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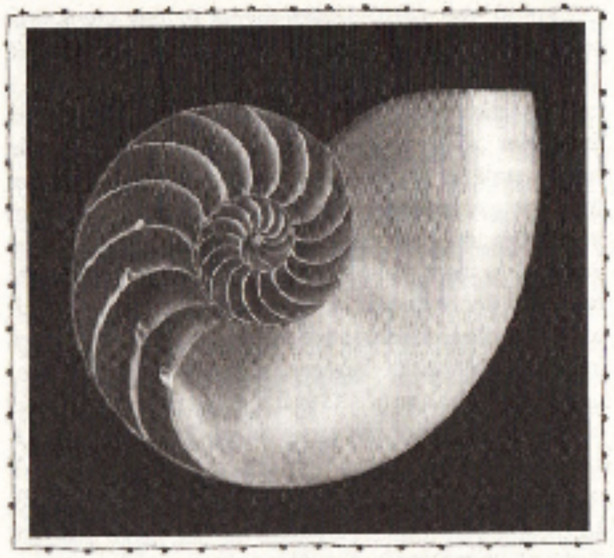
There are probably several reasons why we are drawn to spirals. One may be that, even before science showed just how widespread they are, people intuited that they were a manifestation of forces at work in the natural world: spirals as constant forms appearing in what is always moving, approximating Carl Woese's metaphor for life itself: 'organisms [as] resilient patterns in a turbu-



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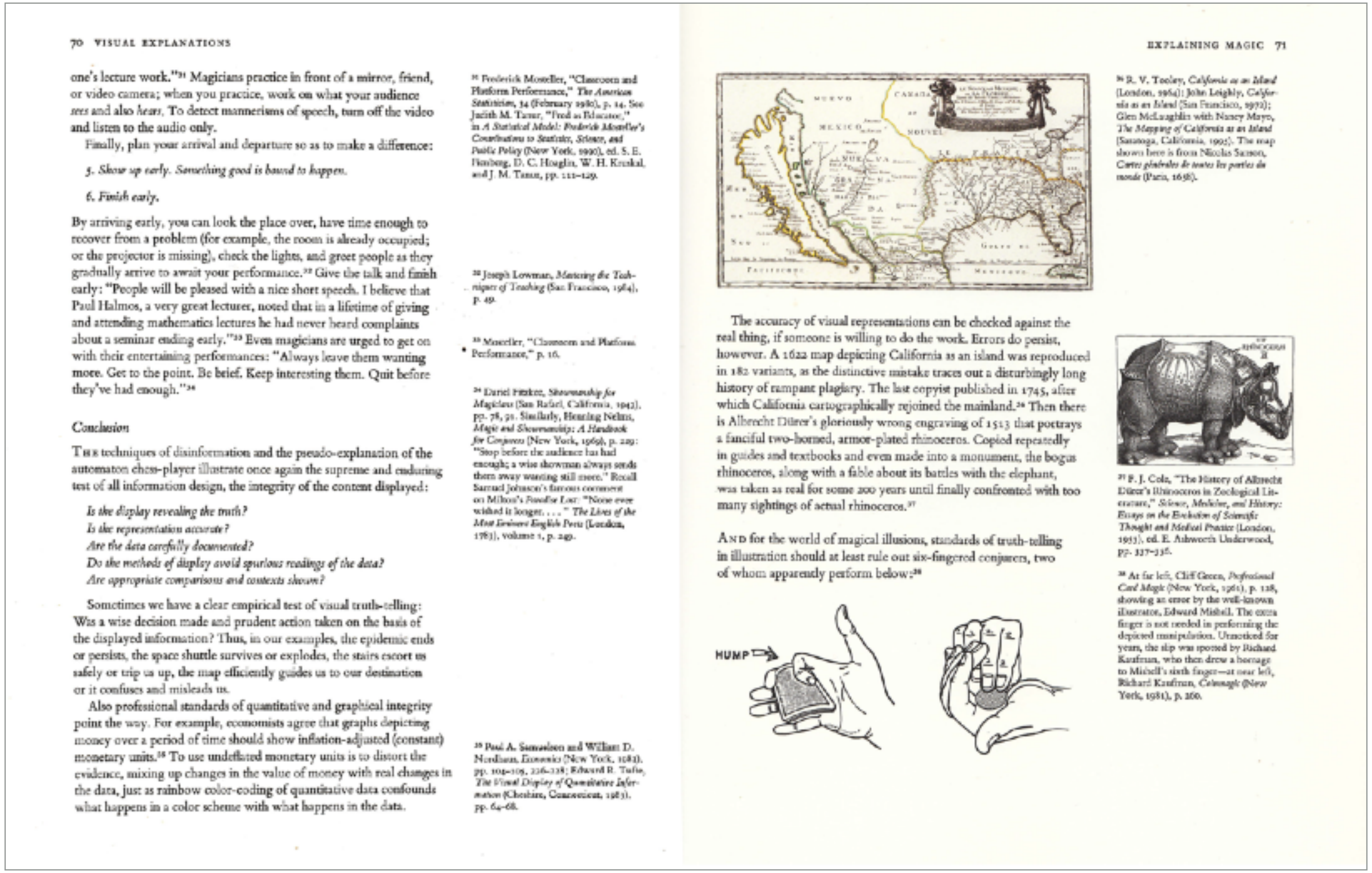
The geneticist Jack Szostak (2011) has suggested that 'simple physical forces' such as those that cause cell membranes to form and divide may yet play a role in attempts to reconstruct the origins of life.

Thompson's *On Growth and Form* greatly enriches the reader's appreciation of the range of spirals and other forms that arise in living things. As a work to arouse wonder it has few equals. As an explanation for how life evolves and develops, however, it is inadequate. Thompson acknowledged as much, writing that his work took us 'only to a threshold'. But even as in the years up to his death in 1948 Thompson was preparing an expanded edition, other scientists were starting to understand metabolism, photosynthesis, heredity and development in new ways: molecular biology was being born.

On the other hand **Edward R. Tufte** is well known for his beautifully designed books about the display of information.

We can see in this example from *Visual Explanations*, that he uses numbers for the margin notes.



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one's lecture work."[31] Magicians practice in front of a mirror, friend, or video camera; when you practice, work on what your audience *sees* and also *hears*. To detect mannerisms of speech, turn off the video and listen to the audio only.

Finally, plan your arrival and departure so as to make a difference:

5. *Show up early. Something good is bound to happen.*

6. *Finish early.*

By arriving early, you can look the place over, have time enough to recover from a problem (for example, the room is already occupied; or the projector is missing), check the lights, and greet people as they gradually arrive to await your performance.[32] Give the talk and finish early: "People will be pleased with a nice short speech. I believe that Paul Halmos, a very great lecturer, noted that in a lifetime of giving and attending mathematics lectures he had never heard complaints about a seminar ending early."[33] Even magicians are urged to get on with their entertaining performances: "Always leave them wanting more. Get to the point. Be brief. Keep interesting them. Quit before they've had enough."[34]

Conclusion

THE techniques of disinformation and the pseudo-explanation of the automaton chess-player illustrate once again the supreme and enduring test of all information design, the integrity of the content displayed:

Is the display revealing the truth?
Is the representation accurate?
Are the data carefully documented?
Do the methods of display avoid spurious readings of the data?
Are appropriate comparisons and contexts shown?

Sometimes we have a clear empirical test of visual truth-telling: Was a wise decision made and prudent action taken on the basis of the displayed information? Thus, in our examples, the epidemic ends or persists, the space shuttle survives or explodes, the stairs escort us safely or trip us up, the map efficiently guides us to our destination or it confuses and misleads us.

Also professional standards of quantitative and graphical integrity point the way. For example, economists agree that graphs depicting money over a period of time should show inflation-adjusted (constant) monetary units.[35] To use undeflated monetary units is to distort the evidence, mixing up changes in the value of money with real changes in the data, just as rainbow color-coding of quantitative data confounds what happens in a color scheme with what happens in the data.

[31] Frederick Mosteller, "Classroom and Platform Performance," *The American Statistician*, 34 (February 1980), p. 14. See Judith M. Tanur, "Fred as Educator," in *A Statistical Model: Frederick Mosteller's Contributions to Statistics, Science, and Public Policy* (New York, 1990), ed. S. E. Fienberg, D. C. Hoaglin, W. H. Kruskal, and J. M. Tanur, pp. 111–129.

[32] Joseph Lowman, *Mastering the Techniques of Teaching* (San Francisco, 1984), p. 49.

[33] Mosteller, "Classroom and Platform Performance," p. 16.

[34] Daniel Fitzkee, *Showmanship for Magicians* (San Rafael, California, 1942), pp. 78, 91. Similarly, Henning Nelms, *Magic and Showmanship: A Handbook for Conjurors* (New York, 1969), p. 229: "Stop before the audience has had enough; a wise showman always sends them away wanting still more." Recall Samuel Johnson's famous comment on Milton's *Paradise Lost*: "None ever wished it longer. . . ." *The Lives of the Most Eminent English Poets* (London, 1783), volume 1, p. 249.

[35] Paul A. Samuelson and William D. Nordhaus, *Economics* (New York, 1985), pp. 104–105, 226–228; Edward R. Tufte, *The Visual Display of Quantitative Information* (Cheshire, Connecticut, 1983), pp. 64–68.

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The accuracy of visual representations can be checked against the real thing, if someone is willing to do the work. Errors do persist, however. A 1622 map depicting California as an island was reproduced in 182 variants, as the distinctive mistake traces out a disturbingly long history of rampant plagiary. The last copyist published in 1745, after which California cartographically rejoined the mainland.[36] Then there is Albrecht Dürer's gloriously wrong engraving of 1513 that portrays a fanciful two-horned, armor-plated rhinoceros. Copied repeatedly in guides and textbooks and even made into a monument, the bogus rhinoceros, along with a fable about its battles with the elephant, was taken as real for some 200 years until finally confronted with too many sightings of actual rhinoceros.[37]

AND for the world of magical illusions, standards of truth-telling in illustration should at least rule out six-fingered conjurers, two of whom apparently perform below:[38]

HUMP

[36] R. V. Tooley, *California as an Island* (London, 1964); John Leighly, *California as an Island* (San Francisco, 1972); Glen McLaughlin with Nancy Mayo, *The Mapping of California as an Island* (Saratoga, California, 1995). The map shown here is from Nicolas Sanson, *Cartes générales de toutes les parties du monde* (Paris, 1658).

[37] F. J. Cole, "The History of Albrecht Dürer's Rhinoceros in Zoological Literature," *Science, Medicine, and History: Essays on the Evolution of Scientific Thought and Medical Practice* (London, 1953), ed. E. Ashworth Underwood, pp. 337–356.

[38] At far left, Cliff Green, *Professional Card Magic* (New York, 1961), p. 128, showing an error by the well-known illustrator, Edward Mishell. The extra finger is not needed in performing the depicted manipulation. Unnoticed for years, the slip was spotted by Richard Kaufman, who then drew a homage to Mishell's sixth finger—at near left, Richard Kaufman, *Coinmagic* (New York, 1981), p. 260.

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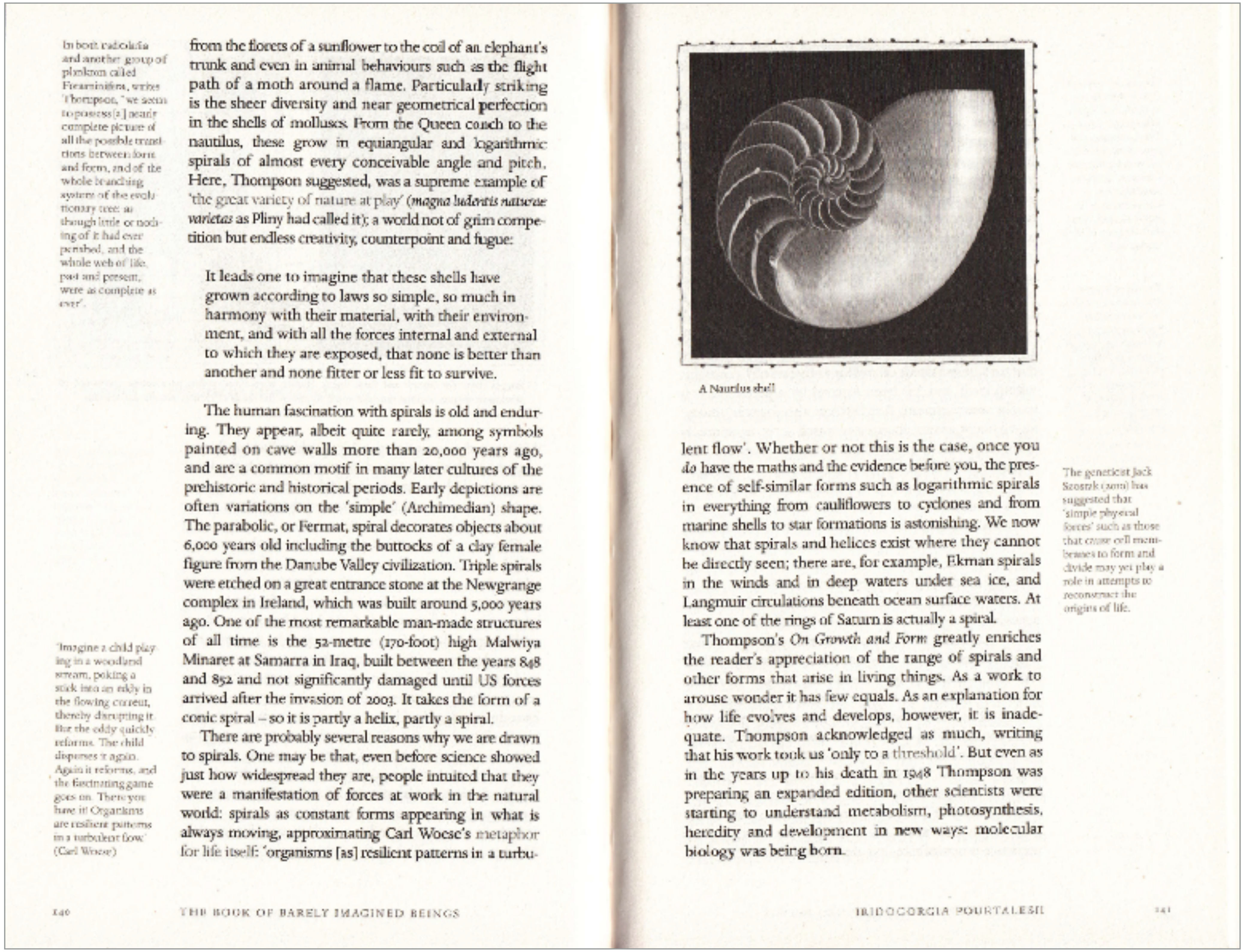

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