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Imagining a Non-Geometrical Rhythm

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Abstract

Rhythm in Western music—particularly in notated music—operates under two basic and fundamental principles: subdivision and proportion. Notions of speed, duration, and pulse are all dependent upon secondary, fixed reference points, a Euclidean grid sitting explicitly or implicitly behind the rhythms of the sounds we hear on the surface. It is a rhythm that is always about *counting*. This lecture explores a rhythm that eschews counting, that engages with speed and duration as primary rather than secondary phenomena, and that emerges through the interface between movement and resistance and from models of force, viscosity, and friction. We will examine some of the limitations of existing rhythmic notation and, using examples from a current composition project entitled *The Wreck of Former Boundaries* as well as several case studies from non-notated musical traditions, a few alternatives for 'non-geometrical' notational approaches will be proposed.

I've been thinking a lot about curves lately.

For the last year or so, I have been mulling over various musical metaphors of arcs and bends, and, to a certain extent, circles, bubbles, branches, and various liquid movements through curved spaces. In many ways my thinking began to take shape in conversations with Alex Grimes, a former composition Masters student, through his interests in notions of viscosity, pressure, and resistance. We spent quite a lot of time in our lessons talking about various models for musical curves: music, and, in particular, rhythm, as molten lava, as a moving, unstable, viscous state, solidifying and melting … hardening and splintering as it cools, liquifying into a gelatinous ooze as at heats up.

I had been struggling for some time with concerns about an increasing ubiquity of notational grids, and in particular the overwhelming dominance of the horizontal and the vertical in the notation of rhythm. This was a dominant image not only in my own work but in the works of many others, and I was noticing it particularly strongly in the work of a group of younger, emerging composers, including, for example, Timothy McCormack, a former Huddersfield MPhil student, Marek Poliks, Robert Dahm, another former Huddersfield student, or Andrew Greenwald. Horizontal and vertical lines were becoming the central defining feature of the notational identity of a significant body of work, and it was clear that this had crucial implications on the kinds of materials those notations could support.

Ironically, given this predilection for the horizontal and vertical, my music has always been about in-between states. It has always been about the glissando, the timbral transition, the movement between bow positions or pressures, the change from one embouchure tension to another, the constant shift from one dynamic to another. That is to say, it has always been about the diagonal. The points on either side have often been immaterial—they are simply the starting and stopping points of unstable, transitional movements. From the beginning, this interest in transitional states has, to a certain extent, fought against the notational conventions of Western musical rhythms, which depict the *onset* and *duration* of a musical event in a single notational mark. Any notation of what happens *after* the onset relies on other notational layers, and implicitly, one might argue, assigns a certain secondary status to those additional instructions. The 'note' is primary, and whatever dynamic or timbral change that follows is purely subsidiary.

The 'note' prioritises attack. Its primary rhythmic identity is where and when its indicated sound *starts* and, from a purely proportional standpoint, how long it lasts. In traditional Western musical notation, even its actual duration relies on secondary notational cues—time signatures, tempo indications, metronome markings. The rhythmic symbol system indicates the number of *beats* for which a given note might be sustained, but we require other information to let us know how long a *beat* is, and indeed even what rhythmic unit a 'beat' might be. Additional layers of parametric change—dynamics, performance techniques, timbre, etc.—are superimposed. Once a note has been sounded, our notational conventions generally assume that the job is done.

Those 'additional' notational layers have taken on increasing primacy in my work over the last few years. Since 2004, my work has focused almost exclusively on the development of an extended tablature notation that has redirected the role of notation from descriptive representations of a desired sounding result towards more prescriptive representations of movements and actions. In the earliest works in this project—for example in *The Crutch of Memory* for solo string instrument from 2004, shown here—each layer of physical activity, each type of interaction between the player's body and their instrument, is given a separate, discrete staff, and each of these staves are rhythmically independent. Arm position, finger widths, bowings, bow pressure and position, etc. all move independently, and each of these layers is in a more or less continuous state of change.

By way of example, here's the the final minute or so of the piece:

< audio excerpt from Crutch of Memory>

The rhythmic identity of what we actually hear in these works often sits at a substantial distance from the rhythmic information shown on the page, and that is perhaps intensified in more recent works such as *What then renders these forces visible is a strange smile* for solo trumpet. At a fairly basic level,

neither tempo nor meter ever really are present sonically, for reasons that will be discussed later, and perhaps even more significantly, what we see as a rhythmic 'event' is often just a change of direction, a change of state, or the point at which some other modification of an already-shifting and unstable sound begins. That is, the 'rhythm' that is represented by the 'note' is very rarely actually an event in itself—it is more often part of a continuum or the apex of a turn. The fact that this happens on several independent layers simultaneously exacerbates the issue.

And already in these earlier tablature works it's possible to see the role of rhythm breaking down even more dramatically. In the excerpt shown here, one can see rhythmic 'onset' points in which the triggered event is itself an unstable, unrhythmicised fluttering. The accents help to articulate the indicated rhythm, but the actual changes in the actions of the embouchure are not explicitly rhythmicised and have gestural identities independent of the rhythmic and metrical grid.

Even *more* recently, the primacy of these shifting, transitional, movements has been brought further to the notational foreground. Starting in 2010, with my *Second String Quartet*, I have been working with a multi-coloured, multi-layered tablature notation that, like the earlier tablature work, indicates the movements of the performers rather than the sonic results of those movements, but here there has been an effort to create a more direct, more communicative, and frankly *simpler* notation for those movements. In this newer notation, the movements of the left and right hands—shown in black and red, respectively—are shown graphically as lines of varying thickness and hue to represent the movements across the length of the fingerboard and string, as well as the amount of pressure exerted by the fingers or bow. All of the local-level gestural movements of the hands are shown graphically, including changes in the spacing between the fingers of the left hand and various forms of vibrato, trills, finger percussion, tremolos, and mordents.

What is most important here notationally is that the material starts to look less explicitly 'parametrical' as compared to the earlier multi-stave works. Although there is an identical level of independence of the various planes of potential activity, the notational image is far more unified and far more explicit in its connection to physical gesture. The earlier notation required a certain 'translation' in its mapping from notation to instrument. In *The Crutch of Memory*, for example, arm position, finger widths, fingerings and bowings were all represented by *numbers.* The transition from a narrow to a wide finger width might be represented by a boxed '1' moving to a boxed '4', connected an arrow; in the newer notation, this change in width is instead represented graphically, as seen in the black lines in the example here.

The movements now no longer look like discrete states but instead appear in the score as the transitional, shifting, unstable movements that they are. To put a finer point on it, the earlier notation still relied on the notion of the *note* or the *notehead.* The earlier notation was about dots; the more recent

notation is about *lines*. Graphically, the *movement* between states has now been foregrounded in the visual representation of the notation, whereas in the earlier work what had been foregrounded was the static state on either end of that movement.

The instability of those movements and the prevalence of shifting, amorphous movement can be seen in the following example from the final few minutes of the piece. It also clearly demonstrates some of the more unconventional performance techniques connected to the tablature notation.

<video excerpt of Second String Quartet>

With the move towards this increased foregrounding of physical movement, rhythm has been pushed further and further to the periphery of my notational approach. It started initially by severing the link between noteheads and rhythms, and in recent works has been pushed even further, now very much on the relative margins of notational information. It becomes increasingly clear from a visual standpoint that rhythm in these works is skeletal, a frame on which activities and events are hung.

I've spoken in the past about this tablature approach as being a more *honest* notational representation of my material. If my compositional materials were movements, not pitches, the notation should reflect that. Notation, above all, helps to establish the implicit and explicit hierarchies in a work, so reorienting the notational image is a crucial redirection towards particular interpretive cues and ciphers. A few years ago, I gave a talk at our department's Research Forum on my multi-coloured tablature work. In the Q&A session that followed, my colleague Geoff Cox asked a characteristically insightful question, which, to paraphrase, went something like this: "You've done all this work over the years to change how you notate almost every possible musical parameter; why does your rhythmic notation still look like *that*?" What Geoff identified, I think, was a certain distance—perhaps even dishonesty—between the notational representations of rhythm and what the actual rhythmic materials were, or at least could have been.

This is not in any way to say that the rhythms I was working with in earlier pieces were illegitimate, but rather that they were a skeleton, a framework, and they were increasingly divorced from the rest of the materials that I was working with. The rhythms had structural significance, and they certainly had a reality as materials in their own right, but they were less integrated with physical activity of the work that otherwise dominated the music's language. Rhythm, meter, pulse, duration, and tempo were treated as a kind of structural 'given'. They formed a collection of proportional relationships and speeds that sat beneath the surface. … More recently, however, I have been looking for a way to make the gestural, physical activity of my music and the rhythms of those movements much more explicitly connected.

Which brings us back to curves.

When I first started seriously rethinking my approach to rhythm, I began obsessively drawing curves, though I wasn't entirely sure why. They were initially just simple arcs, and what struck me was how immediately, how *instinctively* I started overlaying Euclidean, Cartesian grids on these arcs. They started as *movements*, as simple, arcing gestures through space, but—through conditioning, perhaps, or through a certain intuitive desire to find connections and patterns—they became geometries. In an effort to explore this tendency further, I started paying attention to any arcs, curves, or bends that I would find in my daily life: tree branches, telephone wires, cloud formations, bubbles, streams, … What I quickly discovered was that the common element for almost all of these shapes was an intersection between an *intended or inherent* natural movement, energy, or trajectory and a concomitant form of resistance, restriction, or friction. Telephone wires that otherwise 'wanted' to be straight were curved by the force of gravity; streams and rivers gained their curved shapes as their forces and energies reacted to the resistance posed by the density and geological makeup of the stone and rock and mud and sand that the water moved through; the shape of trees and plants was the result of a battle between an effort to reach up or out towards the sun, the force of gravity, and the relative flexibility, strength, or stability of the material of its branches, vines, sprouts, or stems.

I went back to drawing my curves, this time focused far more intently on this relationship between movement, viscosity, and friction. The size and shape of the pens started to become important—and indeed even whether I held the pen towards the tip or towards the end of the barrel—as did the nature of the ink, the pen nib, the texture of the paper, and even the surface the paper was sitting on. The shapes and identities of those curves quickly became less about an arc through Cartesian geometrical space and much more about a byproduct or tracing of a kind of 'interference' between movement, energy, fluidity, velocity, and trajectory on one hand, and friction, abrasion, elasticity, and resistance on the other. Crucially, there was a clear connection in these arcs to speed and duration—these arcs were not neutral lines constructed of coordinates in striated space but were rather the afterimage of physical movement. They were, in a sense, rhythms.

limitations of rhythm

Throughout the process of attempting to build a new way of working with rhythm, a new way of imagining rhythm, and a new way of notating rhythm, I have continually come up against the brick wall of the limitations of conventional Western rhythmic notation. Our rhythmic notation system can do some interesting things, but it's actually quite unsophisticated.

The system we've inherited can really only do two things: it can indicate subdivision, and it can indicate proportion. It can take a given unit and chop it into a number of equal divisions of that unit, or it can group those divisions into juxtaposed values of whole-number ratios. Traditionally, of course, units were only ever divided in 2s or 3s, but in principle any number of equal divisions is possible, and it's of course also possible to subdivide those subdivisions. But the basic limitation remains: at a certain point in the system, it is a *single* unit that has to be divided, and those divisions have to be equal.

Non-metrical juxtaposition of so-called 'additive rhythms' is also possible, but again the values that are juxtaposed need to be related by whole-number ratios, and, critically, our system only ever actually notates the *proportional* relationship between values. Even with additive notation, we can halve or double a string of rhythmic values and nothing, in truth, changes. To a very real extent, the notational values are immaterial. They could be replaced by a string of numbers representing proportion and nothing in the essential rhythmic identity of the material would change.

My former PhD student Einar Torfi Einarsson did some very interesting work exploring a slightly more intricate system of juxtaposition. In his work *Non-vanishing vacuum state*, he sets up a notational system that allows for the juxtaposition of events that are subdivisions of separate streams of divisions of 4, 5, and 7, and these often add up to 'incomplete' bars, which accounts for the unconventional, additive time signatures of, for example, 3/20 + 4/28 + 5/16. (For those who haven't seen such things before, the '20' and '28' work exactly the same as the '16', referring to the division of the whole note (or semi-breve). We're able to jump between duple, quintuplet, and septuplet note values in rapid succession, and we don't necessarily have to have 'complete' sets of those pulse streams (in other words, we don't need seven septuplets—we can, as in the example here, have four).)

 Even in this inventive system, the time signatures still show us the fundamental limitation of the underlying notation—we're stuck with subdivisions, and equal subdivisions at that, even if we can cobble them together in interesting and unpredictable ways. (It's worth noting that this approach has its roots in the notational experiments in 'coloration' of the *ars subtillior* some 600 years earlier, wherein notes appearing in red rather than black have ⅔ their normal rhythmic value, which permits a kind of 'sliding' between duple and triple divisions. The most extreme examples of the era—for example the Rodericus ballade, *Angelorum Psalat,* shown here—include 'incomplete' groupings not unlike Einar's work.)

As we'll discuss in a moment, *speed* and *duration* are for me the two most crucial components of rhythm—'how fast', and 'how long'. *Neither* of these two components are present in a primary sense in our rhythmic notation system. In the examples I've just shown, all we have is proportion. There is absolutely no indication whatsoever of how long any of these items actually lasts in time, how fast we move from one notational item to the next. For speed and duration to exist, our system requires a

secondary notational indication. We need a tempo, a metronome marking, *something* to tell us how fast any given item within the system might be, and that tempo is predicated on an assumption of *pulse* or *beat.*

Conventional notation of course *does* allow us to change that pulse through an *accelerando* or *rallentando*, and it allows us to freeze, sustain, or interrupt that pulse through various notational cues such as the *fermata* or *cesura*. And there have been various attempts to extend this ability to destabilize tempo. In my work *And the scream, Bacon's scream … ,* for example, I use a conductor's staff which forces the tempo to speed up and slow down irregularly and unpredictably in an effort to counteract the centrality of pulse. A similar approach appears in Karlheinz Stockhausen's *Klavierstuck vi*, with 12 proportionally-related tempi indicated by the 13 lines, and Einar again explores an interesting system in his work *Desiring-Machines* for 27 players, with a tempo system that allows for rapid juxtapositions between five independent tempi (and two conductors).

A related and similarly novel approach appears in the work of the German-American composer Philipp Blume, who has developed a notation for flexible and nested tempi. In this example from *Euge, Klugerella!* for trombone quartet, the beams that look light eighth-note beams in fact represent tempo, with pulse speeding up as the lines move away from the staff, and slowing down as the lines approach the staff. These can be nested, as well, as in the example shown, with up to six internal levels of acceleration or deceleration embedded within other accelerations and decelerations.

With these experiments in tempo we get somewhat closer to what I imagine to be a non-geometrical rhythm, but in truth what we really have is bent or distorted or curvilinear spaces. In each case, the grid is still the dominant rhythmic principle—we are still in a Euclidian space—and in each case we maintain a reliance on beats, even if those beats can be expanded and compressed and juxtaposed in interesting ways.

We often conflate 'rhythm' and 'beat' in Western music. In my rethinking of my rhythmic language over the last few months and years, I've tried to force myself to really return to first principles, to thoroughly interrogate what the most fundamental characteristics and properties of rhythm actually are. For me, 'beat'—and, even more so the repetition of beats through 'pulse'—is actually only a fairly small subcomponent of rhythm. It is true that rhythm is about pattern, repetition, and regularity, but it's also about speed and slowness, and compression and dilation, about waves and clouds, about stasis and absence, and about vibration and dissipation. Even a sustained drone has a rhythm, of sorts.

If you'll indulge me, I'd like to illustrate the point with an example from … and this will be rather predictable for those of you who know me well … competitive cycling.

We'll start with the opening sequence of the television show 'InCycle', which I think shows more or less what we instinctively think of when we think of 'rhythm'. <play> The visual rhythms are pretty apparent, and connect mostly to … cycles. That is, the regular repetition of the cadence of pedalling, where each pedal stroke is a 'beat', and to a slightly lesser extent the rotations of cogs, wheels, and hubs. This is a rhythm that is about pulse, loops, and regularity, and that's reflected in the accompanying music and sound design.

Next I want to look at a few minutes of the overhead shot from the final few kilometers of the 5th stage of the Tour de Suisse from last year. Obviously we can occasionally see the pedal revolutions of the riders, but the dominant rhythm of this video is much more smooth and 'gooey'. The 'swarm' of the group is liquid, as individual riders speed up, slow down, move into and out of position, weave around a road obstacle or a curve in the road, or pass a train moving in the opposite direction. We do see effort, and to a certain extent we can see and feel the speed, but the overall impression, particularly when viewed from above, is actually quite *slow*. This is rhythm as wave, as swarm, as cloud or constellation—ebbing, flowing, and weaving rather than beating. <play from ca. 7.30>

And finally let's zoom in. What I'd like to show next is some on-board footage from exactly the same stretch of the same race. The rhythms here are entirely different. The impression of speed is obviously different, and while we do have even more of the pulse-based rhythm from pedalling, we also have the rhythms of every wobble, every bit of steering input, each little touch of the brakes, the starting and stopping of pedalling motions, the rhythm of riders passing or being passed, the rhythms of the elbows-out rough-and-tumble world of near collisions common to the last few kilometers before a closing sprint, the changes in speed of the lead rider (with the camera) and his teammate behind, the occasional touch of a shoulder or a leg to try to open up a gap, the yelling of instructions between teammates (and the yelling of obscenities at opponents) … and perhaps most notably, the elegance of the flowing waves around the traffic furniture of the previous video is replaced by the sudden whizzing by of road islands and the warnings of police whistles. <play example>

It's a complex network of micro-events and micro-rhythms, some of them regular and repetitive, like the rocking of the bike at the end or the looping of pedalling motions, and some of them wildly irregular, unpredictable, unexpected, yet no less *rhythmic*.

For me it demonstrates just how limited many of our usual notions of rhythm really are. The grid, the pulse, the beat, the idea of meter more generally … these are just small components of what rhythm is and can be. Even tempo, as a concept, is often quite limited in our musical vocabulary. When I was an undergraduate I studied briefly with the composer Pauline Oliveros, and in her various Deep Listening exercises she taught us to engage with the rhythm of natural phenomena like clouds or wind, and indeed the rhythm of all of the various sounds that surround us.

There have been many attempts to subvert the dominance of pulse and meter, but these almost always start with the presumption that notation only exists as a means to an end. They are all 'workarounds' that imagine a particular kind of sounding result and then attempt to get as close as possible to that result through the existing notational conventions. In a sense, the notation doesn't actually represent the material, it simply attempts to 'trick' a performer into doing something that 'sounds like' the material.

In the work of Iannis Xenakis and György Ligeti, whose work *Atmosphères* is shown here, for example, we often see conventional 4/4 time signatures and stable tempi coupled with the instruction that barlines exist only for coordination purposes and hold no particular agogic function. In other words, the grid is present, but these composers are attempting to subvert or reject its presence. They ask the performer to ignore the graphical representations of the grid. But even this instruction can't undo the fact that the beats are present, that the points of alignment exist at stable, regularly repeating intervals, and all of the subsidiary components of each 'bar' still realign because of the limitations of subdivision and proportion discussed already.

From the opposite end of the spectrum we have composers such as Brian Ferneyhough, for whom the grid is exceptionally important but is often scarcely audible, as in the excerpt from the *Third String Quartet*, shown here. Meter has a pivotal structural role, not only as a container of a certain number of possible beats or pulses but even more significantly as an organizational unit with its own magnetic forces, pushing and pulling material, compressing or expanding it, passing it through various overlaid sieves and filters. But at the end of those procedures, the links between what is left on the rhythmic surface—Ferneyhough often talks about this as sediment—and any sonic manifestation of the grid is, at best, tenuous, and more often than not non-existent.

My own earlier work is quite closely connected to this approach. To illustrate, let's look back at the first example that I showed you at the beginning of the talk, from the solo voice piece *I, purples, spat blood, laugh of beautiful lips*. The rhythms here are constructed, in a sense, from grids of grids. This short excerpt sounds like this: <plays the excerpt> // The primary grid is constructed from beats linked to the tempo, in this case mostly 8ths, but with two bars of 32nds interspersed. Next we have a series of cross-rhythms that divide the bar or the beat into separate overlaid subdivisions or grids. And of course those subdivisions can themselves be subdivided (in this case by standard divisions of two). And in this case an extra layer of cross-rhythms are superimposed.

If we then pull away any of the 'silent' components from the grid—that is, a point on the grid at which no new event occurs—and combine the three layers into a single illustration of each pulse, and if we remove our original beams which indicated metrical groupings … what are we left with? In a sense, we see the actual surface rhythms of this passage, but in another sense, we've eliminated rhythm

altogether. Set against the blank backdrop, the context of pulse is lost, and so to a rather crucial degree the character of the rhythm has been eliminated. Here's the excerpt again: <plays the excerpt)>

For me, the most significant element that we've lost is the potential for syncopation, for material that appears *off the beat*. We've also lost grouping; we've lost the notion of the 'downbeat' and all of the various implicit and learned weightings and clumpings that come with it. It is now a smooth space, and without its striations there is no longer any pushing or pulling, any sense of gravitation, suspension, anticipation, or fulfilment.

And it's here that we can pivot to start talking about alternative notational models and possible ways of addressing some of the problems of conventional Western musical notation posed above. Many composers in the mid- and late-20th century worked with systems of various forms of time-space notation, almost always relying on indications of time in seconds, usually with some small tic or dash or reference marker. In some ways we've reintroduced the grid, but it's somehow a rhythmically irrelevant grid—its logic and its reality are immaterial to the nature of the rhythms themselves, so the reintroduced striations don't really provide much of the tension or friction we had previously. The grid is largely neutral—or at least musically neutral—so even though we have eliminated the notion of the pulse or the beat, and even though we now have a smooth rhythmic space within which to operate, the fact that it is happening against either a blank or neutrally striated background for me means that we don't yet really have *rhythm.* We have events, and those events have relative durations, but somewhere I think we understand that, even in a non-geometrical space, rhythms are fundamentally about groupings, about weight and pattern, and about vectors and trajectories of energy.

new notations

What I'd like to do for the remainder of the talk is to explore some alternative rhythmic notational models that might permit the kind of 'non-geometrical' space that, frankly, I've been searching for for most of my compositional career. I have an image of a very particular rhythmic identity that I've not yet been able to grasp, and my sense is that the gap between what I want and what I have has come almost entirely from the limitations of existing notational practices. A significant portion of that desired rhythmic character derives from the fact that I've always had a very physical, visceral connection to music and music-making—I've always been, first and foremost, a conductor, and there has always been a clear link between the body, physical shapes and movements, and, to a certain extent, the groupings of beats. Those groupings and those shapes have always been essential to my understanding of rhythm, but I have often found the regularity of those groupings—and even more so the regularity of the potential subdivisions of those groupings—inadequate, so a lot of what I've done

rhythmically as a composer has been set up to subvert, distort, or destabilize what are otherwise quite simple patterns.

Over the last year or so I've been exploring a variety of potential solutions to this problem, and those proposals attempt to explore issues of speed, of grouping, and of duration, including an attempt to integrate the fundamental, inherent attributes of speed and resistance of various physical movements and gestures … though it's worth reiterating at this point that none of these notational proposals are in a finished state and are presented here very much as works-in-progress. I've also tried to force myself to separate this process into two independent strands, one about the nature of the *rhythms* I'm interested in, and one about the more practical problem of *notating* those rhythms.

One of the exercises that I've done—and this in fact comes from some advice I gave to Tim McCormack when he was studying with me several years ago—is to attempt to transcribe the music of non-notated traditions, in particular free improvisation, trying to find a way to represent rhythms that exist outside of the grid of traditional notational systems. The other extremely useful development has been my recent foray into electronic music, which has allowed me to focus directly on notions of speed and duration without having to worry about how to represent those attributes on the page. I'll show an example of the improvisation transcriptions in a moment, but in order to give a sense of the rhythmic character of the soundworld that I'm imagining, here's an extract from the interlude for electronics that will appear in the work *The Wreck of Former Boundaries*, which will be discussed in a bit more detail shortly.

This is roughly the first half of the piece:

<Wreck 5.1-ch excerpt>

grouping/speed/proportion model

The easiest of the proposed notational solutions takes us back to the conversation of curves from the beginning of the talk. The revelation that these curves were the result, or *'tracing',* of the intersection between an intended speed and various forms of friction or resistance has led me to explore notational models that represent those two features—velocity and resistance—as rhythmic values. The solution at this point is fairly rudimentary, but it aims to create a notational image that prioritises perceived force and resistance as the primary arbiters of speed and duration, rather than relegating those characteristics to a secondary role beneath or inside of an independently derived set of pulses and subdivisions.

The proposed notation is very simple. For now, I've stuck with stems to represent onset, though this is something I'd like to continue to try to move away from. The downward arrows on each stem represent

the degree of force or 'intended velocity', and the horizontal bars beneath these arrows represent the relative degree of resistance or friction 'pushing against' that movement. In the current models, these are arranged in a three-point 'scale' for each of the two directions, roughly equating to maximal, minimal, and intermediate degrees of velocity or resistance. And it's also of course possible in the notational system to construct transitions between these states.

It's worth acknowledging that these are, for now, fairly imprecise measurements, and they do require a bit of imagination on the part of the performer, but the aim is that the actual speed or duration of an event will emerge *from the event itself*. That is, if the symbol system indicates how quickly one is *trying* to execute a particular task, as well as the level of real or imagined resistance pushing against that task, the final component that will determine the actual duration of that event is the specified movement. A prescribed amount of velocity and resistance, coupled with a prescribed movement, will result in an otherwise *unprescribed* event duration.

To illustrate, I'd like to look briefly at the work *One Flat Thing Reproduced* by the choreographer William Forsythe, and in particular the audio voiceover that accompanies the dance in the amazing website called 'Sonorous Objects', produced at Ohio State University. The video has a number of overlaid animations that indicate *types* and *planes* of movement, as well as cue systems between the dancers that trigger new movements and actions. On its own this is fascinating, but here what I want to focus on is Forythe's sing-through, which I think illustrates an approach to rhythm that's very close to the one that I've been exploring. Forsythe's vocalisations show a wonderfully asymmetrical, unpredictable rhythmic character—this is clearly a dance rhythm that is not driven by metrical groupings and the stable grid of beats. As the video progresses, we can quickly see that the duration of any given rhythmic event is fundamentally intertwined with the actual movement of the dancer—that is, we have a specific *type* of movement (sliding, arcs, bends, etc.), an amount of *space* that movement is meant to fill, and a relative *speed* of that movement. The event's duration is the result of those three components, *rather than the other way around*, as would be the case in, for example, much classical dance, wherein *beat* comes first, and movement and space fits within that beat.

<play first minute: http://synchronousobjects.osu.edu/content.html#/TheDance>

For those who are interested, I can also recommend Forsythe's Improvisation Technologies videos, which illustrate his approach to movement, space, and 'imagined' resistance and constraint schemes. As a very quick example, here is his introduction to lines and avoidance: <play video: https://www.youtube.com/watch?v=cqGyFiEXXIQ> This is a particularly useful example of the kinds of imagination strategies that Forsythe employs regularly in his work, which are similar to many of the velocity and resistance models that I have been working with recently.

The force/resistance notation I'm exploring works with a range of instruments, and seems well suited to strings—particularly as connected to the tablature work I've developed—and also seems to work well with the notation of breath in winds and brass. The 'rhythms' of course don't work in isolation and require some sort of movement notation.

What I've shown here is a short example from the sketches of *The Wreck of Former Boundaries*. The complete work is scored for two solo trumpets, clarinet, saxophone, trombone, double bass, electric lap steel guitar, and multi-channel electronics. Each of the players except for the two soloists will have a short, extractable solo work that can be played independently, and the first of these that I've been working on is the solo for double bass. This example illustrates the kinds of movements that would determine the speed and duration of each of the work's events. Each collection of symbols represents a particular physical movement across the instrument—which on the double bass can be quite extreme—coupled with a speed or intensity of movement and a particular degree of resistance in the muscles of the arms and body.

As with the *Second String Quartet* notation, the red material represents the movement of the bow up and down the length of the string, and the black notation represents the movement of the fingers along the fingerboard (though, for the sake of this sketch, I've simplified things a bit). Lateral, up- and down-bow motion is indicated in green. And for the sake of this sketch, there is no rhythmic independence at all between the various layers of possible activity.

At this point I've intentionally represented these movement events with equidistant spacing, rather than with an estimated space-time notation. As mentioned, the hope is that events are faster and slower specifically due to the prescribed actions, rather than from a graphical, spatial distribution on the page. It is the equivalent of the curves discussed above, the byproduct of a given configuration of energy, movement, and resistance. So, for example, the opening gesture, which is constructed from heavy, aggressive pressure in the bow, sliding from an area near the end of the fingerboard towards the bridge, coupled with an up-bow across the length of the bow, will be quite a long, slow, grinding gesture, generated from maximal pressure or force and maximal resistance. I imagine it would take something in the realm of 3-4 seconds. The second gesture, on the other hand, consists of very light pressure in the bow (represented by the thin red line), a slight down-bow covering half of the length of the bow, and is guided by maximal velocity with minimal pressure—this is likely to be exceptionally short, thin, and fleeting, lasting no more than a quarter of a second or so.

This approach seems fairly well suited for solo materials, but perhaps still leaves problems for controlling the alignment between players in an ensemble setting. It also, at this point, doesn't show rhythmic groupings particularly well, so I've been exploring a parallel strand of notational models which

attempt to show groupings, speeds, and durations, but do so in an intentionally 'smooth' and loosely defined space.

grouping/speed/proportion model

This second approach has been more of a struggle, and I've been fiddling with various sketches for solutions for many months. It has gone through several iterations, and in truth I think probably there is still work to do before it finds its finished state. Also, for now I'll just show this approach in the abstract, without any connections to movement, gesture, pitch, or other parameters.

The notation has three primary components. The top staff indicates speed, and, critically for my current needs, groupings. The top line of this staff is fast, the bottom line is slow, and these values and the space in between are left intentionally undefined. In the final version I'm likely to give a general metronome marking range for the top and bottom lines, but my hope is that this will be unnecessary. This top staff permits both static speeds and transitional ones, and those transitions can be constructed of both diagonal lines and curves. And, like some of the tempo and pulse examples shown previously—for example those by Einar Torfi Einarsson—each new 'beat' on this staff can be a completely new speed.

The lower staff indicates a few things simultaneously. First, it shows the number of subdivisions of the speed unit shown on the top portion of the staff. Second, the *placement* and *width* of the horizontal boxes in this staff show the relative proportional relationship of those subdivisions. The staff can be imagined as a 'percentage space', with 100% at the bottom (that is, a single event) and 1% at the top. The initial examples shown here simply recreate some very basic subdivisions common to a much more conventional notation—50/50 (or, ostensibly, something like 8th notes), 67/33 (triplets), 25/50/25 (16th, 8th, 16th). Finally, the filled-in space inside each of these horizontal bars shows the actual duration of the event, again indicated graphically as a percentage of the subdivision. This notational component is something akin to a hybrid between rests and articulation—it shows how long something lasts within a subdivision of a given unit, but again the space is intentionally fuzzy in its definition, and, as with the subdivision layer, is fully contingent upon a sliding, shifting speed layer that is itself only loosely defined.

The example shown here is a more detailed, complicated version of the notation, in this case one of the transcriptions of free improvisation that I mentioned earlier. This notation represents a short excerpt of a work from the trumpet player Peter Evans, one of the two trumpet soloists who will be featured in *The Wreck of Former Boundaries*, and I think here you can see the connection to the speeds,

groupings, subdivisions, and durations in the audio sample from the very beginning of Peter's improvisation 'Sentiment', from the album "More is More'.

<plays beginning of the excerpt>

With those principles established, let's listen to the first minute or so of the improvisation. I've tried to be as precise as possible with the rhythmic notation, even notating reasonably subtle variations during the long sustained tone that occupies much of the excerpt. I carefully calculated the exact durations of events with the aid of a spectrosonogram, making decisions about how those durations would be grouped and represented in a fairly intuitive way. The goal, in any case, was to generate a rhythmic transcription that I felt accurately represented the energies, groupings, momentum, syncopation, and directionality that I hear in Peter's performance.

What I like about the system is that it removes pulse from the equation but does so in a way that still has reasonably clear definitions of speed and, through the graphical indication of subdivision, duration. The goal for the project has always been to find models that foreground the notation of those two primary rhythmic features—speed and duration—and to do so through a visual model that doesn't require reference to either external notions of tempo and pulse or to the limitations of equal subdivisions of note values. (As an example of these limitations in conventional rhythmic notation, imagine a unit divided into a ratio of, for example, 9 to 5—rhythmic notation of 9's and 5's are a particular pet peeve of mine—which would require a rather inelegant collection of ties and augmentation dots in traditional notation, even leaving aside the additional necessity of a tuplet bracket, an equally divided metered bar within which to contain that tuplet with a time signature denominator divisible by 2, and a separate and visually detached indication of tempo in beats per minute.)

I also like that the notation allows a speeding up or slowing down at a very local level, and here those changes of speed are an inherent part of the visual identity of the graphical image. Those changes of speed happen at what is, for me, an appropriate 'middle-ground' level, rather than exclusively at a more distant structural level. And I like that I can still show groupings, which, for me, take the essential element of meter—that is, a fundamental three-ness, four-ness, two-ness, etc.—and disassociate it from equal divisions into beats. And I like that this notational approach is quite flexible and can be combined both with my recent tablature notation systems and with more conventional pitch notation. It can also, of course, be combined with the force vs. resistance notational model shown previously, perhaps with the 'force/resistance' notation taking the place of the lower layer of the proportion model.

What I *don't* like about the model is that it still, at this point, looks quite similar to some of the highly geometrical, even architectural examples I showed at the very beginning of the talk. Horizontal and

vertical lines still dominate the visual character of this notation, so I'm still searching for something that better represents the curves and bends and bubbles and branches that I've been obsessing over for these last many months. The system does allow changes of speed that get shown through curved lines, but this seems like a fairly small and not particularly consequential nod in the direction of 'curved' rhythms, or at least a curved rhythmic notation.

In truth, the difficulty for me will always be the fact that representing time on the page—taking a four-dimensional event and reducing it to a two-dimensional surface—will force a certain 'reading' of that space from left to right. The left-to-right-ness of musical notation already starts to force a horizontal image on the blank page, and so lines and beams and staves follow. For the last 5-6 years I've been poking around the edges at the idea of developing a video or animated notation which does away with the 'horizontal' representation of time—for example, my 2009 AHRC grant for the development of the *Second String Quartet* notation, for example, proposed something akin to the Guitar Hero video game —but … in the end I'm a traditionalist, and I love scores. I love bound scores on good paper, and I love the tradition of the performer's interface with the page, so it may be that the video project is for someone else to follow up.

I also don't particularly like the multi-stave approach in this system. I'm looking at ways of integrating the information into a more unified image, but doing so in a way that prevents the image from simply becoming a flat, graphical, time-space notation. I've experimented with various approaches to compressing the material into a single staff, but so far in each case the nested, contingent element of the notation is removed and it loses the resistance, twisting, and magnetic weighting present in the current proposed version. In any case, I'll keep working.

Biography

Aaron Cassidy is Professor of Composition and Research Coordinator for Music & Music Technology. His work has been performed widely by leading international contemporary music specialists and has been featured at numerous international music festivals and venues for new music in nearly two dozen countries. He has received grants, awards, and commissions from PRSF/London 2012 Cultural Olympiad, British Council, AHRC, Südwestrundfunk, New York Foundation for the Arts, American Music Center, Hauptstadtkulturfonds Berlin, ASCAP, and allerArt Bludenz. Recordings of his work are available on NEOS, NMC, HCR, and New Focus Records.