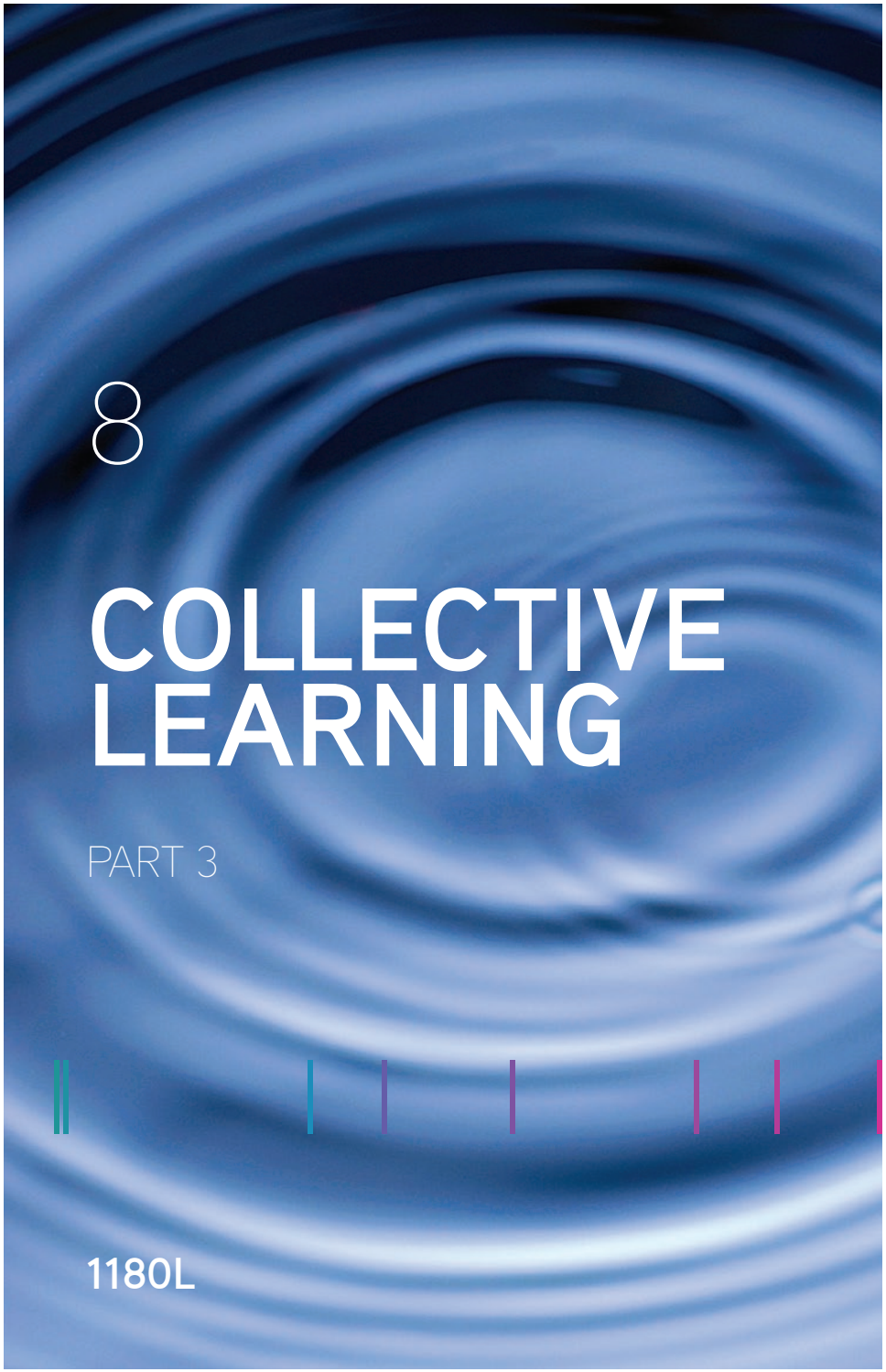
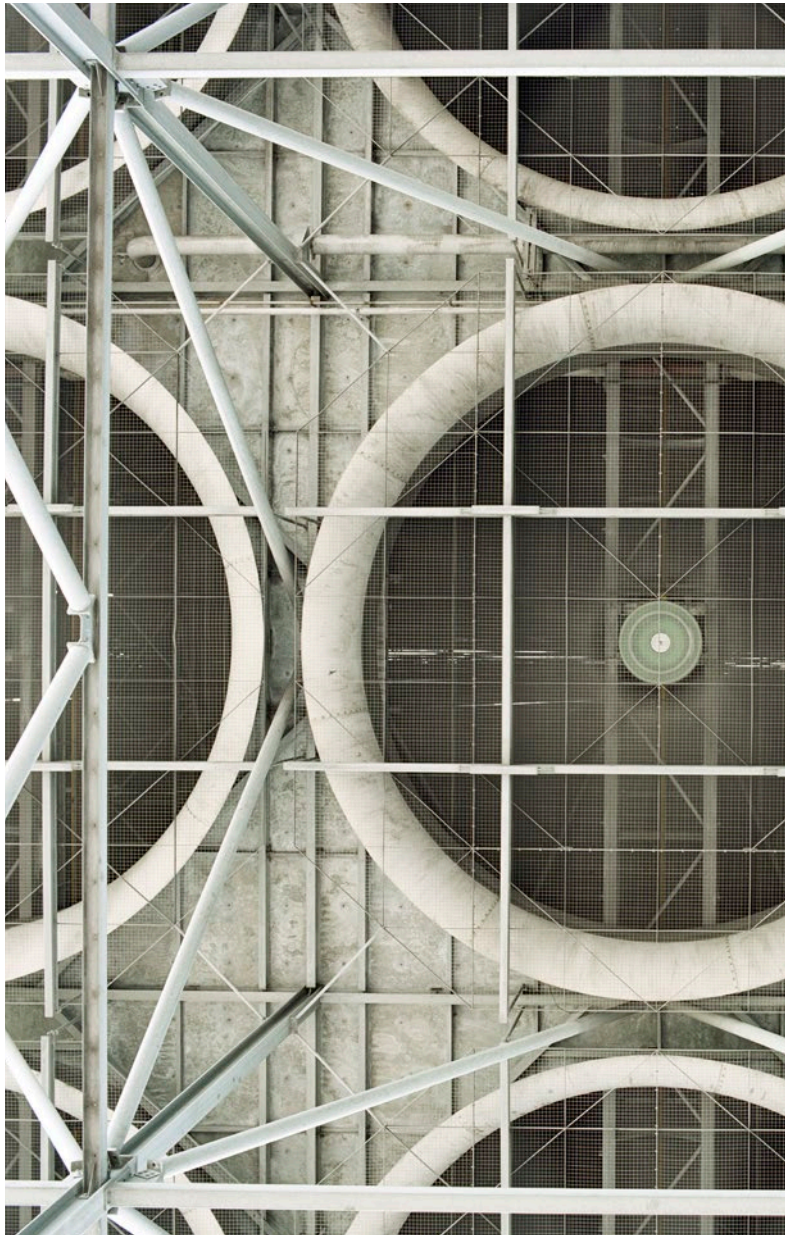


BIG HISTORY PROJECT

COLLECTIVE LEARNING

EXCHANGE NETWORKS AND FEEDBACK CYCLES

By David Christian



A cooling system's thermostat and fans work together to form a feedback cycle

Exchange networks drive the pace of change

We have seen some of the reasons why the power of collective learning seems to increase in the course of human history. With more people and greater diversity, more ideas can be exchanged and accumulated. We have also seen that networks of collective learning distribute information unevenly and that unevenness in the distribution of information supports the unevenness in the distribution of power and wealth. This is a key feature of all agrarian civilizations, one that usually increases as networks get larger.

But networks don't just seem to get more powerful as societies get larger and more diverse; their power also seems to increase faster and faster.

In human history, information seems to accumulate more and more rapidly, so that history itself seems to accelerate. Today, the pace of change is many times faster than it was just a few centuries ago.

Why? Because of feedback cycles.

The mechanics of feedback cycles

A feedback cycle exists when one thing has an effect on another thing, which has an effect on yet something else, which has an effect on the original thing. Causes and effects are linked together in a loop. A familiar example is a thermostat. A fan is cooling a room. But there's a thermometer connected to a switch so that when the room is cool enough the switch cuts off the fan, and then the room starts warming up again. Once the temperature hits a certain point, the thermometer trips another switch that restarts the fan and the room starts getting cooler once more. The fan, the thermometer, and the switch are connected in a feedback loop. This is a negative feedback loop because one part of the chain counteracts the effects of the other parts: the thermostat stops the fan. The result is that the temperature remains fairly stable. As a general rule, negative feedback keeps things stable.

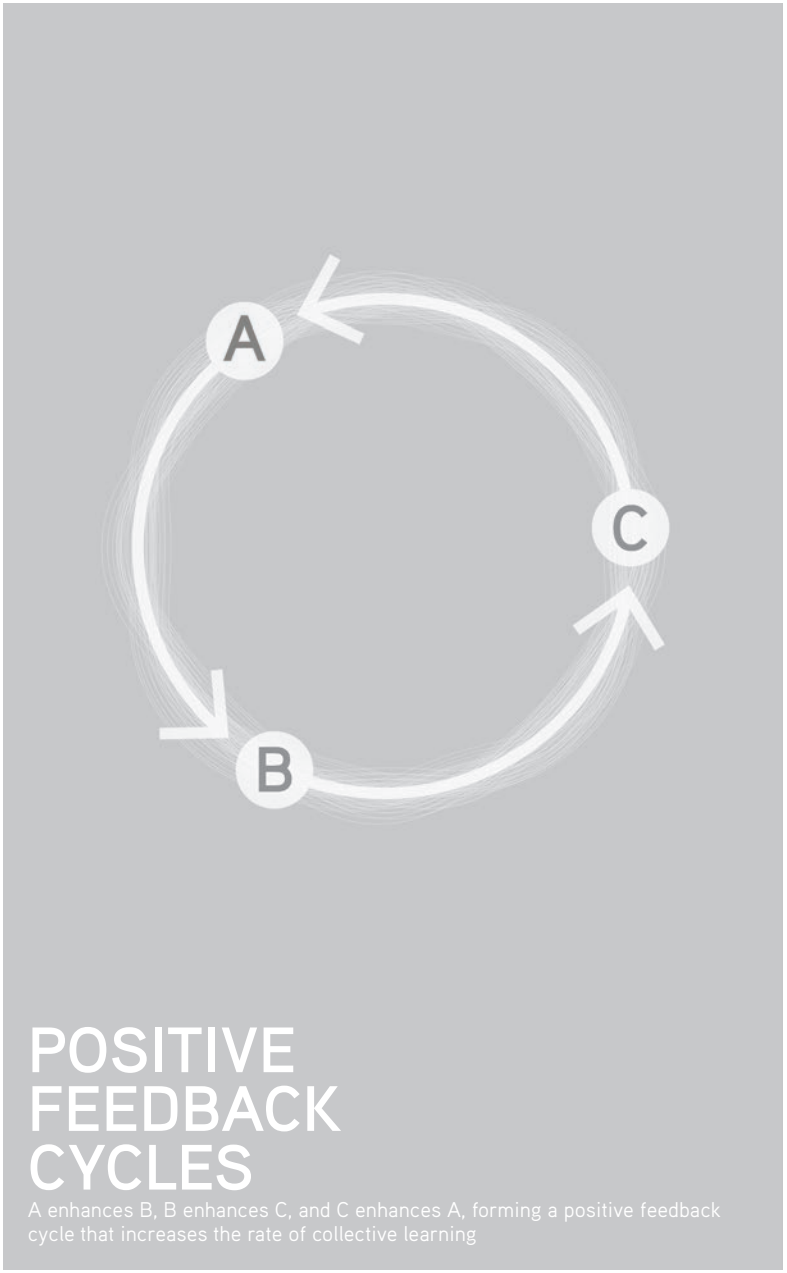
Positive feedback is very different. Imagine a feedback cycle in which each cause increases the effect of the next element instead of reducing or reversing it. That's called a positive feedback cycle. Feedback in an amplifier is an example: a sound goes through a microphone to an amplifier, which amplifies it and then feeds it back into the microphone, so it gets amplified even more until you have to run screaming from the room! Positive feedback makes things happen faster and faster.

In studying collective learning and human history we find many positive feedback cycles. Let's look at one particular type: those based on improvements in the way information is exchanged, stored, and circulated within networks — in essence, innovations having to do with communication and transportation.

Communication and transportation

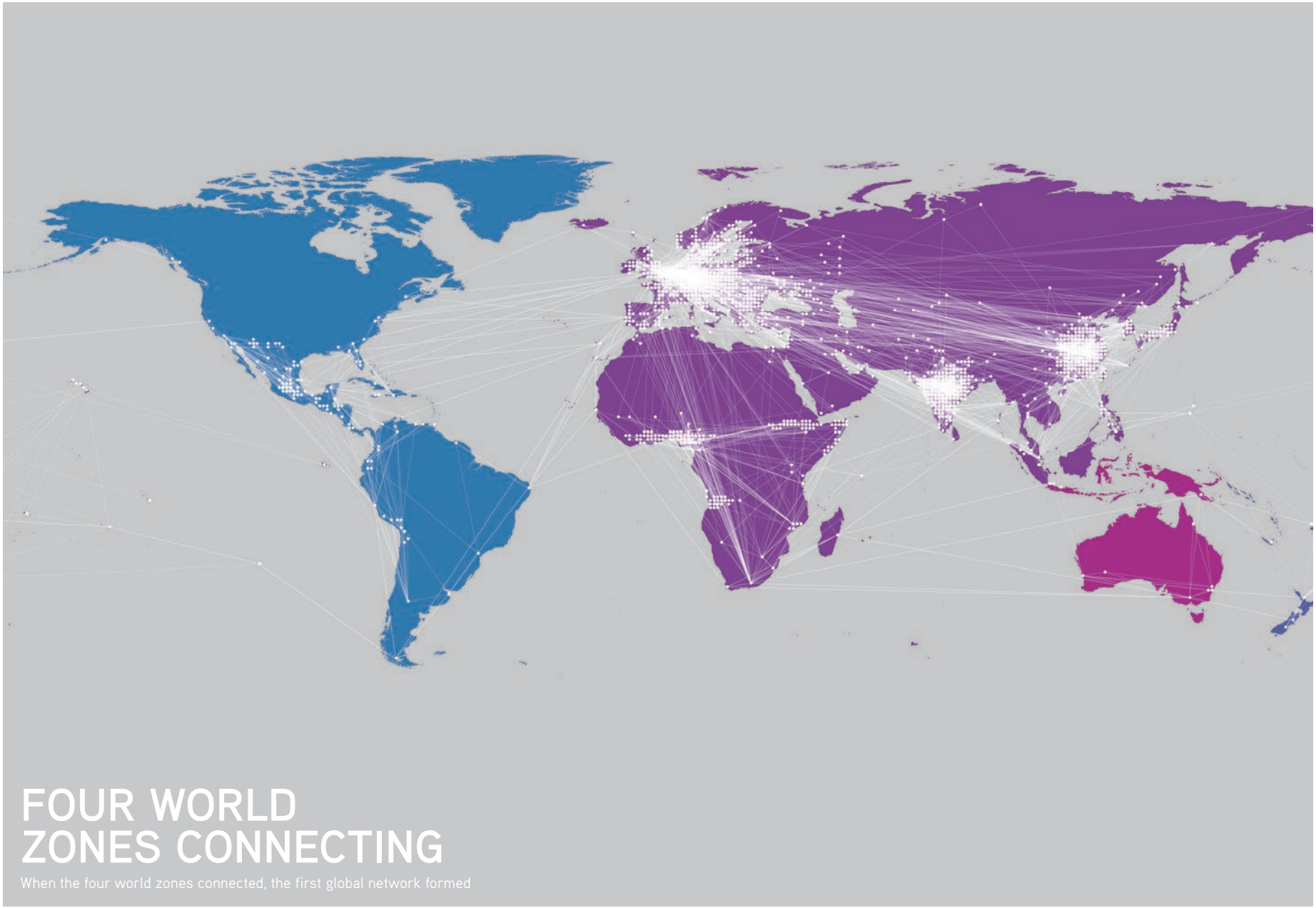
How have humans shared information? The appearance of modern forms of human language marked one way. But in the Paleolithic era, innovations included cave paintings, which undoubtedly encoded and stored a lot of information that we cannot understand today, and storytelling, which, through memorization, allowed for the retention of data about history, society, science, and the environment.

During the last 10,000 years, innovations in communication technologies came faster and faster, from writing to alphabetic writing to government-sponsored courier systems to printing. Modern innovations like the telegraph, the telephone, the radio, and the Internet followed. Each innovation increased the efficiency with which information could be circulated and stored, thereby increasing the efficiency of collective learning, which encouraged even further innovations — a classic example of positive feedback. The astonishing pace of innovation today is simply part of a large trend that goes back to the very beginnings of human history. Collective learning seems to feed upon itself!



POSITIVE FEEDBACK CYCLES

A enhances B, B enhances C, and C enhances A, forming a positive feedback cycle that increases the rate of collective learning



FOUR WORLD ZONES CONNECTING

When the four world zones connected, the first global network formed

We see similar patterns in the history of transportation technologies. Early humans traveled mainly on foot, though boats became important early on too. From about 5,000 years ago, humans began to ride on domesticated animals such as horses and camels, and also used them to pull carts carrying goods, while boats were increasingly used on major rivers. Technological innovation in watercraft allowed for the movement of goods through the Indian Ocean, and, eventually, the circumnavigation of the world starting in the sixteenth century. Geography influenced both communication and transportation.

How geography shapes networks of collective learning

By now, you are familiar with plate tectonics, and you know that the geography of the Earth has changed over time. If things had gone a bit differently, we humans might have evolved in a world where all the landmasses were stuck together in a single continent. That's how the Earth was 250 million years ago, when today's continents were all connected as a single landmass called Pangaea. If humans had evolved on Pangaea, how would that have affected collective learning? For one, it would have made it much easier for humans to spread through the world and to maintain contact with each other. Even if faced with barriers such as large rivers and mountains, humans would surely have found ways to reach all parts of the supercontinent. That suggests that humans might have formed a single, global network much earlier than they did in our actual world. By contrast, imagine if humans had evolved in a world with many isolated islands, separated from each other by oceans. It would have been difficult to move from one landmass to another. And if some humans did manage to cross the oceans, it would have been difficult to get back. This is a scenario for a world of separate, isolated human networks, each developing in its own way and at its own pace. Something similar happened on some of the more remote islands of Polynesia, such as Rapa Nui (Easter Island), one of the most secluded places on Earth.

Our world, as it happens, is somewhere between the two scenarios we've looked at. It has one vast landmass, Afro-Eurasia, made up of two connected continents, Africa and Eurasia. But there are additional, harder-to-reach continents and islands. Our ancestors evolved in Africa, so they had a huge variety of places they could move into, from southern Africa to eastern Siberia. By 20,000 years ago, toward the end of the last ice age, you could find small human communities in most parts of Afro-Eurasia. But humans had also reached Australia (perhaps 50,000 years ago) and the Americas (perhaps 15,000 years ago). In the last 4,000 years, humans entered another region: the Pacific.

The four world zones

We refer to these distinct regions as the great world zones. The first, Afro-Eurasia, is by far the oldest and largest and best connected of the zones. The second largest is the Americas, but this zone was never as well networked as Afro-Eurasia. The last two zones, Australia and the Pacific, held smaller human populations and thinner networks. It was almost as if humans had appeared on four separate planets, each with its own geography, unique environments, and distinctive history.

By comparing these four zones we can see how powerfully geography affected the evolution of collective learning. Populations and networks were much larger and more diverse in Afro-Eurasia, so it is no surprise that innovations — such as the seafaring technology that brought the zones together — accumulated more powerfully there. The Americas saw the appearance of farming and agrarian civilizations, as well as significant regional networks of exchange, though they were much smaller than those of Afro-Eurasia.

Differences in the way collective learning worked in the world zones help explain why the zones had such different histories. They can also tell us much about the impact of the eventual coming together of these zones. After 1492, goods, ideas, peoples, crops, animals, and diseases were shared between the world zones, in what historian Alfred Crosby has called the "Columbian Exchange." The power of this first global network of exchange

The arrival of Columbus in North America established a connection between the two largest world zones

may count as one of the most important of all explanations for the sudden increase in the power of collective learning and the pace of innovation in recent centuries. But the sheer size and variety of the Afro-Eurasian zone explains why countries from that zone have played such a crucial role in recent centuries.

In the last two centuries, further advances in transportation have been head-spinning, with the introduction of railways, steamships, internal combustion engines, airplanes, and space travel. Like the innovations in communication, these increased the possibilities for contact between humans and between different cultures and thereby increased the scale, diversity, and efficiency of collective learning networks.

No wonder human history seems to move faster and faster!

How collective learning works

Rule 1	Collective learning increases when more people are connected
Rule 2	Collective learning increases when there is greater diversity within a network
Rule 3	Uneven distributions of information produce uneven distributions of power and wealth

Positive feedback cycles compound the effects of these three rules, accelerating collective learning

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Positive Feedback Cycles,
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Four World Zones Connecting,
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An 1893 chromolithograph of Christopher Columbus
landing in the Americas
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