HUNGARIAN STUDIES

2005

Volume 19
Number 2

CONTENTS

HUNGARIAN STUDIES VOL. 19 No. 2 2005

HUNGARIAN STUDIES

a Journal of the International Association for Hungarian Studies (Nemzetközi Magyarságtudományi Társaság)

The journal intends to fill a long-felt need in the coverage of Hungarian studies by offering an independent, international forum for original papers of high scholarly standards within all disciplines of the humanities and social sciences (literary history, philology, ethnology, folklore, musicology, art history, philosophy, history, sociology, etc.) pertaining to any aspects of the Hungarian past or present.

Hungarian Studies is indexed/abstracted in America: History and Life, Historical Abstracts, International Bibliographies IBZ and IBR

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Hungarian Studies is published by
AKADÉMIAI KIADÓ
H-1117 Budapest, Prielle Kornélia u. 19.
www.akademiai.com

Order should be addressed to AKADÉMIAI KIADÓ,
H-1519 Budapest, P.O. Box 245, Fax: (36-1) 464-8221, E-mail: journals@akkrt.hu

Subscription price for Volume 19 (2005) in 2 issues EUR 158 + VAT, including online access and normal postage; airmail delivery EUR 20.

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SCIENCE AND CONSCIENCE

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Science is central to the cultural heritage of humankind. It is a meritocritous, fact-based activity in which the quality and value of scientific investigations are alone important. In mediaeval Latin the word used for *knowledge* was *scientia.* The English word *science* came from this word. During the Middle Ages any well-educated person could have almost all available knowledge. For example, Copernicus (1473–1543) mastered all of the scientific knowledge of his time – law, mathematics, and medicine, as well as his favourite discipline, astronomy. Since then science has won the recognition and respect of many societies. In the twentieth century the rate of scientific progress has surpassed that of any other time in history and has grown exponentially. Science has changed our lives; it has changed the world. It has become very specialized: modern scientific disciplines include specialty knowledge possessed only by experts. Science has also become aristocratic: while there are more scientists than ever before, more and more scientific knowledge is incomprehensible to non-specialists and to the public.

Intellectuals generally agree that science and technology are necessary for the functioning of modern society. As a consequence, the European Union is trying to build a "knowledge-based" society in which scientific developments are strongly encouraged. Europe must do this if she wants to keep pace with the United States and Japan. However, the public, cynical of these pursuits, frequently questions spending even limited resources on seemingly obscure basic science. The public would prefer to use established technologies to help people who are suffering now, rather than investing in uncertain new science for the future. Why, people ask, should we invest in research on space, when its benefits, if any, will not be immediately available? Why should we explore the human genome? Misunderstanding the role of science in technological development provokes these questions. Many people do not understand that "Science is exploratory – it must venture beyond current knowledge" (Sharp, *The New York Times,* 1993) while it contributes only incrementally to our present understanding. Taxpayers often do not notice that our everyday lives are overwhelmingly dominated by techniques and instru-

Hungarian Studies 19/2 (2005)
0236-6568/2003/$20.00 *© 2005 Akadémiai Kiadó, Budapest*

ments discovered and developed by scientists, e.g., electricity, radio, telephone, synthetic materials, fax, television, computers, jet planes, satellites, antibiotics, just to name a few. Perhaps if it were made clear how our lifestyles today depend on the scientific advances of yesterday, there would be less opposition to investment in basic science today for the societies of tomorrow.

For example, two generations ago the number one cause of death was infection. In 1928, the discovery of penicillin led to the development of antibiotics. Today this treatment is so effective that bacterial infection is no longer a top killer. However, people do not always appreciate how science has in this way improved the human condition. They do not give science credit for preventing deaths due to bacterial infections only because they fail to realize that things had ever been different; they are not aware of how often previously healthy children of yesteryear died suddenly and tragically from the same bacterial infections that modern science has eliminated as a cause of death. In this way and others science and technology have increasingly become integral parts of our everyday lives. They make life easier for virtually everyone. They allow us to feel that the world is small, permit us to travel 10,000 kilometers in a day, or make it possible to send messages within milliseconds. Almost 2500 years ago it took several hours for a long-distance runner to carry the news of the victory of the Greeks over the Persians from Marathon to Athens. The distance was forty-two kilometers. The new world created by science has established closer links between global events. Because of technology the world has shrunk. Television has made us the best-informed society ever, even though the possible threats to cultural diversity that it has created might be cause for concern.

Despite the many positive effects of science and technology, we should not forget that the products of science are not always so bright and shiny. Science deserves not only credit for the good, but also some blame for the bad. The partial disappearance of the ozone layer, pollution, erosion of biodiversity, toxic and nuclear wastes, the bombing of Hiroshima, Contergan babies, water pollution with pesticides, the catastrophe at Chernobyl, as well as other unfortunate developments, have also, in one way or another, been products of science. I have not even mentioned the role of science in spiritual pollution, and in the increasing gap between rich and poor nations, between rich and poor people. Considering these facts, some questioning of the role of science in modern society might be justified. The public is entitled to voice their feelings of futility and frustration. It is only logical that the public should want to know more about the possible outcomes of the work of scientists, particularly the results of work done at taxpayers' expense. A serious attack on science has come from Vaclav Havel, president of the Czech Republic. *"Traditional science, with its usual coolness, can describe the different ways in which we might destroy ourselves, but it cannot offer us truly effective and practical instructions on how to avert them..."* (*The New York Times,* 1992). Even

a United States Congressman, George E. Brown, has echoed Havel's opinion that science deserves some of the blame for the dangers that threaten civilization (Hilts, *The New York Times,* 1993).

Despite these objections, we should not forget that many of the negative effects of science have been politically motivated. The building of the atomic bomb was essentially technology, or applied science, a gigantic engineering feat based on scientific principles. Also, the decision to build the hydrogen bomb was political, not scientific. American politicians were led to ask physicists to develop weapons of mass destruction by the war against Hitler. Leo Szilárd, a Hungarian refugee, was the first to raise his voice against the atomic bomb. Physicists have been instrumental in providing bridges between the two great powers of the cold war. The success of the Pugwash Meetings initiated in the 1950s was very important in keeping the world at peace. Robert Oppenheimer was right in saying: *"The scientist is not responsible for the laws of nature, but it is the scientist's job to find out how these laws operate. However, it is not the scientist's responsibility to determine whether a hydrogen bomb should be used."* Therefore, the contributions of science to the world need no apology. On the contrary, discoveries made by scientists about the nature of the universe in which we live are among civilization's greatest achievements. Exploring how our brain works and decoding the human genome are some of the most noble and ambitious endeavors of humankind.

The field of genetics has made the public especially interested in learning about the activities of laboratory science. Apprehension and fear of irreversibly altering nature, of creating a monster or a superman through genetic engineering, are increasingly on people's minds. No doubt, these possibilities are no longer merely in the realm of science fiction. A "made-to-order" human being might soon not be just a fantasy, but a reality. If the DNA of now extinct human species, like Homo Erectus or Habilis, could be copied or reproduced, analogous to the events depicted in Spielberg's film "Jurassic Park" for dinosaurs, new individuals with the genetic make-ups of otherwise extinct lines could be created. The public fears that genetics experiments will pave the way to Huxley's *Brave New World,* a world in which natural selection is replaced by planned, technologically assisted human breeding. These fears should persuade society and the public to monitor and control genetics experiments. As a consequence, there is no doubt that we need guidelines to direct scientific investigations. In addition, scientists should be encouraged to obey their consciences as well as to follow the official rules. We must not allow the emergence of another Adolf Hitler, a man who advocates his own version of eugenics, used without limitation, with the intention of creating an "Übermensch." To prevent such a disaster, stringent restrictions on eugenics have been enforced in most European countries, including Hungary.

The Ethical Issues of Science

If we accept that during the next century, more than ever before, the world will be shaped by science, if we believe that science and technology have become integral parts of our daily lives, if we think that science has an enormous social value, if we know that science and its opportunities are able to change the world for the better, and if we know, and we do know, that science and its products are also capable of shaping the world for the worse, then scientists must acknowledge the need for ethical guidelines directing their activities. However, many scientists have had no formal training in the ethics that should guide them in the handling of sensitive scientific and ethical topics. Academic research into the ethics of science is crucial for securing a bright future. It is equally important to emphasize the weighty ethical responsibilities of scientists to the very scientists involved in research. Scientists have long said that they uphold special standards of honesty and integrity. Nevertheless, this claim has been undermined in recent years by one celebrated misconduct case after the other (e.g., the Baltimore case; the charge against Dr. Gallo, co-discoverer of the H.I.V. virus). We also know that falsifying data or stealing the work of others is not as rare as some might hope (Hilts, *The New York Times,* 1993). These are serious ethical problems that can often discredit the activity of scientists and underline the need for formal ethical training.

There remains the question of what type of ethical training to provide for scientists. One possibility would be to teach the prescriptions of the Bible, a book that our Judeo-Christian culture generally accepts as a guide to ethical practice. The guide focuses on the relationship of people to one another and to the world in which they live. However, many of the ethical problems in science are outside of the scope of situations described in the Bible. Therefore, additional resources must be created that discuss what is ethical in extra-biblical situations. First of all, the activity of scientists should protect and promote the interests of humankind and ensure the dominance of good over evil. Of primary importance is precisely what nobody had believed before August 6, 1945 when the atomic bomb, a product of science, destroyed Hiroshima: humankind has the ability to destroy itself. Scientists need to learn that their activities might have consequences that are not always good for humankind. The atomic bomb dropped on Hiroshima taught us that issues of science are also issues of conscience.

Scientists of today and of tomorrow must have the freedom to study what they want; and they must have the right to publish what they have discovered and what they believe to be true. But they also must be obliged to do science in the interests of humankind and its environment, thus ensuring the dominance of good over evil. The responsibility of the scientist is increasingly important in this era of vastly improved communication and greater public scientific awareness and interest.

The public's ambivalence and occasional hostility to science might spring in part from the impression that science is opposed to religion or ethics. Saint Thomas Aquinas, a student of Albertus Magnus, was the first to attempt to reconcile faith with reason. He knew that the world was real, and that it demanded understanding. The thirteenth century in which he lived was an age of prosperity and technological progress, when a primitive agricultural economy was changing into a mercantile, urban society. Martin Luther, the founder of Protestantism, was also successful in paving a path between God and man, between faith and reason. Just as the great European thinkers of the Middle Ages gave the world the methods of science, today scientists have the duty of educating people in understanding the secrets of life. If scientists fail at this task, humankind will not feel safe, and many of those standing at the crossroads between faith and reason, lacking the support of knowledge, will go in the direction of faith and the anti-science feeling of the public will be further increased. Scientists of today should continue paving the road between faith and reason: they should make the "miracles" of the world more understandable. They must share their secrets with society if they expect society to continue supporting them.

What would people, who are skeptical about science, who make a hotchpotch between science and the misuse of science, have said to Michael Faraday? He was asked by his society to improve lighthouses, but it was his individual curiosity that drove his fundamental research into electricity. These skeptical people should be asked to imagine a world without electricity or antibiotics. Furthermore, in the history of science there are bitter examples of what happens to a society that does not support basic science. *Jean-Pierre Charles Revol* (CERN, Switzerland) mentioned, for instance, that the Arabian culture of pre-medieval times brought to Europe vast knowledge in such fields as medicine, mathematics, and astronomy, but for various reasons its spirit of inquiry died and consequently modern Arab society has become greatly impoverished.

Summary

We are now entering into the third millenium. If we can convince the scientific community that knowledge requires moral responsibility, then we will be better able to convince the public of the value of science. If parliaments and lawmakers terminate the improper use of scientific discoveries, then the light of the natural intellect will not be seen as an intruder into the realm of a mystical communion between God and man, between faith and reason. Only if interventions are made will we have the right to expect the world to be more understanding, more tolerant of science, of knowledge, and of one another.

T. S. Eliot, the famous English-American poet, was right in asking:

> "Where is the life we have lost in living,
> Where is the wisdom we have lost in knowledge,
> Where is the knowledge we have lost in information?"
> (T. S. Eliot, *Choruses from The Rock*)

The proper answer is that we have to live our lives with human dignity in the next century, in the era of telecommunication, nanotechnology, and biotechnology, and we have to put our knowledge into practice with wisdom. Therefore, ethics will be more important in the next century than ever before.

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