COMMUNICATION TECHNOLOGIES OF SCIENCE
-
A CHANGE OF SCIENCE-COGNITION

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ABSTRACT
Printed press, printed graphs, photography, film, television and Internet. In my work I try to emphasize these factors as the milestones of communication technology in the context of science popularization. If we look at the technological approach in its development, we find that there is a notable tendency towards a kind of realistic representation in a widening sphere of the public. On the other hand, there is an important change in science cognition within the same social sphere. With the help of the mentioned factors I try to find connecting points and describe the interaction of the two (practical and philosophical) dimensions.

Foreword

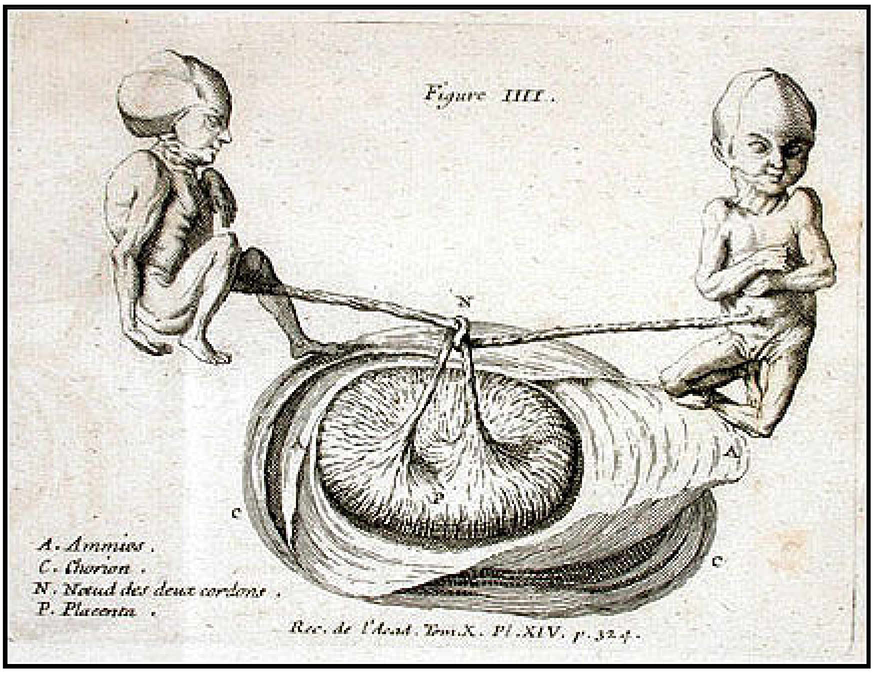
In my study I would like to show how the developing technologies of science communication have changed from the late 17th century until our days. How this process brought the publicity of science towards an increasingly realistic appearance, and what kind of public attitude followed from this shift. Beginning with the emergence of communication technology marked by the invention of the printing press (first printed scientific journals in the 17th century) through the development of photography (and motion pictures) in the 19-20th century until the age of multi-disciplinary communication (Internet and the 21st century), I will try to illustrate the milestones of this movement.
I think it is possible to find a deeper interaction between the increasingly realistic (and objective) representation of sciences through communication techniques, and the public perception (and, as a consequence, the image) of science. I would like to present an aspect where both the technical and the philosophical sides come to view with the same weight. In the philosophical dimension of this train of thought, I aim to depart from the original role of "pure science", where individual functions were the determining elements, and arrive at the network oriented and industry driven "applied form of science".

First steps towards science visualization

Shapin (1985) and McClellan (1999) suggest the 17th Century Science Revolution as the starting point of our research. In the age of the early modern Europe several enlightened philosophical aspects rose to view. *Francis Bacon*'s ideas about scientific knowledge as a kind of useful knowledge, *René Descartes*' practical philosophy about beneficial science, or *Robert Boyle*'s experimental philosophy are the most relevant representatives of that period from our point of view. As a result of these early modern thoughts, we can observe how scientific knowledge could play an increasingly important role in society, and how it started to behave as an objective background or as a social good.
In our context two important factors emerged and brought science closer to society as indirect consequences of this process. One of them was the appearance of scientific journals, the scientific product of the newly founded National Academies. The other remarkable factor was

the spread of experimental methods among scientists. But let us give these components a closer analysis within their social context.

According to Gross, Harmon and Reidy (2002), it is possible to differentiate the specific scientific articles in the 17th century. In the journal of the French Academy of Sciences (*Journal des Scavans*) all the articles were written by professors and scientists, that is, members of the scientific community. In France, the royal budget was the financial organ of scientific life (and of arts), and so aristocrats were the only favored participants of that cultural movement. This was the only circle able to write and also to read the first scientific forums and news in those papers (although reading/writing skills were typical in just a fairly low percent of society). On the other hand, the content of articles in *Philosophical Transactions* (printed and edited by the Royal Society of London) was understandable for a much wider public sphere. In England, the Royal Society was financially supported mostly by the members of a much more extensive community. These fellows were not only the aristocrats, but also more "casual" people such as travelers and other non-scientist lay people. So the writers of these regularly printed papers composed much more easily understandable texts, and these journals were able to spread in a wider sphere.



Picture 1 – Drawing by the Academie Royale, 1693

Gross and others note that the content of both types of papers were related to the natural sciences, especially mathematics, physics, medicine and geography. Visual illustrations were also an important part of all types of newly emerging and constantly developing papers. Especially in the fields of anatomy, geography and biology, the improving printing technological possibilities made these pictures a regular part of these issues (as an appendix at the end of the editions). The drawings (see picture 1.) were usually valued quality works, made by skillful artists. These content-parts demonstrate that the main elements of natural science researches (and published articles) were to go on the empirical observation of nature.

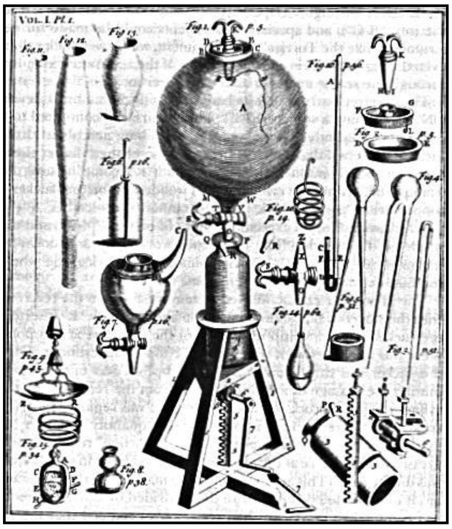
As we mentioned earlier, another remarkable factor started to play an even more important role in scientific visualization: the life of experimental methods. As we can read it by several scholars[1], by the end of 17th century natural sciences turned to the observational way of cognition. It is enough just to think on *Galileo*'s mechanical experiments with balls, on *Torricelli*'s air-pressure measures with mercury-pipes, on *Newton*'s practical lenses and

[1] See Shapin, 1985.

prisms for ray-observation, or on *Boyle*'s experiments to observe the characteristics of air and other gases. According to Shapin and Schaffer's (1985) work, it is interesting to come a bit closer to this factor. In the mid 1600s Sir Robert Boyle (an aristocrat member of the British Royal Society) prepared a huge glass sphere. With the help of his assistant Robert Hooke, they set up experiments in this sphere, which was the best instrument for visual illustration. It was possible to generate a space of vacuum inside of it, and to observe how different materials behaved in there. Boyle believed that his experiment was certified if the participants (as the witnesses) believed what they saw, so they could confirm his newly adopted scientific conception.

Here, a new genre of science communication was born. Trust, as a significant factor of the result of this process was created among the witnesses of the experiments. Since people can believe in science they see, they will have also trust in that science. Sir Boyle believed that knowledge was created among the participants, but many of his contemporary scholars (Hobbes for instance) argued this idea. Although these arguments have their own weight and truth too, the role of visualization is outstanding in trust-creation among lay people even today.

As a conclusion of the introduced elements in early modern Europe, we can state that the social role of scientists was settled and changed for the better, and they became determining and credible participants of society, responsible for seeking objective truth.



Picture 2 – Boyle's Air Pump, 1660

Image of science

Thanks to the new forms of communication, science started to determine its self concept in a wider social sphere. The improving number of scientific journals allowed for the spread of scientific knowledge and for information flow on two levels. Interactivity was the first to emerge following the appearance of the issues, at first only among scientists, but gradually involving lay-people as well. A significant advantage was that the printed issues meant a kind of new platform for reflections on different conceptions and opinions, since arguments and forums of opinion-exchange were usually part of the early editions too.

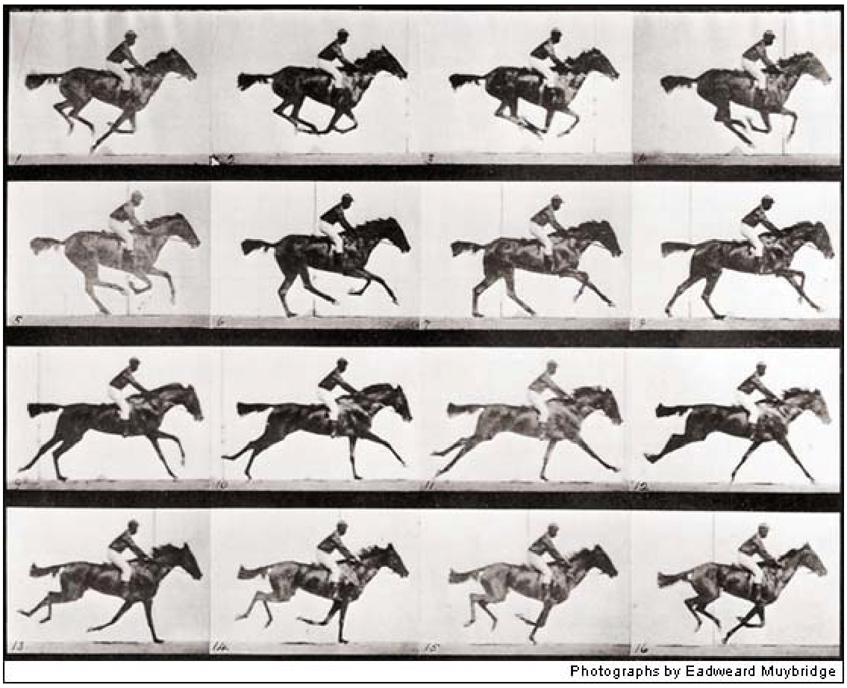
Only several decades later, in the 18th century did the role of universities become strong enough to represent objective scientific knowledge in higher education. Universities and academies meant the theoretical background for scientific life in Western European societies, questing for truth and for objective and pure knowledge. This basic element of objectivity had a fundamental emphasis the later on, in connection with technological inventions.

Hanson (2004) argues that it is possible to represent objectivity if science finds the ways of its own realism, and if it can present itself in its own surroundings. It is an instructive method to compare the forms of realism in science to those in art. In both cases (science and art), we can observe three different frames of realism[2]: the narrative, the auditory and the pictorial. We can find examples for the narrative dimension in written communication in the early editions of Philosophical Transactions, in articles which tried to describe experiments and their

[2] Three different aspects to interpret the category of reality. Hanson 4:1

surroundings as precisely as possible. Auditory realism is also traceable in the early ages, if we just think on the case of experimental witnesses in the laboratories. Here the public audience was convinced of the reality and truth of the laboratory proof because it happened directly in front of them. In the following section of my work, I focus on the third type, the role of pictorial realism.

Realistic Power of Photographs
As in the other cases, pictorial confirmation of scientific facts was also part of the first forms of (written) scientific communication. Copying nature as precisely as possible was one of the main principles of the artist in showing the spectator the surroundings (the discovered and formerly unknown animal or plant species for instance). Drawn pictures helped to achieve the ideal case of a better understanding of scientific achievements in these issues. The convincing effect depended mostly on the drawing skills of the artist.
Technological development brought the audience closer to this (more realistic) direction of cognition. With the help of *Louis Daguerre*[3]'s invention it became possible to fix a still image on a light sensitive material, and reproduce this picture into any number of new copies. This invention created new dimensions in the surrounding imagery and representation. Anyone became able to create for themselves a representation of nature, since the process did not require any further and deeper technical skills.
It became even more popular and general among the public: by the end of the 1840s, almost 100.000 Parisians had their own photographic picture at home. The quick spread of this new representation method helped the public to believe in the convincing power of photographs. Within years, it was an accepted attitude to believe in the truth (reality) content of photographic pictures without doubt. "What we see on these pictures we believe in, since they copy nature" – was the motivating idea. This kind of cognition can be strikingly contrasted with the perception of drawings, where the picture itself stays always a kind of subjective representation, depending on the abilities of the author.



Picture 3 – Photos by Eadweard Muybridge, 1878

Only decades later, with the help of the improving printing techniques did it become possible to reprint these pictures in better quality in papers. In scientific issues, photos were (and still are) an important part because of their realistic and objective mode of representation.

[3] Daguerre, the French painter invented this chemical process in 1837.

There were usually scientific purposes behind taking pictures of nature. *Eadweard Muybridge*, the American photographer used 24 high-speed cameras to take a serial photograph of horses in motion. His immediate concern was to settle the old controversy whether or not a galloping horse ever has all its feet off the ground at the same time. However, the series also showed that the traditional "flying gallop" position, in which both forelegs extend forwards and both hind legs backwards, never takes place[4].

Muybridge's very idea to make 15 or more pictures per one second inspirited the technical inventors: if they project these still images quick enough (at the same pace as they were taken), motion is reproduced inside of us. Again a technological invention[5] helped us to achieve motion (introduce the time factor) in realistic world representation. With this technical possibility several years later, in 1895, a new medium for art and entertainment was born. Here, I will not analyze the effects of films on sciences in more detail, instead, I shall just mention the two most important directions which were noticeable in the very first movies by the end of the 1800s. This new genre, the world of movies was on one hand able to create a realistic representation (as a documentary) of our world[6], but on the other hand it could also create a new and fictional world[7]. From our point of view, science communication could become more efficient through the first form of the presented directions. By the realistic illustration of scientific experiments on films, the life and world of the formerly less known scientists and scholars could come closer to the audience.

Changing times – changing role and image of science

With the (communication) technologies of the 20th century developing at an accelerating pace, people (as the consumers of these inventions) had to get accustomed to the all-dimensional information procession. It was the frozen still-copies (photographs) of the surroundings that caused the first breakthrough in the imagery of ambient nature, and only several decades later did the time factor expand this hardly familiar new dimension. The social sphere had to get used to the flow of accumulated information through the audio-channels in the 1920s[8], following the first radio broadcast, and through audio-visual channels of televison broadcasting in the 1950s. What kinds of changes has this holistic information transmitter world caused within the context of science cognition?
According to Fehér's and Enyedi's (1997) works, we have to emphasize a kind of concept-changing in the original roles of science. The former norms of science have been altered, and instead of the objective goals of observing nature, science adopted a more market oriented form with economical goals, where the applied side of science came to the fore. A new model of knowledge production has been born in connection with application and utilization (1), with a kind of transdisciplinary (2) and heterogenic (3) character. All these three factors are in tight connection with the new communication dimensions. If we think of the first one, we find the possibility of continuous dialogue between researchers and the applying levels (towards the utilization of science in economics, governance and society). In the other two dimensions, communication technology has to solve the problem of an inter-scientist dialogue: among different research fields in case 2, and between scientists towards a successful teamwork in case 3.

[4] See Hanson, 5:7
[5] Development of the stroboscope in 1832.
[6] See the first works by the Lumiére Brothers.
[7] George Meliés was the author the first fictional movies in the same period.
[8] History of Radio (http://history.sandiego.edu/gen/recording/radio.html)

Ziman (2000) draws our attention to "post-academic" science resulting from these new factors. Can we talk about the Mertonian norms of science in a context where scientific researches lost their own goals, and availability alone determines the long-term aims? Ziman talks about the danger that rationality in sciences faces where the role of national academies decreases. These institutions are not significant in the governance of science-politics and research-development processes any more. If these processes involving short-term economical goals will not change, belief and trust in science will also be endangered.

ENCOMPASS – A study case

Finally I would like to present a study case with a positive science communication outcome. Analyzing this production, we can see how the Hungarian Academy of Sciences made definite steps towards recruiting the image of science, primarily on national (but with a strengthening tendency also on international) level, employing multi-dimensional communication forms.

ENCOMPASS (ENCyclopedic knOwledge Made a Popular ASSet) – Mindentudás Egyeteme (or in loan translation *University of All-Knowledge*) was founded by the Hungarian Academy of Sciences and a private company (Magyar Telekom) in 2002, with the goal of reviving Hungary's high standards of scientific education and raising the profile of leading national scientists. "The University operates through a combination of online components and collaboration with television and radio networks, as well as newspapers. ENCOMPASS incorporates the long and respected heritage of international and Hungarian public science, while diverting from traditional forms of teaching and learning",[9] the organizers outline the original aims of the production.

Picture 4 – Logo of the production

György Fábri (2005), one of the original idea-holders and the academic director of the programme explicates the reasons of the production's great public success. One of the most important elements of this success is the exploitation of the widespread communication factors. Analyzing Hungarian science popularization habits, we find a large-scale suppression in different dimensions of the media in everyday information-dispersion. High quality science-publicity magazines are uncharacteristic parts of the commercial television channels, since they do not meet the criteria of "marketable products". If the statement made by these channels is valid and established deeply enough, what do we owe the great public success to? Or, after all, it is possible to manage sciences as a media-able content of knowledge?

In our case we can divide the success-agents in two main angles. On one hand we can find a total-comprehensive media attendance. The production always has a live presentation (1) in an auditorium with several hundreds of attending audience every week. These presentations are edited (and complemented with spectacular visual elements) for broadcast TV series (2). Three Hungarian television channels took on broadcasting[10] with new tales every week. These presentations are selected and sorted out into book series (3) regularly published in hard cover. Finally, we have to mention the presence in increasingly significant electronic press: the homepage (4a) and the interactive DVD (4b) of the "knowledge-product". The daily press issues (5) also add to the wide range of the scientific knowledge transfer. According to the

[9] See the homepage of the series at http://www.mindentudas.hu/en/20050524mindentudas.html .

[10] Although none of them were commercial channels: mtv, m2 and DunaTV are financed by the governmental budget.

former statistical surveys, almost one half of the whole Hungarian population (~5.000.000 citizens) receives information from one of the mentioned six channels. These dimensions determine the other angle: knowledge can be defined as a marketable media-product. With the help of the media-channels, canonical science turns into a useful product without tighter restrictions.

As a conclusion of this case, we can reveal the importance of public attendance in the context of acceptance of scientific realism. According to several surveys among the audience of Encompass, we can feel a kind of appreciation and positive attitude that is expressed in a positive science image. (A significant percentage of the respondents asserted that Hungary is the most rapidly developing country of the region.) In this case the Internet also became an accepted source channel of a credible information flow.

Concluding thoughts

With the demonstrated precedents I tried to emphasize that technical inventions of communication processes play a determining role in the public conformation of science cognition. We could see how these techniques made the actors of scientific life socially accepted and helped the scientific sphere to find its self-concept in the early modern times. Later on, during the 19-20th centuries, the changing public perception of science (from the concept of "pure science" towards "applied science") was also in close relation with technical inventions: the latest communication solutions helped realistic conceptions to be materialized. Although these changing processes (both technical and philosophical approaches) led to our ages, where science is increasingly losing its objectivity, and also deviating from further Mertonian norms[11], I think that communication technologies, if used well, are able to restore the image of science. All the possibilities are technically given, only the effectiveness of utilization is still not solved and used well enough. In the world of media there are several positive cases (programs and magazines[12]) towards this direction, but science is still a rather strange and "bypass" topic in the casual channels, where two-way interactive information flow is hardly enabled. I believe good tendencies will determine future trends towards scientific approach as a natural part of our daily life. Since (scientific) knowledge is a long-term good of society, it leads to a misunderstood perception if we focus on the direct and immediate consequences.

[11] As Ziman emphasizes.
[12] See the programs of the increasing number of thematic television channels.

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