To Show and Explain: The Information Graphics of Stevin and Comenius

Krzysztof Lenk and **Paul Kahn**

As both educators and practitioners in the field of information graphics, we are constantly on the lookout for interesting and positive examples of visual logic and syntax. Again and again we return to the work of Simon Stevin and Johann Amos Comenius, two prominent European scholars and educators who were extremely effective in their use of visual material to compliment their texts.

Background

Simon Stevin (1548-1620) was a Dutchman active in the courts of both the Netherlands and Poland. He was a mathematician, a civil and military engineer, author of textbooks in each of these fields and a professor at the University of Leyden. Johann Amos Comenius (1592-1670) left his native Bohemia and lived as an exile in Poland, the Netherlands and for a brief time in both England and Sweden. He was famous as a leading protestant theologian, an innovative theoretician of education, a successful schoolmaster and the author of vocabulary textbooks.

In the period when Stevin and Comenius began their innovations, the European language of diagrammatical notation had been well developed. The medieval period had produced a large body of diagrams in the manuscript book tradition. Diagrams were widely used to provide visual support for the description of universal order according to various philosophers and theologians. Such diagrams strove to represent a unified model of the physical and metaphysical aspects of the world. Diagrams in circular form were particularly common during this period because the circle clearly represented an abstract model.[1] Examples of this medieval style are visible in Ramon Llull's (d.1315) logical models of Divinity (*see figure 1*) and the diagrams of the Seven Days of Creation by the illustrators of *The Nüremburg Chronicle* of 1493 (*see figure 2*).

The Renaissance of the fifteenth and sixteenth centuries changed the focus of intellectual discourse from the macroscopic to the microscopic. It was a time of retreat from medieval general models of the universe. The thinkers of the time were driven by the need for a more precise understanding of the physical world. That understanding had to include all details, the links between the details, as well as the

Visible Language
Volume 26, Numbers 3 and 4
Summer / Autumn 1992
Diagrams as Tools for Worldmaking

Figure 1 **An abstract circular diagram** from the *Enciclopedia universal ilustrada*, Barcelona, 1923

Figure 2 **The Sanctification of the Seventh Day**, Latin edition of *The Nuremberg Chronicle*, 1493. The sphere surrounding the earth are labeled from the smallest: water, air, fire, the moon, Mecury, Venus, Mars, Jupiter, Saturn, ring of the Zodiac, Crystalline ceiling and prime force by which the universe is kept in motion.

structures and mechanisms that made the pieces work as a whole. There was a need to develop new forms of visual notation to compliment known methods of verbal description and to support this new intellectual exploration.

Some of the most interesting achievements in the field of visual investigation are worthy of summarizing here:

- The development of geometric perspective by Giotto (1266-1337), Alberti (1404-1472) and Paccioli (d. 1514) helped to develop a presentation of the world whose visual order was more "realistic," e.g., closer to the visual distortions of the world as we see it (*see figure 3*). All elements were well coordinated according to their position in relation to the line of the horizon.
- An intensification of curiosity toward the world of nature, in particular the studies of human anatomy by Leonardo da Vinci (1452-1519) and Andreas Vesalis (1514-1564), resulted in the development of precise methods of visual recording (*see figure 4*).
- The unprecedented conceptual studies of nature by Albrecht Dürer (1471-1528) changed the way the natural world was represented. Dürer sketched from nature, did a thorough investigation of the relation of all natural elements and their proportions and finished by formulating general rules of presentation. His diagrams, developed by applying sophisticated grids, led him to search for a method by which he could objectively record the difference between the general rule models (the "ideal") and the particularities of what is actually found in nature (*see figure 5*). By the middle of the sixteenth century, developments of this methodology allowed illustrators to be not only descriptive, but also to explain particular details and structures with a higher degree of sophistication than was previously possible.

Simon Stevin.

Stevin's *Weeghconst* (Art of Weighing), which appeared in 1586, described in precise mathematical detail the principles of gravity and methods for determining centers of gravity. His achievement preceded Galileo's theory of gravitation by half a century. But it was Stevin's visual pedagogy that is most interesting. He relied on the fact that a reader of his book carried in his conscious mind a practical experience of weighing different objects. A reader was also familiar with the hand-held scale, together with its arms, point of support and small counterweight used to measure the object being weighed. Stevin's educational mission was to explain the rules by which such a mechanism operated. Convention would have him present the results of his investigation into the physical principles of weight and gravity in the form of a table of numbers. These numbers might be illustrated with purely geometric diagrams. Such visual notation would be understandable to someone who, like the author, had already absorbed the key to their meaning – a student who already understood the principles being

Figure 3 **Proportional system for the head**
from Luca Pacioli's *De divina proportione*, Venice, 1509.

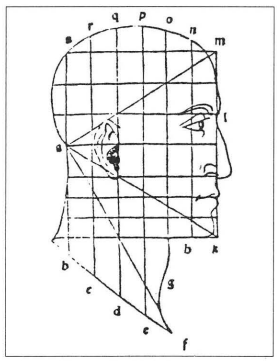
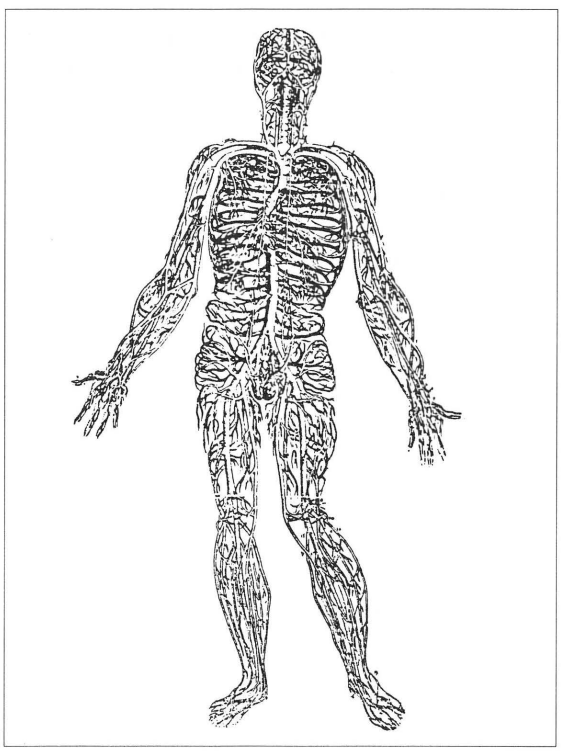


Figure 4 **Diagram from Andreas Vesalius**, *Fabric of the Human Body*, 1543.



2
Struik, Dirk Jan. 1981. *The Land of Stevin and Huygens: a Sketch of Science and Technology in the Dutch Republic during the Golden Century.* Dordrecht, Holland: D. Reidel.

explained. But explaining to the student who already understands is not the challenge of education. What of the student who does not yet understand the abstract principles? Such a student cannot get past the barrier of a visual reference that remains unconnected to the world he sees. This is the barrier that all educators must confront: new information can be perceived and absorbed by the mind of the receiver only when it can be connected with some other information already existing in the receiver's store of experience. The structure or framework must be there before the new information can take its place.

It was Stevin's unique contribution to place his visually abstract, geometric explanations in the context of objects already known to the reader from his everyday experience (*see figures 6.1, 6.2 and 6.3*). The horse pulling a heavy wagon up the hypotenuse of a triangle, two men carrying a rectangle with a visible center of gravity first along a flat surface and then up a hill: these are a few of the many fine illustrations Stevin created to accompany his treatise (*see figures 6.4 and 6.5*).

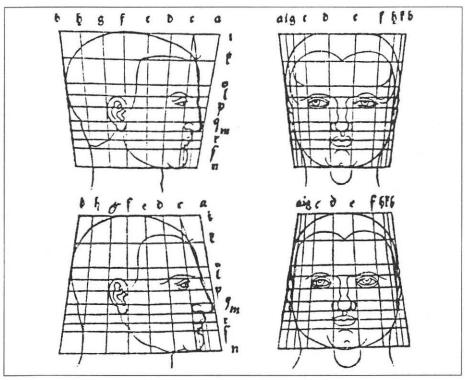
By doing this, Stevin exploits the student's ability to associate thoughts on several different levels at the same time. In this way the author sends pieces of diverse information on several simultaneous levels, mixing realistic and abstract conventions, expecting that the reader will connect the pieces of the puzzle in an appropriate fashion. His technique of overlapping conventions produced information graphics that instructed the engineers and explorers of his time and four hundred years later still fascinate us. In this era of electronic media, when the manipulation of visual elements through technology has become so facile, Stevin's method should be an inspiration. Many of his diagrams beg for animation and the kind of multi-window presentation made possible by today's hypertext and multimedia software applications.

Stevin, a proud practitioner of vernacular language, wrote his books in Dutch rather than Latin. He did this not only to reach his countrymen, many of whom had all but abandoned the Latin of the Spanish court they had rebelled against, but also because he believed his native language was the best one in which to express scientific thought.[2] This movement away from the universal Latin as the means of intellectual expression toward the developing vernacular languages of Europe went hand-in-hand with the other intellectual currents of the Reformation and Counter-Reformation. This attitude toward the importance and value of vernacular is an interesting point of overlap between Stevin, the Dutch engineer, and Comenius, the Moravian minister, who flourished during the next generation. For as much as any other educator, Comenius helped establish vernacular as the language of universal education.

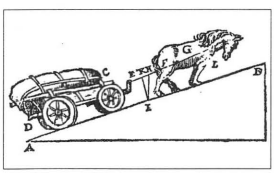
Johann Amos Comenius

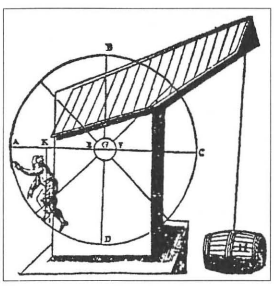
Comenius was a schoolmaster by profession and a minister of the protestant church known as the Unity of Brethren. In the 1620s, hostility between the Bohemian protestants and the Hapsburg catholics

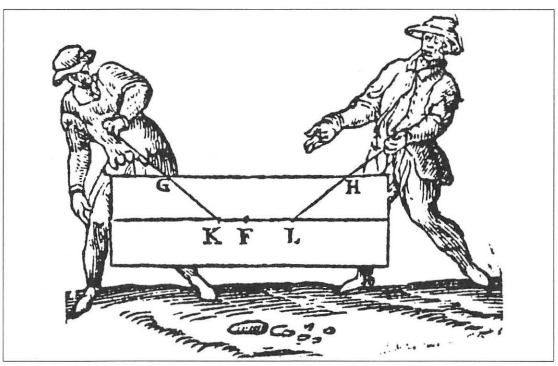
Figure 5 **Diagram from Albrecht Dürer,**
Die vier Bücher von menschlicher Proportion, 1528.

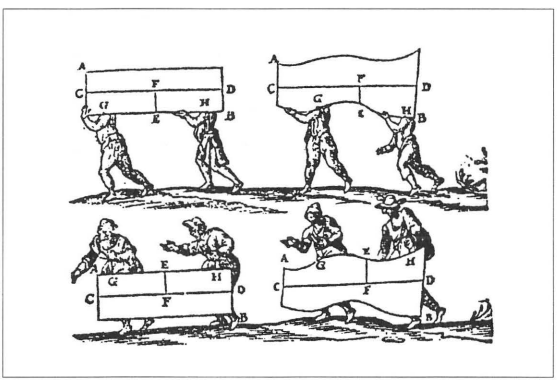


Figures 6.1-6.5 **Diagrams from Simon Stevin's**
***Weeghconst*, 1586,**
reprinted in *Principal Works*, Vol. I.
Amsterdam: C.V. Swets & Zeitlinger, 1955.









3
McArthur, Tom. 1986.
Worlds of Reference: Lexicography, Learning and Language from the Clay Tablet to the Computer.
United Kingdom: Cambridge University Press.

4
Sadler, John Edward. 1966.
J.A. Comenius and the Concept of Universal Education.
London: Allen & Unwin.

forced him to flee with his congregation into Poland. He had already developed a radical educational philosophy, believing in universal education and something close to what we today call child-centered learning. He believed students should learn about the world around them in their own spoken language. However, there were no textbooks that reflected this philosophy. The textbooks of the time relied on abstract word lists and declensions rather than Comenius' methodology of teaching language by associating words with things grouped in categories.

While studying at the university, Comenius had read Francis Bacon's *Novum organum* (1620) in which the English philosopher proposed science as the best way to understand the world. He later adapted Bacon's secular organization of knowledge and joined it with the developing tradition of phrase books, such as William Bathe's *Ianua linguarum* (The Gate of Tongues) which matched Latin with vernacular vocabularies.[3] The result was *Janua linguarum reserata* (The Gate of Tongues Unlocked), a textbook first published in 1631 in Lesno, Poland on the printing press carried there from Bohemia. After the first Czech-Latin edition, the book was quickly translated into every language of the day and reprinted in dozens of editions. A second vocabulary book using a similar methodology, *Orbus pictus* (Picture of the World) was produced in 1653 and aimed at a younger audience.

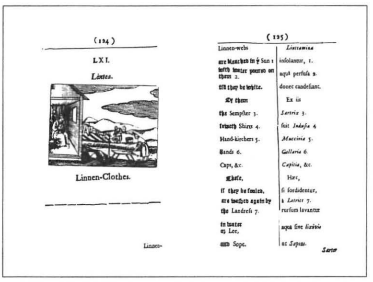
The success of both these books is difficult to exaggerate. Its acceptance as a teaching text throughout Europe in Comenius's own lifetime was nearly universal. It was translated into Turkish and Arabic by missionaries. Harvard College still holds copies of an early English edition inscribed with the names of the first Native American students who used the book to study Latin and English within a decade of its publication. Editions in German, French and English continued to appear well into the late nineteenth century.[4]

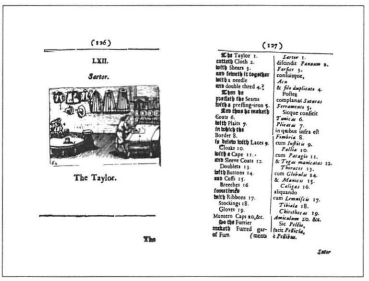
The books were organized along several new principles. First, language was taught in relation to things. Second, things were grouped into "natural" categories. Third, all things were illustrated. The connection between an illustration of a "thing" and the word for it in Latin and the vernacular language was made through number coding (*see figures 7.1 and 7.2*).

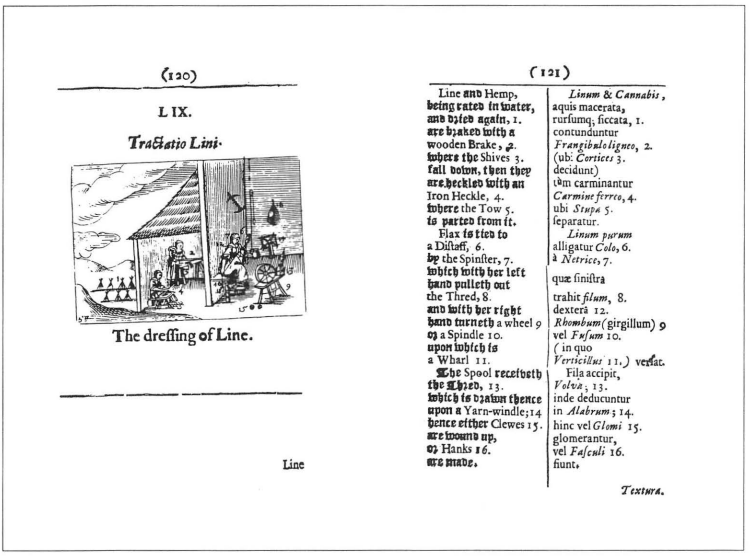
The *Orbus pictus* intended for the youngest pupils introduces words in thematic groups. The student experiences the world as an ordered collection of utilitarian things and the textbook reflects and reinforces this experience while introducing new words to express what the student already knows. Illustration is an important part of this pedagogy. Each plate shows objects grouped according to category or the process in which they participate. "The dressing of line" shows the outdoor drying of beaten hemp along with its indoor preparation. Realistic elements in the illustration have numbers connecting them with appropriate vocabulary in Latin and the vernacular language (*see figure 7.3*). The student experiences the composite illustration and the bilingual text simultaneously as parts of a single message. This is the

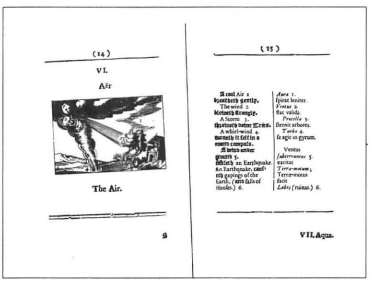
Visible Language
Volume 26, Numbers 3 and 4
Summer / Autumn 1992
Diagrams as Tools for Worldmaking

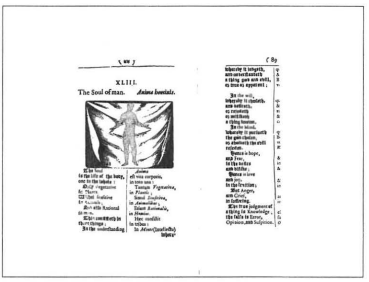
Figures 7.1-7.5 **Spreads from Johann Amos Comenius' *Orbus sensualium pictus,*** translated by Charles Hoole, London, 1659.











same methodology employed today in the many "visual dictionaries" and word books found throughout Europe.

On reflection, the illustrations in Comenius' books only appear to be realistic representations of the world as we see it. In fact they are collections of elements that are carefully and artifically composed. To see the process by which flax becomes line we must see the inside and outside of a building at the same time, so a wall is cut away. The symbol of the wind (a face in a cloud) is combined with a realistic image of a tree being torn from the ground (*see figure 7.4*). Reality is distorted in the service of pedagogy, but enough of the world as we see it remains so that we can recognize the context in which to understand the new information being presented. If I have seen wool spun I can recognize the spinning of flax. I know how much physical strength it takes to rip a tree from the ground, and so I can associate that strength with the symbol for wind. The reader recognizes particular elements in each illustration and can now name them with the help of the text. But the world of the illustration has a minimum of direct correspondence with the world as we see it. The visual manipulation by Comenius – or better his visual editing – eliminates from the display everything that does not correspond to words. We see only the world we can name, even when the subject is the soul represented as a human shape (*see figure 7.5*).

Conclusion

The activity of Stevin and Comenius came at a time of rapid change in the European world. The foundations of Latin education were shaken. Development of vernacular languages and their acceptance for education created a strong demand for printed books, spurring the further development of the printing industry. Protestantism had initiated a movement toward mass education and broken down the intellectual monopoly of the old university system. Geographical discoveries and a new scientific understanding of the natural world helped to develop a new methodology of seeing the world in more realistic terms.

All this demanded change in the methods of visual notation. The contributions of Stevin and Comenius were important steps along this path. Their work, so innovative in their own day, looks obvious and natural to use today. The work of both men continues to be an inspiration to the contemporary designer of information graphics.

Visible Language
Volume 26, Numbers 3 and 4
Summer / Autumn 1992
Diagrams as Tools for Worldmaking

Douglas McArthur
has a Ph.D. in French from the Sorbonne and teaches in the French Department of Manchester University in England.

His research interests are in the range of human expression and the relationship between expression (and particular forms of expression) and epistemology.

Semiology provides a broad perspective for analyzing the range of signs, their differences in form and function, along with the relative efficiency of different signs for different purposes and situations. Some general semiological notions are applied to the printed page.

Acknowledgement:
Extracts from Jeremy Bentham's *Chrestomathia* and Richard Owen's *Palaeontology* are reproduced by courtesy of the Director and Librarian of the John Rylands University Library of Manchester.

University of Manchester,
Department of French Studies,
Oxford Road,
Manchester M13 9PL,
United Kingdom.

Visible Language 26:3/4,
D. McArthur, pp. 282-297,

Rhode Island School of Design,
Providence, Rhode Island.