

# The tube worm turns

Science needs a new breed of Renaissance man and woman.

Roel Snieder

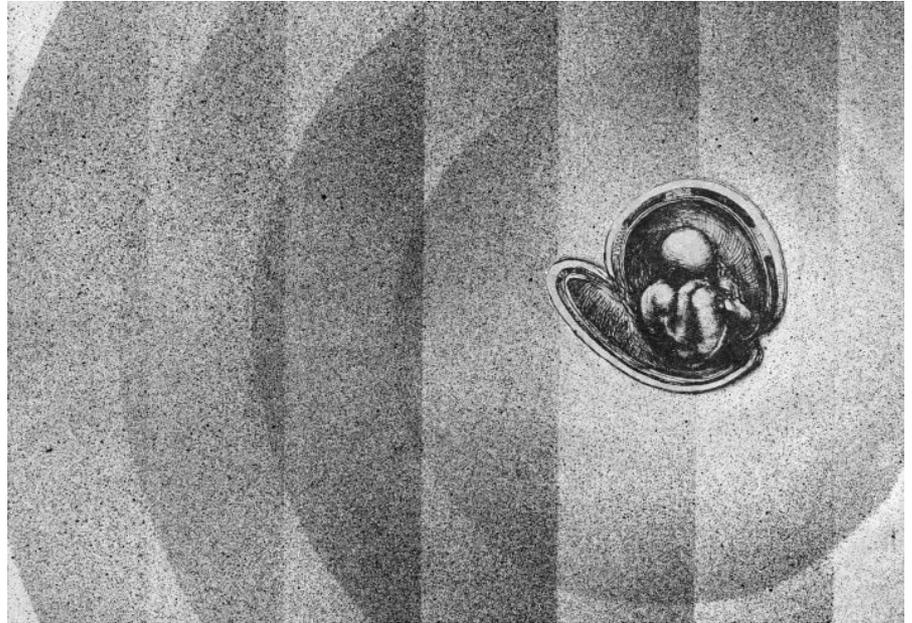
The past millennium has seen a dramatic change in the way scientists operate. During the Renaissance, scientists often had extremely broad interests. Leonardo da Vinci made great progress as a scientist and engineer, but he also was a painter, sculptor and architect. His interest in the anatomy of the human body was to grow into a *cosmografia del minor mondo* (a cosmography of the microcosmos). The phrase captures a connection between the macrocosmos and the biological world that is hard to find today.

In his work *Vetturale della Natura* (Conveyor of Nature), he made important contributions to fluid dynamics. As an engineer, he worked on the design of pumps, flying machines and other devices that formed an interface between his scientific interests and the needs of humankind. Because of his extreme breadth, Leonardo is the prime example of the *Homo universalis*. In the Renaissance, many scientists were also active in the field of religion; they often struggled with the conflict between their science and the religious views of that time. For some of them, such as Giordano Bruno, this struggle had a fatal ending.

Since the middle of the millennium, science has become increasingly specialized. These days, a scientist is a physicist, a biologist, a sociologist or other specialist who focuses primarily on her or his own field of interest. Even though there may be rare examples of scientists with an extremely broad area of expertise, *Homo universalis* has become virtually extinct.

This is not a positive development — specialization creates isolation. The scientific community can be compared to a population of tube worms. These animals live in colonies on the ocean floor at locations where hydrothermal vents release nutrients into the water. The tube worms are highly specialized; they survive only by extracting nutrients from the water at these vents. The worms cannot travel to other vents, which prohibits interbreeding among different colonies. Although they are well adapted to the harsh conditions of life on the ocean floor, they are completely reliant on the stability of their habitat. The specialization of tube worms has made them ill-equipped for new challenges.

But perhaps it is not quite fair to compare the scientific community to a collection of tube-worm colonies. There is now an increasing need to broaden the outlook of



Best of both worlds: Leonardo da Vinci meets modern remote-sensing techniques.

science and scientists once again. This development is spurred partly by the study of very complex systems. An example is the Earth's carbon-dioxide cycle, with its important implications for global climate. This cycle can be understood only by the combined efforts of chemists, biologists, physicists and Earth scientists. Because of the effect of industrial emissions on this cycle, this problem also has political, economic and social aspects. In addition to these complex problems, many fields that were traditionally separate are growing together. Biotechnology, granular media, the prediction of the world's population and optical computing are all areas that cannot thrive without the input of scientists from different disciplines.

In this sense, there seems to be a need to resurrect *Homo universalis*, but in a different form — not with the extreme breadth of a genius such as Leonardo da Vinci, but as a being who can work in an interdisciplinary team; who has the interests and the skills to 'look out of the box'; and who can com-

municate effectively with colleagues from other fields.

Many universities have recognized this trend and, because of present-day students' aversion to hard-core science, have developed broadly orientated programmes with titles such as 'science and society' or 'science and innovation'. But a scientist can make an innovative contribution to high-level interdisciplinary research only when she or he has mastered at least one discipline.

Interdisciplinary research should not be confused with 'no-disciplinary' research; in an interdisciplinary team, the contribution of each team member must be rooted in a professional knowledge of one research area. The failure of universities to acknowledge this obvious fact in the development of interdisciplinary teaching programmes leads to a watered-down version of a traditional scientific education. This is unfortunate because there is a real need for scientists with the skills and interests to interact with those from other fields.

Our challenge is to transform the scientific community from a collection of tube worms into an interacting web, resembling a diverse and rapidly evolving ecosystem where each member brings its own specialization to the party. This requires the resurrection of *Homo universalis* in a form appropriate for the twenty-first century. ■

Roel Snieder is in the Department of Geophysics and Center for Wave Phenomena, Colorado School of Mines, Golden, Colorado 80401, USA.

**H**omo universalis  
needs to be  
resurrected as a being  
who can work in an  
interdisciplinary team.

JAN WILLEM SNIEDER