



All Together Now

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London's Millennium Bridge is one of the most beautiful to cross the Thames. After a 1996 competition held by the Southwark Council, with the involvement of the *Financial Times* and the Royal Institute of British Architects, the "Blade of Light" design submitted by renowned architects Sir Norman Foster and Partners, engineering firm Over Arup & Partners, and sculptor Sir Anthony Caro was selected for the first new bridge to be built across the river in over 100 years. The 1,082 foot bridge would connect the Tate Modern Gallery, on the river's south bank, with the neighborhood surrounding St. Paul's Cathedral on the north.



On June 10th, 2000, Queen Elizabeth II presiding, some 100,000 people turned out for the opening of the Millennium Bridge to be first among those to cross it.

Shortly after they began to cross the bridge, however, the pedestrians felt it begin to wobble from side to side gently. As they continued to cross, the wobbling became more and more obvious, and soon, the bridge began to sway and twist in regular oscillations, forcing people to cling to the banisters to avoid falling. As the oscillations grew increasingly extreme, pedestrians feared the bridge might collapse under them. The bridge was closed to the public on June 12th and remained closed for two years while engineers designed a fix. What went wrong?

In a 2005 *Nature* article, "Crowd synchrony on the Millennium Bridge," Cornell University professor of theoretical and applied mechanics, Steven Strogatz explained the source of the oscillations.¹ Walking one foot at a time, humans exert some amount of lateral force with each step, for balancing purposes. The bridge engineers understood this but expected that the randomness of pedestrians' footfalls would offset this lateral force.

But as the bridge-crossers altered their gait so as to compensate for the bridge's lateral sway, the rhythm of that sway led the pedestrians to alter their gait in unison. Their collectively adjusted footsteps magnified the bridge's lateral motion: the more the bridge wobbled, the more people adjusted their gait to maintain balance, creating ever greater lateral force, and the worse things got.

"I'm not a civil engineer. I know nothing about bridges," says Strogatz. "What I do know is group behavior."² It wasn't some design failure that led to trouble upon the Millennium Bridge, it was the unexpected and spontaneous synchrony in the behavior of the crossing pedestrians.

Throughout natural and physical systems, researchers have found countless instances of such self-organized groups, interacting in accordance with a few simple rules, to produce often surprising collective outcomes. Scientists call these outcomes 'emergent properties'.³ We witnessed a dramatic example of such spontaneous synchrony in the financial markets earlier this year, when day-traders self-organized on chat-site Reddit and began to trade in unison, driving the market capitalization of the otherwise languishing GameStop from a 2020 low of \$250 million to over \$25 billion.⁴

Scientists are learning that many organisms are organized into social ecologies, even if this is not obvious at initial glance. Trees in forests, for instance, have been found to coordinate spontaneously through a communications network of threadlike fungi, *mycorrhizas*, that connect individual trees at their roots - the forest's own version of Reddit - to form a superorganism.⁵ Iain Couzin, director of the Max Planck Institute of Behavior at the University of Konstanz in Germany, studies swarming behavior in animals. His research has bearing on the behavior of the *human* animal, with lessons for those searching for a predictive 'science' behind seemingly spontaneous mass protest movements.⁶ Todd Haugh, a professor of business law and ethics, finds similar examples of "behavioral contagion" at work in corporate misconduct and compliance.⁷

In a pioneering study, the Bank of England's Andy Haldane and the late Chief Scientific Adviser to the UK Government and President of the Royal Society, Robert May, drew analogies between financial markets and the dynamics of ecological food webs and the networks within which infectious diseases spread. "There has been a spectacular rise in the size and concentration of the financial system over the past two decades," Haldane and May wrote in 2011, "with the rapid emergence of 'super-spreader institutions' too big, connected or important to fail." The banking system must therefore be regarded as a banking "ecosystem," they argued, demanding

appreciation for the interconnectedness between firms and how those might facilitate “propogations” – that is, emergent outcomes – across the financial system. “Looking at financial risk through a network lens indicates a fundamentally different rationale for prudential regulation,” Haldane and May concluded.⁸

What is true at the macro-systemic level of the banking system is true at the micro-systemic level of individual firms, which might be examined for their own *eco-systemic* health. This approach may inform efforts to study how culture (rules of interaction) drive conduct and misconduct (emergent outcomes).

ENDNOTES

- 1 Steven H. Strogatz et al., “Crowd Synchrony on the Millennium bridge,” *Nature*, vol. 438, 43-44, 2005. <https://www.nature.com/articles/438043a>
- 2 Steven Strogatz, “Explaining Why The Millennium Bridge Wobbled,” *Science Daily*, Nov. 3, 2005. <https://www.sciencedaily.com/releases/2005/11/051103080801.htm>
- 3 Kevin P. O’Keeffe, Hyunsuk Hong & Steven H. Strogatz, “Oscillators That Sync and Swarm,” *Nature Communications*, vol. 8, 2017. <https://www.nature.com/articles/s41467-017-01190-3>
- 4 The Economist, “Day Traders Have Sent GameStop’s Share Price Sky-High,” Jan. 27, 2021. <https://www.economist.com/graphic-detail/2021/01/27/day-traders-have-sent-gamestops-share-price-sky-high>
- 5 Ferris Jabr, “The Social Life of Forests,” *The New York Times Magazine*, Dec. 2, 2020. <https://www.nytimes.com/interactive/2020/12/02/magazine/tree-communication-mycorrhiza.html>
- 6 Adam Rogers, “What the Science of Animal Networks Reveals About Protests,” *Wired*, July 31, 2020. <https://www.wired.com/story/what-the-science-of-animal-networks-reveals-about-protests/>
- 7 Todd Haugh, “Leading a Healthier Company: Advancing a Public Health Model of Ethics and Compliance,” May 10, 2021. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3843166
- 8 Andrew G. Haldane & Robert M. May, “Systemic Risk in Banking Ecosystems,” *Nature*, vol. 469, 351-355, Jan. 19, 2011. <https://users.physics.ox.ac.uk/~Foot/Phynance/nature09659.pdf>

“All Together Now” features during an animated sequence in *Yellow Submarine*, and again towards the end of the film, introduced by The Beatles themselves. It’s really a children’s song. I had a few young relatives and I would sing songs for them. I used to do a song for kids called “Jumping Round The Room”, very similar to “All Together Now”, and then it would be “lying on your backs”, all the kids would have to lie down, then it would be “skipping round the room”, “jumping in the air”. It’s a play away command song for children. *All Together Now*: Directed by Brett Haley. With Auli’i Cravalho, Rhenzy Feliz, Justina Machado, Judy Reyes. An optimistic high schooler with musical aspirations must learn to accept help from her friends to overcome her personal hardships and fulfill her dreams. It’s a portland oregon based film, and outdoor 24-hour activity in the outdoors aint always as pleasanht as eeyory’s house, i wouldve chosen rabbits hole if in same circumstances... *All Together Now*. song. One, two, three, four, Can I have a little more, Five, six, seven, eight, nine, ten, I love you. A, B, C, D, Can I bring my friend to tea, E, F, G, H, I, J, I love you. (Bom bom bom pompa bom) Sail the ship (bompa bom) Chop the tree (bompa bom) Skip the rope (bompa bom) Look at me. (All together now), All together now, (All together now), All together now, (All together now), All together now, (All together now), All together now