Book Reviews

The Book as a Scientific Instrument

Astronomicum Caesareum. PETER APIANUS. Facsimile of the 1540, Ingolstadt, edition, 122 pp., illus., with a companion volume, *Peter Apianus und sein Astronomicum Caesareum*, including a facsimile of Apianus' German commentary and an introduction, in German and English, by Diedrich Wattenberg, 108 pp., illus. Edition Leipzig, Leipzig, 1967. Regular edition, $465.50; special edition of 200 numbered copies, $489.50.

In this age when the paperback book is probably doing more to change the process of science education than all the new teaching methods, it should not be difficult to appreciate the intimate connection between the printer's craft and that of science. It has always been a potent source of historical interaction. The technology of printing has already been shown by Lehmann-Haupt to have arisen from the technique of engraving used by Gutenberg's immediate predecessors to print playing cards. We know that even before this there had been a continuous tradition of engraving on sheet metal for the very special craft of making astronomical instruments such as the astrolabe—the medieval stereographic slide rule—and the equatorium, which computed planetary positions. Not only, then, may printing have developed from the craft of the instrument-maker, but the very illustrations that made scientific books so special may have come by the same route, for after a little diversion by way of the wood-block engravers, it was the same instrument-making craftsmen, such as Thomas Geminus and Humphrey Cole, who made the astrolabes and who engraved the fine plates for printed maps and the illustrations to Vesalius' anatomy.

If science helped give birth to the printed book, it was clearly the printed book that sent science from its medieval habits straight into the boiling scientific revolution. Science did not need any renaissance, for science had never been lost during the Middle Ages as had the literature and the arts of antiquity. Science had been passed without any effective breaks from antiquity, through Islam, to the active scholars of our Western centers of learning in the 13th and 14th centuries. The great new push, then, came not with the Italian Renaissance—Galileo was a latecomer in modern science—but with the Reformation in southern Germany. That Augsburg and Nuremberg became the centers for printing and for scientific instruments is no accident. It was of course the rapid dissemination of knowledge to whole new classes that created the modern, new attitudes to both science and religion at the end of the 15th century.

The tremendous force of the interaction between science and book printing is to be seen in the large number of scientific texts among the incunabula, and in the activity of notable scientists in the foundation and running of important early presses. Perhaps the best and clearest example of this is Regiomontanus (Johannes Müller of Königsberg), who probably did more than any other person to refound the science of astronomy and clear the ground for the well-known sequence of Copernicus, Brahe, Kepler, and Newton. When Regiomontanus was coming back from his study tours about 1470 he decided to settle in the strategic city of Nuremberg, and there he founded the complete combination of observatory, printing press for scientific books, and manufactory for scientific instruments.

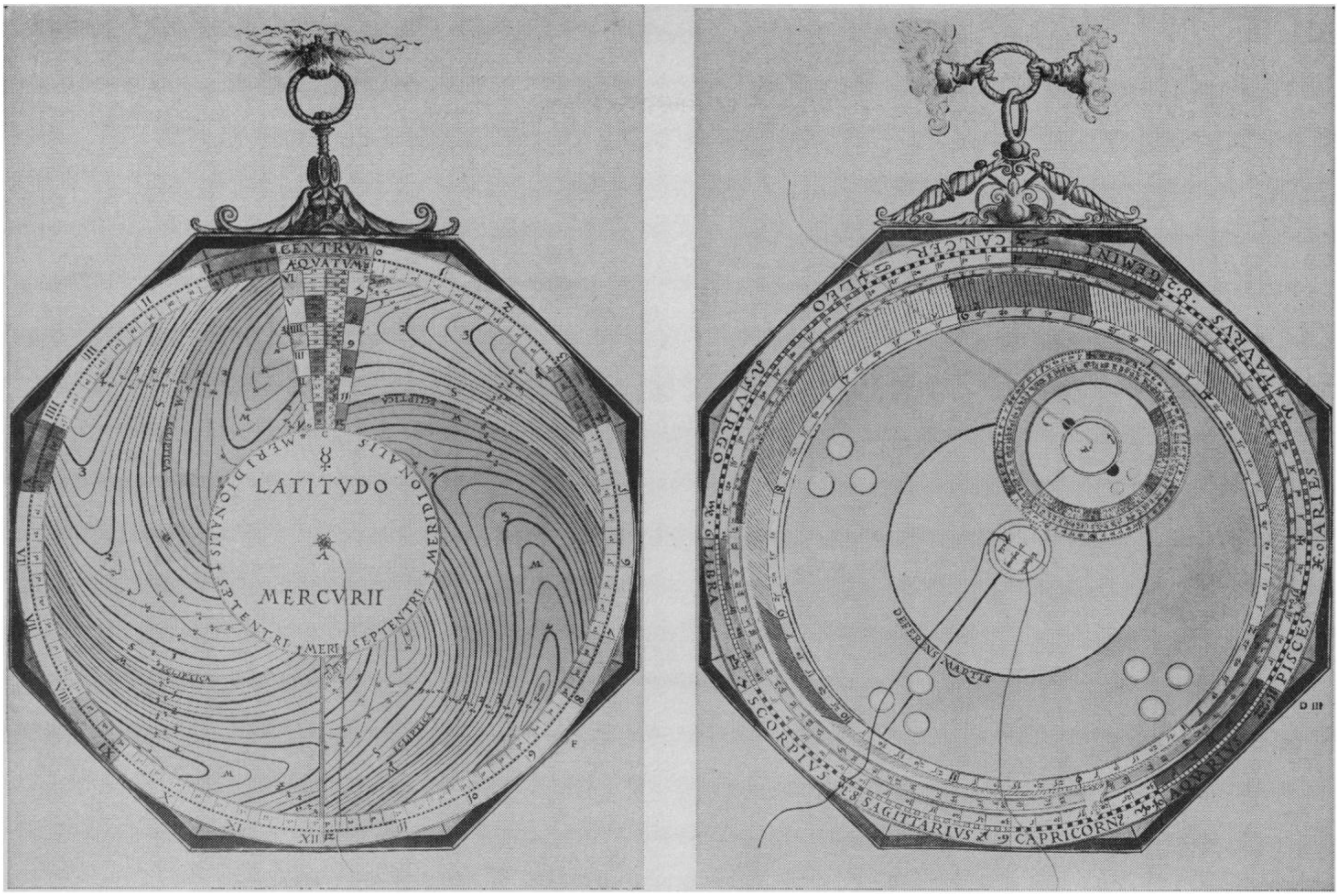
Thus the makers of scientific instruments begat the book trade, and the rise of the book in turn begat more scientists and more instruments to help their work. A last twist of history, a most elegant bending back of the process, began early in the 16th century. The book began to be the medium for a quite new activity in science that now completed the circle. The book itself became a sort of scientific instrument. The new printed instruments were not entirely new, however. Even in medieval manuscripts the use of volvelles (*volvella*)—little discs of parchment that could be rotated on string pivots and that carried scales that could be read with string cursors like a circular slide rule—had been quite popular. The influential Alfonsine Tables of the 13th century had described such instruments in metal, and several hands seem to have adapted the metal instruments into parchment ones to illustrate the manuscripts describing their construction and use. We find many astrolabes and equatoria constructed in this way, and even more commonly there are simple volvelles that may be used for the popular Easter date computus, the Golden Numbers, Sunday Letters, and all the rigmaroles of the passion for calendarics that afflicted the scholarly church at that date.

The perfect reproduction of printing made possible for the first time a sort of mass production of this special type of scientific instrument in the same way that it had led to the mass production of artificial manuscripts. It became through the 16th and 17th centuries a most popular thing to print a text on the astrolabe and equatorium, on dialing, or on computus, and to illustrate it and at the same time embody an instrument by embellishing the text with fine volvelles.

It was of course always a most expensive business to make these volvelles, which had to be cut to shape—often there were many little discs to a single volvelle—and fixed in place with considerable care. In spite of this care, it is quite common to find even in otherwise well-preserved examples that pieces of the volvelle have become detached and lost. Because of this difficulty the mass-produced instrument did not entirely supersede the old hand craft of scale engraving. It was indeed long after the invention of the slide rule and the calculating machine that the ruling engine and other such devices began to realize the dream that the tools of science could be produced in perfect and reproducible form at will by that magical technology of the printing press which also gave science its power of communication and archival learning.

Apianus' Masterpiece

The person who started this imaginative dream was Peter Apianus (1501–1552), professor of mathematics at the University of Ingolstadt in Bavaria. He did it by conceiving and publishing a superbly elegant folio volume that must stand forever as one of the high points in the history of the printer's craft, and without doubt as the most luxurious and



Volvelles for finding the celestial latitude of Mercury and the celestial longitude of Mars.

intrinsically beautiful scientific book that has ever been produced. Van Ortroy's bibliography of Apianus (1902; reissued, Amsterdam, 1963) records only 30 known copies, and S. A. Ionides [*Osiris* 1, 356–389 (1936)] could add only five more; it has always been a quite rare book, and in the majority of known copies some of the volvelles were broken or incomplete. The full splendor of the book has therefore been visible to very few people, and hardly ever to the astronomers and scientists to whom this work was directed. Even in the early days, when Halley tried to get a copy of the book to use its excellent data on the previous visit of his comet in 1531 he could not find one anywhere.

It is therefore a great day in the history of scientific books when there appears a facsimile edition of this masterpiece, Apianus' *Astronomicum Caesareum*, first published at Ingolstadt in Bavaria in 1540, and now reproduced from the fine copy bought by Tycho Brahe in 1599 and now in the Gotha Landesbibliothek. All praise is due to the publisher, Edition Leipzig, for having undertaken such a formidable task in the first place and for having executed it with such perfect craftsmanship, from the four-to-eight-color phototype and hand coloring work to the good calf leather and satisfying gilt-edge binding, as well as the deceivingly exact reproduction of the type. Most important of all, the volvelles are sturdily constructed and exactly fitted. The facsimile is issued together with a complementary volume containing a bilingual (German and English) explanatory text of 32 pages by Diedrich Wattenberg of (East) Berlin, to which is added a reproduction of the little German summary edition of Apianus, also published in 1540, and now even rarer than the big book. The only unkind things one can say is that the new explanatory text by Wattenberg adds virtually nothing to the scholarship of the standard biobibliography published by Siegmund Günther in 1882—Wattenberg consults only sources in German, does not even mention the work of Ionides, and understands little of the astronomical content of the work—and that the high price of the new edition leaves the work still out of the reach of most scholars. One hopes, though, that the production in East Germany, presumably as a prestigious cultural tour de force—and one that really merits appreciation—will mean that copies will be spread around by presentation and exchange as much as by direct purchase.

The name of Apianus is a latinization of the original family name of Bienewitz or Bennewitz (of the bees); the family still survived in Leipzig in 1901, when the firm of M. Bennewitz published a history of themselves in honor of Peter's quatercentenary. He was born at Leisnig in Saxony in 1501, received his elementary education at the University of Leipzig, and then followed the footsteps of Regiomontanus to the University of Vienna. His first publication, in 1520, of a map of the world, is also, perhaps, the one to which he owes most of his fame; it is the earliest printed map of the world in which the name "America" is given to the new-found continent.

About 1526 Apianus was married, and shortly afterwards he moved to the University of Ingolstadt, where he remained for the next 25 years, until his death, as a professor of mathematics, having 14 children (one of them, Philip, succeeded him as mathematician) and collecting one aristocratic privilege after another for himself and for his brothers in return for his admittedly excellent record in the production of scholarly books. Publication in those days did rather more for one than merely remove the threat of perishing; if the book was luxurious and dedicated, like this one, to two reigning monarchs—that is, to the Emperor Charles V of Rome and to his brother King Ferdinand of Spain—then one got various patents of nobility. One of these is, I think, my favorite among honors bestowed upon men of science; Apianus was appointed *Comes et Miles sacri Palatii et Aulae Lateranensis,* which entitled him "to appoint notaries and to legitimize children born out of wedlock."

The Love of Elaborate Perfection

In those last few decades of Ptolemaic astronomy, before Copernican thought and the new mathematics of Kepler and Newton swept all before them, there came an intoxication of perfection among astronomers. All were in love with the sweet completeness with which the universe had been mastered, and in this spirit so many toiled magnificently to show this perfection to the layman and to posterity. The huge and elaborate armillary sphere by Santucci in the recently ravaged Museum of the History of Science in Florence shows this perfection by its thousand carved and gilded wooden circles modeling the universe, and the mighty elaboration is in just the same genre as that displayed here by Apianus. All lovers of graphs and nomograms, of ingenious mechanisms and "beautiful" experiments, will appreciate the depths of emotion in the heartcry of Kepler, who in *Astronomia Nova* (chapter 14) wants his science straight:

> Who will provide me with a source of tears to bewail the misdirected efforts of Apianus, who in his *Opus Caesareum,* as a faithful servant of Ptolemy, has wasted so many fine hours and so many highly ingenious arguments on constructing a most complicated maze of spirals, loops, lines and whirls which represent nothing more than what exists in the imagination of man, and is wholly divorced from nature's true image. His work demonstrates one thing only, namely, that this man, with God's gift of a profound and penetrating intellect, could have mastered nature. Instead he was satisfied and even pleased that he had invented those artificial constructions (in competition with nature herself) and that he had succeeded in making those mechanical models. Thereby he may have earned the prize of perpetual fame, but let us not forget the damage he has caused through the success of his works; and what shall we say about the empty art of the producers of automatons, who used 600 or even 1200 wheels in order to produce the figments of the human imagination, and who were gloating in triumph about their achievements and were claiming prizes because of them.

I have heard the same feeling expressed among those who fear a similar intoxication today with the power of the computer used as an end in itself instead of, as they think should be, a means to an end.

All the prettiness of the book reminds one inevitably of a very clever computer program. The fancy typesetting and use of mirror type, and the embellishment of color and decoration, including entirely nonfunctional handles and the hands to hold them on each instrument, these are all extrinsic to the purpose. But in the scientific purpose itself the same neatness and elegance prevails; a pretty and elegant way to do things is always to be preferred, and this shows up again and again in the design of these instruments and in all the other instrument books and publications of Apianus. The essential beauty of science is not, after all, a bad thing, and this book captures so much of the essence of that essential beauty and was itself a most crucial and powerful force in bringing together at a single point in history the power of scientific theory, beautifully elegant instrumentation, and the technique of printing. At any price it is good to have available in perfect form this great milestone in scientific history.

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Spermatozoa

Animal Gametes (Male). A Morphological and Cytochemical Account of Spermatogenesis. VISHWA NATH. Asia Publishing House, New York, 1966. 342 pp., illus. $13.50.

Nath has written a detailed monograph on the morphology of spermatozoa, and their differentiation. The book deals with a wide range of animals—mammals, birds, reptiles, fish, insects, molluscs, crustaceans, myriapods, nematodes, arachnids, and a few other species. It has undoubted value as a modern specialized supplement to the classical writings of Retzius (1906–09) and Wilson (1928). The book contains several references to works published in India which may be unknown to many investigators elsewhere. Unfortunately the author has had to rely on many secondhand sources because of the unavailability of non-Indian journals. This is a problem which faces many scholars in underdeveloped countries and toward which one is sympathetic.

As a general work the book has certain shortcomings both in style and production. Only some of these can be listed. First, the author assumes that his readers are fully aware of the overall morphology of the spermatozoa of any species he chooses to discuss. For example, his chapter on avian spermatozoa plunges directly into a detailed discussion of acrosome formation in the fowl and duck, and not until three pages later are the uninitiated informed of the two types of avian spermatozoa. Second, it is difficult to understand why a modern student of cell structure should discuss separately studies done by light microscopy and those done by electron microscopy. Yet this format is followed in eight of the 12 chapters. However, in the first chapter, which covers mammalian spermatozoa and is probably the best in the book, an alternative style is adopted. Here the author deals systematically with all parts of the spermatozoon and integrates studies made with several techniques. It is a pity this format was not adopted throughout the book. Third, the book is not a general account of spermatogenesis, as its subtitle claims, but deals almost exclusively with the final stages. These stages involve the morphological transformation of the spermatid into the adult spermatozoon, and are therefore only a part of the total process of spermatogenesis. Fourth, the placement of 184 figures at the end of the book, after 141 pages of text, makes the book very irritating to read, and this is made even worse by the fact that several of the electron micrographs are inferior reproductions of the original publications. The information appears accurate, however, and it will be a useful source in future work.

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