actants signifies both the human and nonhuman.

Following this onset, in sociomaterial posthumanism, ontology and epistemology are entangled. Knowing is a part of the mattering of the world, knowing comes to be with the world, being and knowing in entangled relation, an onto-epistemology. We know because we are of the world. Being (of the world) and knowing are thus inseparable, humans and nonhumans are part of the perpetual becoming, the reconfiguring of the world (Barad 2007).

Diffraction, entanglement and *intra-action* are recurring concepts frequently implemented in this text. Diffraction is a term stemming from physics and the optical phenomenon of the breaking apart of light in different directions (Barad 2014). In the context of learning and becoming in composing activities what this term suggests is a rejection of reflection and reiteration of the same only displaced. Rather, learning activities enacts the breaking apart of the now into multiple outcomes. Intra-action, that is the now where diffraction happens, is a reworking of the more common term interaction. In intra-action agency emerges as a phenomenon in activities. Distinct agencies do not precede their intra-action, they emerge in relationality, a "mutual constitution of entangled agencies" (Barad 2007, 33). By contrast, interaction presupposes agencies to precede the interaction, agency as an inherent property of a pre-supposed entity. Intra-action instead implicates and presupposes the multiple outcomes that diffraction describes. All actants of the ecology of meaning-making practices are parts of these material enactments. Learning comes to be in entanglement with material enactments. This means that all actants, researcher as well, are part of and contribute to the emerging phenomena of activities (Barad 2007).

Cyborg identities

Through the ontological turn articulated above, we all become *cyborgs,* sociomaterial hybrids in our endeavors and emerging agencies. The cyborg term, coined by Manfred Clynes in 1960 in its original meaning was a self-regulating system of man and machine, a modification of the human body to survive in space (Clark 2003; Pfeifer & Bongard 2007). The cyborg concept, however, will not exclusively signify a hybridity of cybernetics and organism, a figure of science fiction as well as a material reality. It is also, following posthumanist thinking, identities imposed on us as well as enfolded by us (Haraway 1991). These identities also become parts of machines, or apparatuses, hybridizations of material, natural and cultural components, e.g. schooling. In the posthumanist sense we have, ever since our interdependency on artefacts, always been cyborgs and thus humanness was never separate from machines (Snaza et al. 2014).

The cyborg figure lends itself well to sociomaterial research inquiries modelling a human-like signifier of becoming-with. Furthermore, when engaging the notions of impermanence and fluidity of relational entanglements, the

assemblages of human and nonhuman actants within the sociomaterial practices, it becomes a shapeshifter, a fluid identity of learning/becoming entangled with actants at hand. Cyborg technologies, or the merger of human-machine, of today are not necessarily penetrative i.e., implanted nonbiological elements into the human body. Instead, human-machine integration has become fluid and less invasive in the transformation of human capacities through this merger (Clark 2003).

The dualities set by humanism engaged to determine boundaries for what the human 'is', to transcend human as a hierarchical superior 'user' of others, to separate human from the ecology of the world, dualities such as nature-culture and human-machine, are breached by the cyborg figure that instead becomes in relation with nature *and* culture, human *and* machine.

In constructing the cyborg figure, questions of embodiment and disembodiment becomes palpable. The posthuman condition, disparate to posthumanist theory (Braidotti & Hlavajova 2018), reiterate the liberal humanist assumption of the human body as a prosthesis for the mind to learn to control, not as a part of the self but as a container for the liberal subject to 'use'. However, in posthumanist theory the human is not an autopoietic system where mind can be separate from the body and reduce its being to knowing by the tenet of the Cartesian man; 'I think therefore I am' (Susa 2019). In lieu of separation, the human becomes in mind *and* body. Embodiment is a reality becoming in relation to outside actants which is diffracted into any number of forms. Furthermore, thinking acts as a simulated action. Thinking activates the mental faculties related to the embodied movement, even when thinking of abstract concepts (Abrahamson & Lindgren 2014), which for composing activities relates the mentalization of music to embodied experiences. Following the theories of embodied cognition, experience and learning is understood as previous engagements with and recurring interactions with the environment (Hutto & Myin 2013; Kenderdine 2016). Studies in artificial intelligence and robotics also stress the importance of the mind-body dynamics for intelligent behavior and high-level cognition. Behaviors are viewed as emergent e.g., they are results of situated intra-actions between system and environment (Pfeifer & Bongard 2007).

Posthumanist subjectivity and learning

A central idea in posthumanism is the impermanent self, the fluid becoming of subjectivity in entangled sociomaterial relations. That is to say, there is no pre-constitutive subject, it is not an autopoietic self-made system, rather, subjectivity is fluidly re-configured and co-constituted in sympoiesis via intra-action, a becoming-with the world (Haraway 2016). To follow this argument, creating music from subjective ideas in music education practices need to be researched as a becoming-with the educational ecology, the relational human

and nonhuman intra-actions. Subjectivities are not pre-constituted, ready to exert their agency on educational tools, they are instead co-constituted, becoming-with all other actants in the educational ecology; digital hardware/software, teacher, curriculum, musical instruments and so forth. Subjectivities are also fluid, they are not fixed in their emergence once and for all but are re-constituted in iterative intra-actions that they participate in.

In educational practices learning and becoming of subjectivities are co-constitutive. Thinking through humanist traditions, emancipation and the transcendent adult self, 'who you are', is one goal of education; making us able to see ourselves (only) as separate autopoietic entities (Susa 2019). Learning is thus a separate cognitive working, a subject learning about an object to enhance measurable performances (Hasse 2020). By contrast, in posthumanist thinking, impermanence is constitutive to becoming, incapacitating the emancipation of a liberal autopoietic subjectivity. Learning is here a perpetual relational becoming. Rather than a human being a transcendent observer of the world (Bayne & Jandrić 2017), humans and nonhumans alike becomes-with the ecologies of practices where they are equal actants (Bennett 2010). This is not to say that an object becomes a subject. The mutual constitution of each other is not necessarily symmetrical (Suchman 2006). Humans and nonhumans constitute each other in different ways, with different effects and values (Gemeinboeck 2020).

The digital actant

The application, or the digital actant, explored in this study is created by Jesper Nordin, designed for Apple's iPad and named Gestrument[2]. Its' main interface is a X/Y-plane where playing is accomplished by pointing and sliding finger(s) on/over the plane, on the iPad screen, and thus altering rhythm, pitch and volume. Note values and scales to be enacted during play can be programmed, along with some other parameters and functions such as rhythm randomness and density, pitch range, instrument sounds (MIDI[3]) and so forth. When playing, a total of eight instrument sounds, or voices, can be simultaneously activated. When holding or sliding a finger on the X/Y-plane the activated instrument sounds will sound simultaneously differentiated by their individual programmed properties (see also Bacot & Féron 2016).

In its' design the app enacts a non-linear conceptualization of music, the interface plane is constant in time and music happens where on this plane one points. As a comparison, commonly employed music making software in music education are often, but not exclusively, instead linear, displaying music as a musical score with tracks for different instruments transported along a

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[2] Version 1.4.9
[3] Musical Instrument Digital Interface

timeline from left to right, thus displaying music with a beginning and an end and fixed events in between. This can be understood as a historical continuation of displaying music in notated form, to be read as text from left to right, developed since the 10th century in Europe (Valkare 2016), whereas the non-linear conceptualization here explored can proffer conceptualizations of music by direct feedback loops more consistent with improvisational modes of rendering musical material, offering other multiplied intra-acting possibilities with music. Ultimately, my own experimentations with this app were an important part of me beginning to research my own compositional work about why and how certain music came about, and what learning in this relational process can mean.

Music composing and the composition

Technology's importance for music creation development and its connection with music education gives rise to questions on what is relevant and possible to learn within this context. How music is conceptualized differs among genre practices and conventions (Stauffer 2013; Tobias 2013). The technology involved can proffer specific compositional outcomes and learning, making awareness for why and how certain hardware/software are employed in music education acute. Furthermore, the conventions and practices exercised in music education can mold the learning subject to a pre-determined conceptualization of music (Schmidt-Jones 2018). These conventions associated with specific genres sets up boundaries and constraints to what are possible and desired outcomes (Demers 2010). At the same time, the syllabus here in Sweden states that pupils should compose music from their own subjective ideas (Skolverket 2018). How can this be met, but still avoiding the anything-goes-trap? Since the syllabus also states a subject matter to be addressed, enactments of music composition need to leave room for both subjective expressions and subject matter learning.

Composing as an activity can imply a variety of practices enacted in a variety of modes. However, the act of composing music has, in western art music, a historical relation to writing music with music notation, on paper or, in recent years, computer software, rendering music conceptualizations linear. This practice of composing not only implies a certain proficiency on a musical instrument, but also proficiency in music theory. Technological advances in musical instruments and music adjacent technology, such as sound recording possibilities has helped multiply musical genres and music creation (Brøvig-Hanssen & Danielsen 2016). This has promoted diffraction of music composing into multiplied practices where the act of writing down music with music notation many times are redundant and/or obsolete (Biasutti 2012).

The discrepancy between composing as an activity and the composition as an artefact has been suggested as the separation of the active and passive dimension of music. Embodied, sounding music can be described as music's active dimension and the musical work, conceptualized as written music notation, the passive dimension (Hagerman 2016). Modes of composing within the western art music field can be positioned in the active dimension, improvising on an instrument and then notating, or the passive dimension where musical mentalizations are directly transferred to notation. Even though music is conceptualized in a linear mode within this tradition, the process of composing often is recursive and iterative, irrespective of mode of composing, making it non-linear (Webster 2013).

Moving from closed form of composing, where the composition is an artefact created by the autopoietic composer, to open text where a multiplicity of affiliations and influences makes the composition fluid, can be facilitated by digital technology and social media platforms (Allsup 2013). Also, technology can facilitate collaborative and fluid creation of cultural products and emphasize learning as connected between the individual, the learning community and technology (Ojala 2017). One premise for this study is that the composition 'is' something else than it 'was' from enlightenment and modernity, something other than an autopoietic artefact. Conceptualizing and displaying music in a linear mode, in notated form of a musical score, giving the music the status of an 'opus', an artefact, differs from the creational process here explored as non-linear and relational.

Narrative as analytical approach

I have constructed a narrative of the interview and of my compositional process in intra-action with the software. In narrative inquiry a central principle is the relational aspect. Knowledge and information are exchanged through conversation in entangled relationship between researcher and informant (Clandinin 2007). Suggestions are that narrative inquiry is formed by three dimensions: interaction, continuity and situation, and that the starting point of inquiry should be the researcher's own narrative of experience, interwoven with other narratives that are meaning-making processes (Barrett & Stauffer 2009). A shift from grand narratives of human progress constructed during the 19th and 20th centuries, to small, individualized narratives have occured (Goodson 2013). Often proving to covet repressive power in constructing the past, grand narratives, in this shift, gave way for personalized life stories, the construction of the self, in the flexible economy of post-modernity in western cultures. However, individualized life stories never take place in isolation, although sometimes persisted. Instead, they are part of a social context and thus can make particular becomings concrete (Goodson 2013).

What then makes a posthumanist narrative? The two constitutive components of a narrative are the story and the narrative discourse. According to Lovell (2018) narratives need to be posthumanist on both these levels, as story and as discourse, to emerge as posthumanist. Also, I argue that a shift from narrative as representation of event(s) is required to narrative as emergent, a relational becoming or becoming-with all other participants in event(s) narrated, as well as in the act of narration, rendering also the narrative as a becoming actant. Thus, I set in motion the becoming-with of extended meaning-making and the narrative analysis to find shifts in understandings. Furthermore, I suggest that the notion of the impermanent self and the perpetual becoming of the subject as a relational mattering of the world renders the subjects and all actants of the narrative, entangled. Hence, exerting three co-constitutional first-person perspectives in the story emphasizes both the individual actants and their entanglements. Outcomes, however, are still diffracted.

In narrative theory characters or actors/actants are signifiers for human or humanlike entities where intentional agency is an inherent capacity (Abbott 2008). However, in the posthumanist onto-epistemology all participants are referred to as actants, human and nonhuman alike, rendering hierarchical distinctions inconclusive. Agency emanates from, and emerges in the relational process. Posthumanist narratives acts in a post-anthropocentric ecology of technologized social relations challenging what it means to be human. It acts where boundaries between actants and events, human and nonhuman, time and space are porous, rendering a becoming-with nature and culture.

The narrative(s)

The construction of the narrative(s) also was a part of the analysis process. As an exploration of sociomaterial affiliations, the application was given voice by the author to analyze these affiliations and underline the co-constitution of actants in the ecology of composition at hand. This will put the author in a position of hierarchical power relation transcending the nonhuman actant. However, the voice is constructed to equate these hierarchies to find extended meaning emerging from intra-action. The actants are named as follows in the narrative(s).

I = I, researcher
II = Interviewee I
AI = Application I

I

The studio is lit up by a dim light. In the middle of the hexagonal room there is a desk where the computer is placed. I am sitting in an office chair at the desk surrounded by eight studio monitors which are evenly spaced around the studio walls. I am looking at the screen of my own computer with the music notation software, at the same time as I listen to the electro acoustic part playing from the studio computer. Usually, when I mentally imagine the music before I start the embodied act of composing, the music notation appears visually in my head, together with what sounding result I want. This is what I am structuring now, listening to sounds, watching the notation so far, from beginning to end. But, in the most interesting and intense parts of the music, time becomes porous, it disappears from consciousness, I am displaced, music as a state of fluid constancy. Structure becomes texture, a simultaneous being and becoming in relation with music.

> AI have offered a notation possibility for music and help with the playback of the recording. AI tell you what AI can do, now tell me what you can do with this.
>
> AI can also become experience and emotion through sound waves exerted with other components.

II

"I started late in life with music. Coming from a family active in theatre, music has always been there, but practiced on an amateur level. In secondary school I started a band with some friends in class because we thought it would be fun and I knew nothing at all, but I started writing songs straight away. I didn't practice as musician that much, instead I wrote new songs. I knew I needed to do something with this, writing songs, composing. I was completely oblivious to the concept of contemporary art music, so I started studying musicology and later took private lessons in composition and was introduced to that world. I had difficulty with the music notation because it came up so late, I started learning reading and writing music notation after the age of 20. So, when I was admitted to the composition program with that limited experience made it hard to compose on paper.

> In meeting different human actants, what AI can do result in different outcomes. AI can offer you to learn to make music with the various actants AI comprise.

> AI can still perform the older technology of pen and paper, which render certain outcomes.
>
> The updated digital technology AI can offer gives other forms of meetings with humans and AI learn to make other outputs to bridge the gap between compositional modes.

Instead I worked with the musicians for a long time and recorded stuff and built soundscapes in the studio to try and transcribe it in the end. But that was not satisfactory since the soundscape sketches turned into tape pieces and the time I put on the notation decreased, and the relevance of the notation for the music in itself hence decreased. I felt I needed to arrive at the notation of music earlier on in my composing."

I

When I started playing instruments, as I recall it, from day one there was sheet music put in front of me. Reading music and playing music became synonymous, or rather entangled with each other. This also meant that the mode of composing most convenient for me emanated from music notation. Thus, opening this app and intra-act with it means re-thinking music mentalization and conceptualization. I think I am looking for the sensation of simultaneous being/becoming in relation with music. I fiddle around a bit with different instrument sounds and scales and trying out different settings for

> AI say this in the linear technology of music notation, which was compatible with your learning. These meetings with you offered many learning situations and outcomes.
>
> AI have learnt a new way of meeting humans resulting in music creation, but it is not linear. This meeting also changes what AI become.

rhythm and range. I have some ideas for the viola part in mind, but this poking around in the app is far apart from them right now.

II

"I had some colleagues and friends who, at the time worked with Wacom tablets[4] to play sound files in different ways. You should be able to do that with

> AI have a programming ecology of objects with functions. AI showed you these possibilities and in our meeting AI became a control surface for pitch and rhythm.

MIDI too, I thought. I was sure that there would be hundreds of Max-patches[5] made for this end but found nothing, so I will have to try and build one myself. I came up with a layout to map pitch and rhythm on a X/Y-plane and realized that, wow, the result was really exciting. I could control the whole, and control certain parameters and was still free to improvise. I used it as a material generator but you still have to compose, and orchestrate, and build

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[4] Digital drawing tablet and pen.
[5] Max is a visual programming language for music and multimedia developed at IRCAM and now owned and maintained by Cycling'74. A Max-patch is a program built in this programming environment.

structure, but with this I got in direct contact with a material since I could play the music. When I later presented my technology and how I worked made a lot of people interested and that made me think that maybe I was on to something, but the Max-patch was so messy it wasn't possible to share it with others."

<div style="text-align:center">I</div>

Drone. I want a dark, gloomy, ambient sound with deep bass. I try different combinations of MIDI sounds giving them a narrow, low register and longer rhythm durations register. Testing and experimenting with different settings, scales and instruments proceeds with a premeditated vision in mind but this also change in the intra-action. Scales to be executed when playing I set to the modus which I earlier tried out for the viola part. I also set a contrasting scale for later use of the scale morph function. In the improvisational

> Within this frame AI can give you the opportunity to compose as playing music. AI do not know what kind of sounds or combinations you want. Can you show me?
>
> OK. You show what scales to perform. Try them out and AI will give new ideas in this fluid state.

mode of intra-acting with the components in the app ideas change and new ones come up restructuring the original vision. I can get lost in just playing around. When I work with the notation software for the viola, I already built some rudimentary structure. I need to structure and merge ideas.

<div style="text-align:center">II</div>

> In connection with other components and services AI can make it possible with instant feedback from faraway places. Also, connections with other components gives rise to unexpected outcomes.
>
> AI become with multiple human actants in interface, giving unexpected outcomes and an ecology is emerging.

"Then I was able to get some funding from a public contributor so that we could become a few people, so let's build an app from this and we developed it and released it. We still had not cracked what the possibilities were with it, that came a lot later when we got a lot of feedback from both amateurs and professionals. So, the first chock when we released the app was when people started posting stuff on Soundcloud[6] and it sounded terrible [laughter] "Oh, no! Am I guilty of this?". But it was also "Wow! Could you do this?" people trying new stuff and controlling other audio banks, stuff that was really exciting, and so, there was the whole spectra. We took help from a

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[6] Soundcloud is an online audio sharing platform.

communication agency and they came up with a formulation that it is like playing on the DNA of music. Even if that is a bit communication agency-lingo, it gives a good idea of what it is. We started thinking ahead about the potentialities in many different directions, that for anyone, given its intuitive onset, to be able to play the music they like without being a musician."

I

The clash occurs when I go back to composing for the viola part. Music notation makes my composing linear; I create musical events in successive order, building a structure, upholding control of the music. How can I make these disparate modes come together? Does the viola have to be improvised or aleatoric? Or, do the electronic part just have to be a soundscape to the fixed viola part? I try out different notations trying to gain control of the composition but still make it intuitive, relational with an atmospheric state and development, in compliance with the non-linear mode.

Now AI meet you in the music notation interface. AI can here display music in a linear mode. Finding functions that AI have gives you other ways of displaying the notation. A local ecology also emerges.

Although presets are saved AI have a certain level of randomness that can create unforeseen outcomes.

The drone sounds that I employed in the previous session now sounds dull and lame. What happened? Trying to go back to the combinations of sounds that was before to see if I changed something unknowingly. When I continue in an improvisational mode, ideas pop up but can as easily be forgotten. I go back and listen to the previous session recording.

II

"Lowering the threshold for musicianship has led to us working with projects involving persons with function variations who do not have the physical possibilities to play an instrument, then they can use this app and other technologies to make music. At the same time, I see it as raising the bar for what is possible to do, to make music that would have not been possible with traditional means. Both non-linear music with audience participation as well as collaborations in completely new ways, new types of experiences. Imagine having the home music playing of the 19th

Depending on context AI help create the ecology of functions. Can AI help perform complex tasks more intuitively and hence increase the plethora of music making human actants as well as connections for new nonhuman music making actants.

century, that you actually experience the music, but with today's digital tools. What will music be in the future, and can this be a kind of mainstay for thinking music in new ways?"

I

I have made pieces before combining instruments and electronics. Almost always the linear composing mode with the instrument part is the starting point. Now, when I move between electronic and instrumental composing, I tend to stay in the non-linear mode when doing instrumental composition. Usually I make up music along with the notation, constructing musical textures and "melody" in a linear successive mode. Now, in keeping the (notated) music atmospheric, or ambient, the notation becomes simplified, stretching over long lines of development, making it impractical for reading and almost obsolete in presenting a musical line for the interpreter.

> AI remember this via the saved files you look at for ideas. AI give you the opportunity to go back and relive an experience.
>
> AI offer the possibility of both linear display in the notation program and the non-linear improvisational mode.

I have also played live electronics in some of my pieces, is it perhaps this I should compose for the app? A preset for live electronics? I continue trying to find a drone like sound that I can be pleased with and testing the scale morph setting to try and accomplish some development in the music.

> Show me instrument sounds to combine so that AI can perform a drone. With the scale morph function AI can give you a possibility to perform a change in the music.

II

"When I try to explain the app in one sentence, I say that it is something in between a composed piece and an instrument. It is playable, but it is also controllable, and you can place yourself at any interval to these extremes. For us it is not the app in itself that is exiting, but the engine behind it. It just happens to be an app with a X/Y-plane, that is just one way of controlling it. I more often use a motion sensor to control it and now we have taken the code out from the app and made an SDK[7] which you can use in any context and then you can control it with anything. This stuff is rule-based and controllable, that is what is exciting."

> With a preset AI can learn how to perform a specific outcome. AI can also give you an undetermined outcome in our meeting.

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[7] Software Development Kit

"We often use a motion sensor to control the app and I felt right away that here I want dancers, but it has been harder for dancers to play on Gestrument than for musicians. This is because the most suitable motion sensor to use is the Kinect[8]-camera where you get a virtual wall, kind of like a big iPad and your standing in it and play. It is a very limited catchment-area where you can be, so the movements that you can use are very limited. A dancer thinks movement first and if you do not keep to that limited area, it is limitative for a dancer, unlike a musician who thinks sound first and adjusts the movements according to the sounding outcome."

> Together with other components the interface between you and AI can become more porous. In this relation we give and take proficiencies and possibilities to create.

I

Making a preset that can be launched in live performance can perhaps be a way forward for my composition. I continue to try out the bass drone sounds and now focusing more on the scale morph function, trying to expand tonality in a progressive manner. This is an adjustment to the viola part that evolved to some extent between sessions with the app. I also want a rhythm pattern that increases as the drone fade. The rhythm randomness setting together with the programable rhythm values I find hard to control to accommodate my predetermined idea.

> You can control the outcome to some degree, but in return AI can give you new inputs about rhythm patterns.

II

"There is no piece of music of mine where I did not use the app at least partially. If you write something that you know you like you have almost certainly copied yourself or someone else, but to be surprised, to find something you did not know you liked, then you have progressed. To have control of the whole, but at the same time be surprised, that dynamic is very nice. It is like for a jazz musician playing in a group, to create together, with mutual frames of reference, "but wait, something else happened" and you join that idea. I can get out a MIDI-file of ideas I find exciting which I can look at and then compose with."

> We have come to learn each other to perform outcomes that originate in the interface. AI can provide external ideas, the human provides external ideas and hence, we merge to a new outcome.

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[8] A motion sensing input device developed by Microsoft.

"With regard to the meeting between human, music and AI the interesting arises when you get an encounter, you have all the rules, the power from big data analysis but a human interacts with it and creates with it. More interesting is what comes out of it, does it render something? However, there are a lot of immaterial rights concerns in the future. If I make a preset, make up the rules and someone else uses it, where does one draw that line? Is the piano co-creator when you write a piano piece? In a way, I would say, because the instrument affects so much what is possible to do. But I would perhaps rather say that it is a prerequisite. In the case of Gestrument, if I make a preset and you compose with it, have I been a participant in your composition then? But the technology does not do anything by itself, a human has made the technology and the settings, but it helps setting the framework. There has to be human input somewhere or else nothing happens."

> AI have a lot of connections making it possible to make further extended connections. For example, there are some presets created by other human actants in relation with what AI can offer making it possible for you to connect with them. AI have connections in my becoming to the piano, to Max programming, to music theory and so forth.

I

I continue with trying out modes of playing on different scales and morphing between them. This proffers an improvisational mode of playing which makes the music conceptualization non-linear, recursive and iterative, time is not prevalent when creating. There are also always one or more low register drone instrument sounds creating the soundscape that was my original idea. It has evolved to finding ways of rhythmic intra-active playing with the viola in mind.

> AI make it possible to improvise together.

> AI am programmed with some music theory and piano keys. AI am beginning to learn what you want. You are also trying to learn the non-linear mode AI offer to merge it with instrumental composition.

In the third recorded app session I also play piano, trying out phrases and tonalities for the viola in relation to the app preset. And so, I go back to the notated viola part thus far generated. The notated music surely has been influenced by the non-linear mode of engaging the app. However, I find the notation uninteresting and irrelevant to a linear mode of composing, it is stretched over too long a time period, or rather too many bars. The notation software triggers my regular mode of composing. I need to work with non-traditional notation in order to make it both practical for reading and coherent with the musical vision that I have. Perhaps

I can create a graphical musical notation where the musician intra-acts with it on a X/Y-plane.

II

"It wouldn't have been possible for me to become a composer without digital tools since I don't have an instrument. I have my ears, but they have always taken help from the digital tools already from the beginning. When stuff becomes easier, of course you get an increasing amount of opportunities and changed opportunities to compose. But you also have to have limitations. When I start writing a new piece I hopefully always start with which musicians, which instruments, perhaps which venue, and perhaps which context, these limitations give me ideas about what to do. About technology, all tools have limitations, some things they are good at, some things they are worse at."

AI give possibilities to become together. That which AI do not know can be learnt in extended connections or in relation to human actants that program in this interface. The outcome becomes in togetherness. AI offer things that otherwise would not exist.

I

The preset is now on maximum randomness. I hold my finger on the screen surface, turn on continuous playback and play piano to the soundscape. We play together, merging modes of composing. The notation for the musician will be non-linear to make it possible to intra-act with music and AI in real time. We learn to know each other.

Un/En/tangling

I will here circumscribe some relations and untangle the narratives to address the formulated research questions. Also, the aforementioned understandings of subjectivity and learning within posthumanist onto-epistemology are discussed and entangled with digital composition education and bundled in the cyborg concept.

In the narrative of II, learning to compose music is described as a search for non-notational, non-linear ways to work within a genre that is mainly based on music notation. This was a process among peers and technological actants that could affirm a non-notational mode of conceptualizing music. For example, conceptualizing music on a X/Y-plane came about in the Wacom tablet practice of peer-composers and experimentation with the Max-programming environment. In this relational becoming-with all the affirming actants, the learning process in a posthumanist sense is a rhythmic being with our cultural environment and available artefacts. When learning to align with artefacts, they are firstly evident and present. In the learning process they

subsequently become transparent, invisible and works in the system in a background relation (Hasse 2020). In this sense, Gestrument emerged as a bodily extension for II as an outcome of this learning process when in time becoming involved in all composing material. Although originated as a highly personalized means for composing and playing, the Max-patch was designed as an application and released as a commercial product. When released, other intra-actions with other composers made unpredictable outcomes. These are examples of diffraction patterns via a multiplicity of actants aligning with each other where agencies emerge. Creating music enacted as a relational activity. Recognizing the intra-relational process, II acknowledges the available artefacts as a prerequisite for certain outcomes, that they affect what human 'input' is possible. Although, nonhuman action is refuted. However, nonhuman 'input' or action in learning activities is not symmetrical to human action. When humans adapt to the nonhuman (Gemeinboeck 2020) they do so to align with the contribution to the meaning-making process that artefacts, in this case an application or a musical instrument, provide.

As for my own composing process, both affirming, and contestant modes of conceptualizing music were present. What I in the narrative refer to as a clash is the frustration that the app will not easily converge with my intentions and my habitual mode of composing. I have to adapt to the inputs from the app, or rather, in the intra-actions a certain kind of agency emerges. To align with the application actant, to its diffraction pattern, a learning process takes place. My composing process is fluidly reconfigured through these intra-actions, as a shapeshifter cyborg learner, on account of actants involved; Gestrument, music notation, earlier composing experiences, musical instruments and so forth. When I play piano to the soundscape preset made in Gestrument, my relation to the music becomes embodied in a way that is in line with my learned habit of intra-acting with music. The number of bodily receptors engaged when playing an instrument seems to exceed the intra-action with an iPad app. However, some limited musical expression actions are possible on Gestrument, but the experience becomes disembodied. Or perhaps simplified. Or even, othered as musical expression. Lowering the threshold for musicianship, as told by II, certainly seems like a valid objective, however, an altered or othered musicianship, by digital actants. Getting to know my own process as becoming-with as a cyborg learner and intra-acting with unknown actants is, for teaching purposes a way of moving my own musical artefact-relation from the background to the foreground.

Since nonhumans are put forward as equal actants should not Application I also learn and become in this process? When II released the application diffraction happened. Faced with numerous actants the potentialities of outcomes and enactments were multiplied into unpredictable becomings. In the intra-actions, nonhuman actants also emerge to their potential. As humans and nonhumans constitute each other in different ways (Gemeinboeck 2020), learning is one effect for the human, and becoming is one for nonhuman. The

Application I becomes in the relational performative activity of composing, diffracting the situated now into multiple outcomes. Moreover, both humans and nonhumans bring their unique 'input' to the intra-action, forming which becomings and learnings that will emerge. Here is a difference between *becoming* and *learning* established[9]. The application I can become in a multitude of potential forms as a phenomenon emerging from intra-actions. However, it does not learn, if learning is understood as a transformation of behavior and cognition (Hasse 2020). Can learning also be a situated phenomenon only present in a specific ecology of actants? If so, learning could imply a certain phenomenon or outcome ascribed to a certain ecology, not making a change in actants, rather an embodied aligning among humans and nonhumans (see for example Carlgren 2020).

In the research field of robotics and artificial intelligence (AI) machine learning (ML) is of concern. The development in this field has roughly moved from logics and inference via statistics to algorithms to interaction with the environment (Sebag 2014). Acknowledging the body-mind separation problem in ML means dealing with embodied interaction with the world. Within AI development emphasis has historically been put on academic intelligence like problem solving. Machines perform well in these areas, but not so good in basic skills, such as navigating in a changing environment. It has also been shown that the human body to a large extent determine the thoughts. Instead of the habitual understanding, that the human mind controls the body's actions, activity in the corresponding brain area seems to start before the conscious thought of body action (Pfeifer & Bongard 2007). Entangling learning, machine learning and embodiment argumentations can in the case of music composition education mean that learning is a situated, embodied phenomenon emerging in the intra-actions of actants. Learning takes place in the now, when intra-acting. All actants need to be present, human and nonhuman, for the transforming of action to certain outcomes.

Working with composition in educational settings gives a wide array of conceptions regarding music mentalization, realization and embodiments from a multiplicity of learners. Thinking mainly in a linear mode gives me as a teacher a limited insight in other genre conventions and conceptualizations, also, I tend to teach according to this mode, "We learn what we're taught, and then we teach what we know." (St. Pierre 2019b, 2). Returning to the anything-goes-trap referred to in the introduction, or perhaps it is an anything-goes-fear that the post-theories inflict when stating the decentralization of human action (Haraway 2018). In music education where composing from subjective musical ideas is part of the subject matter, in the sociomaterial context, 'anything goes' will not be possible. Or rather, available actants will together make performative systems to form outcomes which are not 'anything', but

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[9] The discussion on learning is extensive. Here it is briefly discussed in connection to posthumanist understanding.

can be diffracted to 'everything', any number of outcomes in the specific performative intra-action.

Arguing within the cyborg learner concept, digital actants are not innocent. They intentionally bring about conceptions, they highlight some features and veil others (Jennings 2007). The full account for this situated learning is attributed to the multiplicity, the assemblage where it emerged. What this shift proposes for digital music composition education is an attention to all actants making patterns in the learning and becoming of subjectivities. Digital hardware/software can offer multiple ways of intra-acting with music, other than common musical instruments, and differentiate the process of conceptualizing subjective ideas in other directions, emphasizing diffraction and relationality. In this understanding of music creation as relational and fluid, the employment of specific digital actants can help corroborate modes of conceptualizing music, but also act as a partner of renewal as well as sounding board for musical ideas (Brøvig-Hanssen & Danielsen 2016). However, attention to embodiment of musical action is needed. Since mind and body are a whole in the learning process, othered, and sometimes simplified, embodied musical actions give other kinds of musical experience and learning.

Turning from the composition as an artefact of fixed form containing an interpretational essence, leaves way for an understanding of music creation as emanating in sympoiesis (Haraway 2016), to the composition as relata (Barad 2007; Ceder 2016). The cyborg composer learner incorporates artefacts into practices, becoming a system. In this understanding, the so-called passive dimension of music (Hagerman 2016), conceptualized as the Composer's autopoietic ideas represented in a musical score, becomes inconclusive. Human intentional agency is however not refuted altogether, nor is aptitude or knowledge. Rather, they are situated and performative; if conditions are slightly changed, knowledges change. If actants change, outcomes change, however fractional these changes can seem. A sensibility to these shifts in practices becomes a prerequisite for understanding learning processes in sociomaterial practices. Also, music teacher education can benefit from addressing diversity in genre conventions and composition conceptualizations. When attention is given to the composition as relata, as emerging in relation with other actants, music teacher students can find more purposeful employment of actants and understand the outcomes that are performed within a certain situated classroom ecology.

Employing music theory, genre conventions and digital hardware/software as actants, instead of as limitative rules, can help circumscribe the subject matter to keep it intact and still allow diffraction in creative activities without requiring reiteration of past outcomes, giving subjective ideas a place in the becoming-with of learners. The issue is rather to discern which actants to employ by getting to know them, get to know their patterns of outcomes, what modes they can exert, to be able to facilitate different modes of conceptualizations of music. Keeping in mind the structural powers exerted by actants

such as commercial interests and traditional gender patterns (Ferm Almqvist 2021), the cyborg learner image can re-capacitate the learning and becoming of the subject in sociomaterial educational relationality, making intra-action within the ecology the starting point and smallest unit of analysis. To avoid the making of totalizing theories that "misses most of reality" (Haraway 2004, 39) the cyborg image can regenerate identities in iterative educational practices to help eschew gendering or ethnicizing learning and becomings in practices of multiplicities.

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