Review

The Order of Time, Carlo Rovelli, trans. Erica Segre and Simon Carnell. New York: Riverhead Books, 2018. Translation of *L'ordine del tempo* (Milan: Adelphi Edizioni, 2017). ISBN-13: 978-0735216105.

When one thinks about books dealing with the topic of time, the first that is likely to leap to mind is Stephen Hawking's *A Brief History of Time* (2017), and with good reason. While the book contains some technical data, it is full of speculations about what time and the universe mean for us. As Hawking (2017, 187) concludes, "We find ourselves in a bewildering world. We want to make sense of what we see around us and to ask: What is the nature of the universe? What is our place in it and where did it and we come from? Why is it the way it is?" As individuals ask these kinds of questions they may also ask: What is information? What is the relationship between the universe and what informs us? Does time play a role in this complex universe and how we are informed. When the questioner is an information professional the queries take on a particularly significant feature. This review essay will not answer the questions, but some new and illuminating features of time will be explored.

Very recently, Carlo Rovelli has written *The Order of Time* (2018). Perhaps it should be mentioned that Rovelli's specialization is quantum gravity; this influences his ideas about time. In this extended essay, Rovelli offers insights about time, while at the same time revealing some of the mysteries that remain about what time is and how it is manifest both in the universe and in our lives. He includes only one equation, "$\Delta S \geq 0$" (27). He (2018, 27) explains:

> This reads: "Delta *S* is always greater than or equal to zero," and we call this "the second principle of thermodynamics" .... It is the only equations of fundamental physicals that knows any difference between past and future.

It is the only one that deals with the flow of time. It is Rovelli's book that will be the focal point of the present piece. Much of what he has to say has pertinence to the understanding of information and the ways people are informed (even though he seldom even mentions the word "information"). Spoiler alert: This is a book that everyone in the field of library and information science can learn from, if the reader seeks analogies and sometimes reads between the lines.

That said, Rovelli says almost nothing about information, but what he writes about time has decided implications for our field. Quite early on he (2018, 63) he says:

> Aristotle is the first we are aware of to have asked the question "What is time?," and he came to the conclusion: time is the measurement of change. Things change continuously. We call "time" the measurement, the counting of this change.

We can examine Rovelli's definition in the context of discursive practice. Let us assume that a person puts something into "print" (with print being a convenience for making an utterance public by means of whatever media). That utterance may induce change in the minds of those who read it; it may provoke a different notion of what "is." There is some discernible change that can be articulated. Moreover, that change itself can be discussed—even argued about—in further discursive practices. Other readers may have their ideas further changed by the subsequent discussion. Those changes may also be discernible, possibly through further discursive practice. Take Sigmund Freud as a tangible example. He wrote a number of books, but let take his thoughts on taboos as one example. While he expressed ideas on taboo, others, down through the years, have added to the discourse on the topic. I am not saying here that every writing has resulted in changes in though, but many commentaries have elicited change. Time becomes something that is almost fluid, with discourse moving backward to Freud and through time (sometimes backward and forward) on the subject of taboo. What is time in this example? What is time in the context of the history of ideas?

If we consider the organization of information and knowledge, we may accept the opinion of Michel Foucault (1977), who took "Freud" to be, not only a creator of discursive practice himself, but also a symbol of discourse that is carried out with his name and his ideas that are integral to what comes after his own life. We may decide a discourse is "Freudian," even though Freud did not write it and is not directly responsible for it. We can organize the discourse around the concept of "Freud" to accommodate Freud's utterances as well as those that follow him. As Foucault (1977, 132) suggests, Freud, as an initiator of discursive practice:

> not only made possible a certain a number of analogies that could be adopted by future texts [moving

> beyond past and present] but, as importantly … also made possible a certain number of differences."

The field of discourse that was created also cleared space for practices other than his own—practices that also remain within the practice that was initiated. While it may seem that this structure represents an arrow of time, it actually is complex passage that embodies change. This is not like a clock (an example that Rovelli uses to illustrate granularity of time; time as measured in quanta). A clock moves on one direction and is indispensable for helping humans follow a certain path of time. But this is not the only feature of time. As he (2018, 87 emphasis original) states, another discovery "made by quantum mechanics is *indeterminacy*: it is not possible to predict exactly, for instance, where an electron will appear tomorrow." It is also not predictable where data will appear or how they will take shape. Individuals who are presently studying "big data" should take indeterminacy to heart; the form of the data set may not be an exactly stable entity.

It might be said that indeterminacy operates in ways other than quantum. There may be the possibility of indeterminate evolutionary change as well. Rovelli does not speak of this kind of change (being a physicist). Paul Halpern (2017, 85) raises the matter. He says:

> Humans have the remarkable ability to understand themselves, anticipate future possibilities, reshape the environment, and map out to cosmos, among other advanced attributes. Technology, the product of human ingenuity, similarly becomes more advanced from era to era. Therefore evolution offers a progressive arrow of time. Which arrow of time will win in the end, the thermodynamic or the evolutionary? Unless things change, it will be the former.

The first part of Halpern's statement is essential; humans are capable of accomplishments because of evolution … and more. Where one can call his opinion into question comes when he speaks of progress and the arrow of time. He (2017, 86) corrects himself to a considerable extent by writing, "Instead of a cycle or an arrow, the sum over histories approach suggested a third distinct way of viewing time; as a labyrinth of every bifurcating possibilities." A cursory examination of political history tends to support Halpern's notion, at least to a considerable extent. When it comes to progress, there are some challenges; "progress" has various definitions, and not all refer to progress in time or in physical terms. Progress in knowledge, society, etc. can be disputed.

Rovelli does not speak of progress as such, but he does explicate entropy. Moreover, he draws from Ludwig Bolzmann in his definition of entropy. He (2018, 159-60 emphasis added) is explicit and eloquent in his discourse on entropy:

> But there is something that does not add up. Energy—as I was told at school—is conserved. It is neither created or destroyed. If it is conserved, why do we have to constantly resupply it? … It is not energy that the world needs in order to keep going. What it needs is *low* entropy.

Rovelli (2018, 160) is clear about the meaning of his admonition, "Without low entropy, energy would dilute into uniform heat and the world would go to sleep in a state of thermal equilibrium—there would no longer be any distinction between past and future, and nothing would happen." Our very lives are comprised primarily of low states of entropy, so that there is growth and even death. In a metaphoric state or low entropy, there can be memory and there can be plans for the future. The entropic state though, as Rovelli stresses, is physical.

[As an aside, other, previous theorists are committed to the idea of entropy. In the field of information theory, Leon Brillouin (1962) also draws on Bolzmann to affirm Claude Shannon's engineering-oriented work. According to Brillouin, though, there is the possibility, with the study of information, to realize the negative of entropy. As he says (1962, 153), "In the case of free information, we prefer not to think of a connection between information and entropy, since the relation between entropy and the number of cases is defined only if the cases are complexions [sic] of a physical system." On the other hand (and more recently), Vlatko Vedral (2010, 74) is of the opinion that "information, rather than being an abstract notion, is entirely a physical quantity." It is evident that Brillouin and Vedral are at odds in their conceptions. Brillouin separates physical from human communication; I admit to siding with Brillouin in this regard; I will return to the idea later.]

In some ways Rovelli (2018, 30) simplifies the concept of entropy: "The growth of entropy is nothing other than the ubiquitous and familiar natural increase of disorder. This is what Bolzmann understood. The difference between past and future does not lie in the elementary laws of motion; it does not reside in the grammar of nature. It is the natural disordering that leads to gradually less particular, less special situations." This may appear to be materially no different from what Vedral has to say, but Rovelli emphasizes the point that the world exists optimally in a state of low entropy. This is not to say that high entropy is not possible; humans can make a difference in, say, the environment. Without the intervention of humans, though, the natural state *can* approach low entropy. When we consider information (in the sense of

human communication, not in Vedral's purely physical definition), humans can affect the order and disorder of the outcome. Consider James Joyce's novel, *Finnegan's Wake*; Joyce deliberately created a work of high entropy, leaving the reader to make the sense out of the novel. Consider further a work by Ernest Hemingway—say, *The Sun Also Rises*. This can be considered a novel in which lower entropy inheres. With these examples, it seems apparent that humans can have an impact of the entropy of communication (as Brillouin would have it).

If this essay allows for some speculation, we can learn that, given states of low entropy as being more often the case than not, the organization of information and knowledge has a life in the past, the present, and (to some extent) the future. Perhaps it does not exist—or has relevance—in the distant future; even low entropy has an additive effect. Also, discursive practice increases; as it increases it is an agent of change. This very essay may prompt some readers to pick up Rovelli's book, to learn from it, to quote from it. These acts transform the cumulative discourse that humankind can have access to. Rovelli, make no mistake about it, is a materialist; he believes the mind is a phenomenon of the brain. Even if a reader is not a materialist (or is *mostly* a materialist but believes there are some inexplicable elements of the mind—as David Chalmers (1996) does when he claims to be a *mysterian* when it comes to the complete workings of the mind—there are concepts at the heart of *The Order of Time* that humanize the physical. Rovelli (2018, 182), for example, can claim, "this is what time is: it is entirely in the present, in our minds, as memory and as anticipation. He can invoke Saint Augustine, Marcel Proust, William of Okham, Edmund Husserl, and others as he brings the human into the picture.

One thing that Rovelli's book elicits is a wonder for what time is, what it is not, and how we can comprehend it. As one reads it, the nature of information may also arise—what it is, what it is not, and how we can comprehend it.

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