Artist Residency Sparks Fruitful Collaboration

Sophia D. Merow

Edward Crane and Liam-Taylor West began meeting in September 2020, sometimes via Zoom, sometimes at one of the glass whiteboards in the courtyard of the University of Bristol's Fry Building.

During these one-on-ones, Crane sketched—without recourse to equations, mind—the big ideas behind his research[1] on self-organized criticality. Consider such complex real-world phenomena as avalanches, financial crashes, and electrical cascades in the brain, he prompted. All involve a slow build-up of energy or potential followed by a large release, the precise timing of which is unpredictable. At scales large and small, Crane explained, the frequency of these releases is related to their size by a power law. Self-organized criticality aims to understand why.

As the two talked, Taylor-West tried to distill what Crane told him into a handful of pithy phrases, jotting them in his notebook to run by Crane for accuracy later. Until he had a solid grasp of the concepts discussed, Taylor-West did his best to refrain from considering how they might lend themselves to audiovisual artistry.

Then Crane shared some colorful videos showing simulations of forest fire models.

Taylor-West's conversations with Crane were part of his education as an artist-in-residence at the University of Bristol's School of Mathematics. A composer working toward a doctorate at the Royal College of Music in London, Taylor-West had been drawn to the residency—enabled by a partnership between the university and CREATE-REACT, an organization that pairs artists and scientists to foster interdisciplinary collaborations—because he had already begun injecting some mathematics into his music. He was incorporating randomization processes as a way of adding variation and unpredictability to how chords were built, for instance. "I felt that the ideas being studied by mathematicians would be an excellent source of inspiration for my work and would push me beyond my own simple experiments," he remembers.

More than 20 Bristol mathematicians expressed interest in exploring with Taylor-West how their research might inform or inspire sonic art. Crane, for one, hoped that working with Taylor-West might bolster his perhaps rusty ability to communicate with the mathematically uninitiated. "I think we owe it to the taxpayers who fund much of our research to explain something about what we're doing and why, in a non-technical way," he says. "The idea of being helped to express something about my research in a totally new and non-technical way appealed to me."

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[1] *See, for instance,* `https://arxiv.org/abs/1811.07981`.

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Figure 1. Liam Taylor-West's residency-culminating exhibition, *IN/FINITE: Order in the Unknown*, ran at Liberty House in Bristol January 19–30, 2022.

From the spark of Crane's simulation show-and-tell grew "Forest Fire," one of five[2] interactive light and sound installations included in Taylor-West's January 2022 exhibition *IN/FINITE: Order in the Unknown*. While a mathematician might recognize in the piece a very small instance of the Drossel-Schwabl forest fire model,[3] there's no mathematical prerequisite for viewer engagement with the 10-by-10 grid of LED lights. A green light represents a tree, a red light fire. Trees grow and fires start at random, and viewers can alter the probabilities of these events via a no-touch controller. As forests sprout, as fires ignite and spread to neighboring trees, cascades of color illuminate the grid.[4]

And there's a musical dimension too! Each of the grid's 100 squares can be dark, red, or green, and there's a sound associated with each of these possible states. A dark square is silent. When a square goes green, it triggers a slow melody that outlines a chord, which becomes more dissonant as it rises. When a square turns red, it produces a sharp, punch bass note; these notes form a rhythmic sequence as the forest goes up in flames. Taylor-West added variety to the simulation's score by recording several versions of the melody, some on clarinet (Lloyd Coleman) and some on synthesizer (Georgie Ward). The bass note associated with the fire also varies among three possibilities, switching whenever more than half of the grid is green.

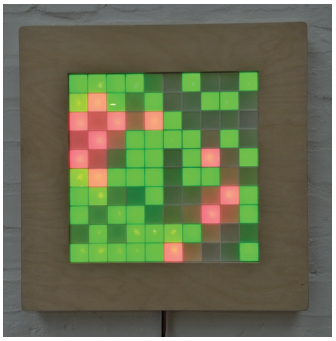

Figure 2. A freeze-frame of "Forest Fire" in action. See video—and hear sound!—at `https://bit.ly/33nz3Bc`.

Crane and Taylor-West both deem "Forest Fire" a success. Taylor-West thinks he accomplished what he set out to do with the piece: to render the workings of the forest fire model obvious to the general viewer and to convey the sense that random events can create structured, predictable systems. Crane, who vetted both the code that underlies the installation and the few sentences of descriptive text that accompany it, admires how Taylor-West identified the heart of the self-organized criticality matter and devised an intuitive and engaging way to present it to a general audience. "I love the way that by interacting physically with the piece you get a great sense of how the feedback works, which you wouldn't get from simply reading about it or looking at graphs," he says.

And both Taylor-West and Crane expect the residency to have a positive impact moving forward.

"Almost all of the work I have lined up is related to it in some way," Taylor-West reported in February. He was writing a piece for the BBC Concert Orchestra based on the structure and growth of aperiodic sequences (to which Bristol mathematicians Felix Flicker, Henna Koivusalo, and Demi Allen had introduced him); he and some of his School of Mathematics collaborators were hoping to secure grant funding for continued work together; "Forest Fire" and the other pieces from the *IN/FINITE* show were slated for exhibition at other venues.

For his part, Crane came away from the collaboration more motivated than ever to devote time and effort to explaining his work to non-mathematicians. "I think it is important that this is seen as part of our professional responsibility and not just a nice add-on," he says. "Working with Liam has reminded me that 'explaining my work' can mean a huge range of different things, depending on the audience."

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Credits

Figure 1 is by Lloyd Coleman.
Figure 2 is by Liam Taylor-West.
Author photo is by Igor Tolkov.

[2] *Read more about the other installations at* `https://bit.ly/3h6KHn5`.

[3] *"It is quite closely related to site percolation on the square lattice, a model that a lot of mathematicians would be familiar with," says Crane. "The Drossel-Schwabl model is simple but it turns out to be very difficult to analyse mathematically, unlike the mean-field forest fire model (which I work on) and some one-dimensional forest fire models that are pretty well understood. The Drossel-Schwabl model hasn't been proven to display the key features of self-organized criticality, and big simulations suggest that maybe it doesn't. But it does make for a very nice visual model of the feedback mechanism."*

[4] *Watch footage of "Forest Fire" in action, and you'll spot a third color: yellow. Taylor-West added a process to the piece that was not present in the mathematical model that inspired it: tree aging. Green squares in the artwork become more yellow over time. "This means that if the probability of fire breaking out is really low," Taylor-West notes, "you eventually end up with a full grid of green lights slowly turning yellow, which adds to your sensation as an audience member that a fire MUST be about to start soon (which of course is not how random events work, but it is interesting that we expect a fire to be more likely after a period without any)."*