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Is Mathematics a Unified Whole?

Mathematics Elsewhere: An Exploration of Ideas Across Cultures. *By Marcia Ascher, Princeton University Press, Princeton, New Jersey, and Oxfordshire, UK, 2002, 207 pages, $24.95.*

Terence Cave, in his introduction to the Penguin Edition of *Daniel Deronda,* writes that

"The nineteenth century was . . . a time of intensive interest in the common forms of human experience lying beneath the proliferation of cultural and linguistic variants."

This intensive interest has been vigorously carried forward into the 21st century by Marcia Ascher, professor emerita of mathematics at Ithaca College, who has devoted much of her professional life to the study of the mathematics of what she terms "small-scale cultures."

BOOK REVIEW
By Philip J. Davis

The "elsewhere" of her title includes, among other places, southern India, Ethiopia, the Marshall Islands, Madagascar. Flipping the pages, we meet unfamiliar peoples: the Bakuba, Malekulas, Tamil Nadus, Tshokwes, Yorubas; our eyes light on strange words: kolam, sikidy, mettang, tika, to name but a few. The topics treated, on the other hand, are by no means strange—at least at the popular level; among them are divination, calendric arrangements and cycles of time, stick charts for navigation, systems of human relationships, rice flour designs.

First, a very brief description of some of the mathematics the author finds embodied in these five topics.

Divination. This requires a random element followed by the application of a deterministic algorithm. Sikidy, a divination system used in Madagascar, begins with the diviner taking a handful of dried seeds of the fano tree, prepping them spiritually, and then dropping them randomly into four piles. There ensues an elaborate process of interpretation based on the number of seeds in the piles, a process that the author has analyzed in the language of Boolean algebra and switching circuits.

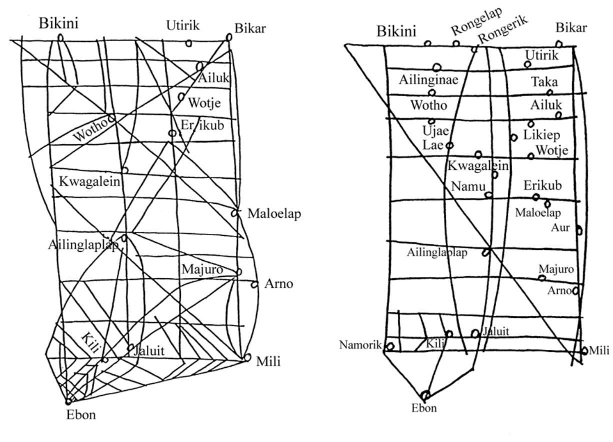
Cycles of time and calendars. We are quite familiar with lunar, solar, and lunar–solar calendars, and the various ways in which intercalations and festivals are defined within them. The lunar–solar Jewish calendar is explained in detail. What will certainly strike most readers as strange is that certain calendars are based on current biological phenomena. Thus, Trobriand Islanders intercalate a month depending on when the *milamala*, a sea worm, reappears.

Regarding cycles with short periods, the seven-day week might strike us as both natural and universal. But to the ancient Maya, cycles of 13 and 20 days are important. The Javanese–Bali intermesh ten different cycles. In a mathematical analysis of systems incorporating concurrent cycles, Ascher makes use of Euler's phi function.

(Readers who are interested in the details of the wide diversity of calendric systems might very well consult two books by Edward M. Reingold and Nahum Dershowitz: *Calendrical Calculations* and *Calendrical Tabulations 1900–2200,* both recently published by Cambridge University Press. The former (1997) gives algorithms and programs for fourteen calendars, while the latter (2002) provides tables for their interconversion.)

Stick charts. Of the navigational charts constructed by the Marshall Islanders from palm ribs tied with coconut fibers, Ascher writes:

"What they show is meaningful *only* if one knows something about *wave piloting*. . . . The wave piloting system depends on a conceptualization of the dynamic interplay of land, wind and water."



Navigational charts constructed by Marshall Islanders from palm ribs and coconut fibers can have meaning only for observers familiar with the conceptualization of the dynamic interplay of land, wind, and water on which the charts depend. From Mathematics Elsewhere.

Standard (i.e., western) diagrams depicting wave reflection, refraction, and diffraction around an island amplify Ascher's discussion.

Human relationships. Here, the book considers relationships between sisters, cousins, and aunts as well as those depicted in the organizational charts of a large corporation. The Basque community of Sante-Engrâce had a concept of equality (giving and receiving of blessed bread and of cooperation in cheese making and shepherding) that is cyclic and not hierarchical. Ascher does not find the relationship static but rather a "dynamic process of interaction involving rotation, serial replacement and alternation." Modular arithmetic is invoked by way of a mathematical description.

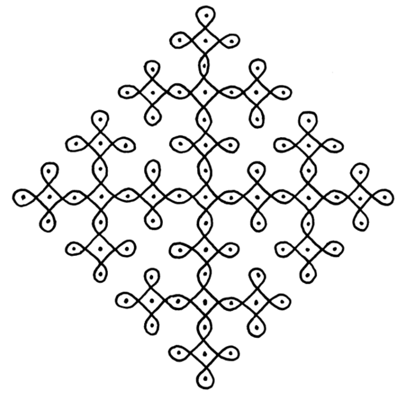
Rice flour designs. Ascher describes the designs made by women in Tamil Nadu, in southern India, on the thresholds of their homes each morning:

"The designs, known as *kolam,* are created by using rice flour in the hand and slowly trickled in a thin stream from between the index and the middle finger. The kolam tradition is closely tied to, and expressive of, the values, rituals, and philosophy of the people of Tamil Nadu."

A mathematical description of the production of kolam figures is given in terms of string languages and rewriting rules. The book's description of the "Anklets of Krishna," a kolam series, is reminiscent of the free groups of noncommutative Möbius transformations employed by Mumford et al. in their recent *Indra's Pearls* (reviewed in *SIAM News*, September 2002).

The bottom line of *Mathematics Elsewhere*—you might even say the moral of the book—is that different groups of people living in different places and at different times organize their worlds of thought and action differently. All the topics are described within the human context of place and time, and without any "advanced-nation" condescension. Nonetheless, they are clothed in our advanced mathematical interpretations. For us as mathematicians, mathematics is "common sense," the way things are. Ascher's descriptions in mathematical terms would be as incomprehensible to most of those living in the cultures she describes as was the explanation given to anthropologist Clifford Geertz by the family of a Javanese boy who fell out of a tree and broke his leg:

"The spirit of his deceased grandfather pushed him out because some ritual duty toward the grandfather had been inadvertently overlooked." (From *Local Knowledge,* 1983.)



Kolam, designs created in rice flour by Tamil Nadu women in southern India, are described in the book under review in terms of string languages and rewriting rules. Shown here, from Mathematics Elsewhere, *is a figure from the kolam series "Anklets of Krishna."*

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"Different places = different worlds" may strike the reader as a cliché, yet *Mathematics Elsewhere* turned my mind to the deeper aspects of mathematics when it is used to exhibit common forms of human experience that lie beneath cultural variants. More precisely, it has led me to ask (but hardly to answer):

(1) To what extent can we legitimately describe and interpret an ancient or an isolated culture in light of our contemporary mathematical culture?

(2) To what extent is mathematics really unified? Or to put it another way, has what we call the mathematics of, say, the Maya or the Malekulas emerged strictly within those individual cultures?

Historians of mathematics have shown that cross-fertilization surely exists, although some of their conclusions may be iffy. For example, it has been claimed recently that our Arabic–Indian numerals originated not in India but in China, having been derived from a system of computation with rod numerals.

Among the "myths" harbored by our mathematical community and stressed by Reuben Hersh (in his 1997 book *What Is Mathematics, Really?*) are the closely related statements of unity and universality. The myth of unity, Hersh writes, asserts that

"There's only one mathematics, indivisible now and forever. Mathematics is a single inseparable whole."

As to the myth of universality, it states that

"The mathematics we know is the only mathematics that can be. If little green critters from Quasar X9 showed us their textbooks, we'd find again $A = \pi r^2$."

The inter-interpretability exhibited in *Mathematics Elsewhere* is often cited as evidence for both unity and universality. But this depends on a definition of mathematics that is sufficiently restricted to exclude the cultural underlay. My own definition of mathematics is that it includes everything that makes its core comprehensible. (And I'm not sure how to define the core.)

I see unity only in a weak sense. Transporting myself mentally from the South Seas to a Hilton Hotel, where a meeting of mathematicians is under way, I find that I can understand only a small fraction of what is being presented. I suspect that this is true of a large fraction of the attendees. If someone were to counter that "in principle" I could understand it all, I would answer that "in principle" is one of the most evasive phrases in our vocabulary. Linguists and anthropologists worry that an estimated 3000 human languages will disappear in the next century. And I worry (or perhaps exult) that about 3000 new mathematical languages and cultures will emerge in that time.

Ascher sees it both ways:

"Most cultures do not set mathematics apart as a distinct, explicit category. But with or without that category, mathematical ideas, nonetheless, do exist."

It is we who have separated out certain ideas and dubbed the system so created mathematics.

As regards universality, some years ago, as part of an effort to establish contact with putative extraterrestrial beings, messages involving mathematical symbolisms were prepared for shipment into space. As I recall it, a number distinguished mathematicians, who assumed universality, worked on this project.

In a review of Alexander Stille's *The Future of the Past* (*New York Review of Books*, December 19, 2002), John Terbogh writes:

“A recent anthropological study done among Quechua-speaking people of the Andes . . . challenges the idea that the conception of numbers is culture-free or culture-neutral.”

Again, Ascher sees it both ways:

“The question is sometimes raised as to whether math is discovered or invented. My own view is that both occur: mathematical systems are created . . . but then, resulting from the relations within them, further relations are discovered to exist. Social systems are surely the creation of the people within whose culture they are found. But no doubt, as time goes on, additional logical implications of the relations become apparent.”

What does our inspection of the mathematics extracted from a culture tell us about that culture? Not too much. Terbogh, in the review mentioned earlier, asserts that,

“We moderns have documented nearly everything about Machiguenga culture . . . that can be captured in written, visual, and aural media. But what is it to *be* a Machiguenga? That is something that can’t be captured by any medium.”

What, then, according to Terbogh, is the value of studying and reformulating isolated modalities?

“It enriches us who live in the contemporary world. It informs us about our origins and informs us how we became what we are.”

Just so. Ascher’s splendid book is rich in possibilities for raising readers’ horizons: anthropological, educational, mathematical, and philosophical. The notes and bibliography are outstanding; they are sufficient to satisfy an amateur mathematician who wants to read a bit more about the mathematical systems used in the descriptions, as well as an anthropology-oriented reader who wants to go to the scholarly sources from which Ascher has culled her material. The book may even entice some young scholars to extract and interpret the mathematics of other “elsewheres.”

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